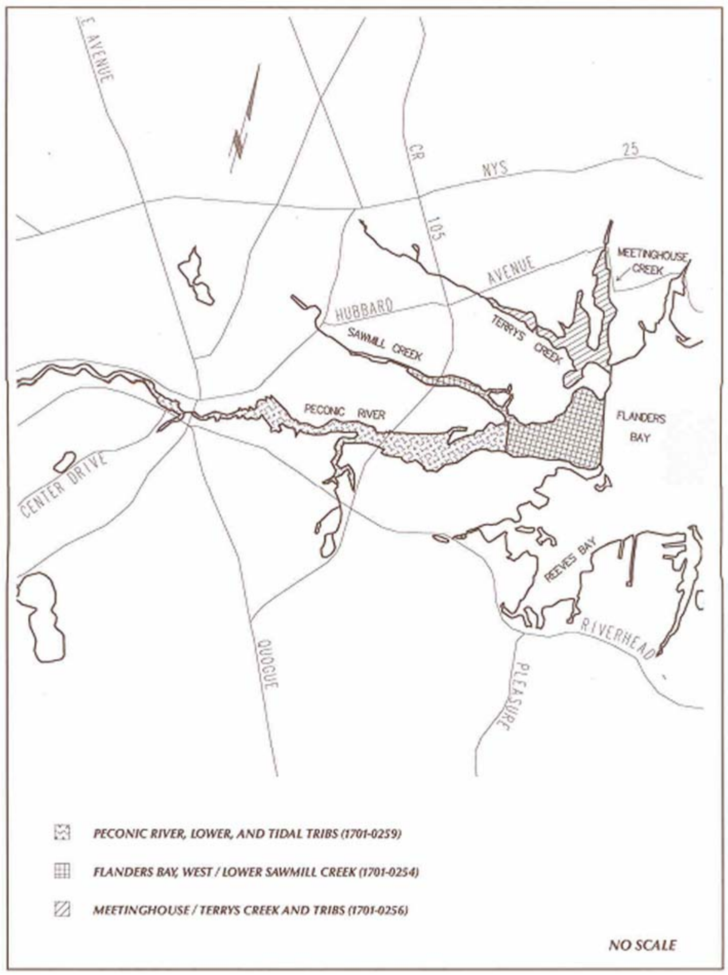
Total Maximum Daily Load for Nitrogen in the Peconic Estuary Program Study Area, Including Waterbodies Currently Impaired Due to Low Dissolved Oxygen: the Lower Peconic River and Tidal Tributaries; Western Flanders Bay and Lower Sawmill Creek; and Meetinghouse Creek, Terrys Creek and Tributaries

September 2007



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September 2007

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The Peconic Estuary Program (PEP) is a partnership of governments, environmental groups, businesses, industries, academic institutions, and citizens. The PEP's mission is to protect and restore the Peconic Estuary system. Learn more at www.peconicestuary.org.

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Total Maximum Daily Load for Nitrogen in the Peconic Estuary Program Study Area, Including Waterbodies Currently Impaired Due to Low Dissolved Oxygen: the Lower Peconic River and Tidal Tributaries; Western Flanders Bay and Lower Sawmill Creek; and Meetinghouse Creek, Terrys Creek and Tributaries

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Executive Summary

Pursuant to Section 303(d) of the Federal Clean Water Act (CWA), this document contains nitrogen discharge loads for three sewage treatment plants (STPs), one other wastewater treatment plant, and for municipal stormwater facilities in the Peconic Estuary System. These loads will form the basis for regulatory permit requirements. It also contains target loads for other sources of nitrogen to the Estuary, including atmospheric deposition, groundwater, and tributaries.

The CWA creates a process where States establish meaningful uses and appropriate standards for waterbodies. States must also periodically assess waters to see if these standards and uses are being attained. If standards are not being met, States must determine what must be done to achieve standards. This includes considering pollution from point sources discharges (such as outfall pipes) and pollution sources that are diffuse (termed “nonpoint sources”). The combined pollutant load from both the point and nonpoint sources cannot exceed that amount required to achieve or maintain water quality standards. This combined pollutant load (called a Total Maximum Daily Load or TMDL) needs to also include a margin of safety to account for uncertainties, and consider seasonal variation, future development and growth.

Estuaries are areas where fresh water from the land and salt water from the oceans mix. They are among the most important ecosystems on the earth, serving as important nursery and spawning areas for finfish and shellfish. These coastal areas are also highly valued by humans. The Peconic Estuary System of eastern Suffolk County, NY has been designated an “Estuary of National Significance” under the Clean Water Act. In order to address both problems and threats facing the Peconic Estuary and its watershed, a Comprehensive Conservation and Management Plan has been prepared.

Like many other estuaries, nutrient over-enrichment (in the form of excess nitrogen loadings) is a priority management topic for the Peconic Estuary. Nitrogen comes from many sources, both natural and as a result of human activities. Sources include wet and dry atmospheric deposition, sewage treatment plants, stormwater runoff, and groundwater that becomes enriched as a result of excess fertilizer being applied to lawns, landscaping, and agricultural crops, as well from on-site waste water disposal systems (“septic systems”).

While nitrogen is an important nutrient for a healthy ecosystem, excess nitrogen can lead to problems. Too much nitrogen can cause too much algae to grow. When algae blooms and then dies, the decomposition process consumes oxygen. Aquatic plants, including algae, also use oxygen at night through respiration. The combined effect of plant decomposition and respiration can cause dissolved oxygen to drop to low levels, especially in the early morning hours and during the warm weather months. Aquatic animals need dissolved oxygen to live. When conditions become stressful due to low dissolved oxygen levels, some organisms may suffocate and die, while others may flee the area.

Based upon data that has been submitted by the Suffolk County Department of Health Services (SCDHS), the New York State Department of Environmental Conservation has determined that three waterbodies of the Peconic Estuary System are not meeting dissolved oxygen standards. They are: the Lower Peconic River and Tidal Tributaries; Western Flanders Bay and Lower Sawmill Creek; and Meetinghouse Creek, Terrys Creek and Tributaries. It is important to note that in order to achieve dissolved oxygen standards in these waters both now and in the future, it is necessary to look at the nitrogen contributions

from not only their contributing watersheds, but nitrogen loads from the entire Peconic Estuary Watershed.

A sophisticated water quality model has been developed through the efforts of the Peconic Estuary Program which can accurately predict water quality conditions based on current conditions and nitrogen loadings as well as changes that can be expected as nitrogen loadings change in the future. An important consideration was the nonpoint source load from various land uses. Loads from any individual land parcel can be estimated to increase, decrease or stay the same, depending on land preservation efforts or residential or commercial development, as well as the effectiveness of implementing applicable management practices such as at agricultural operations, existing development, and new development. Factored into this analysis is the nationwide and local implementation of controls under Clean Air Act laws, which are projected to have an important positive impact on water quality. Limitations on point source discharges (including sewage treatment plants and regulated stormwater areas) are important locally in improving water quality.

This TMDL effort has resulted in the identification of a “practical load reduction scenario” which includes a reasonable cumulative full build-out scenario for the watershed, addressing farmland preservation, preservation of open space and developed but further subdividable land parcels, and future residential and commercial development both inside and outside of sewer districts. It also establishes achievable nitrogen loading rates groundwater from agricultural operations, golf courses, and existing and new development, including the need for greater management in watersheds of currently impaired waterbodies. Reductions in the nitrogen loading from atmospheric deposition are also taken into account. Finally, this TMDL establishes nitrogen wasteload allocations for point sources discharges from the Riverhead, Sag Harbor and Shelter Island Heights STPs, and Atlantis Marine World. Discharges from STPs at Brookhaven National Laboratory, the Naval Weapon Industrial Reserve Plant and Plum Island are also discussed. Wasteload Allocations for stormwater loads are included, which will affect entities subject to the Phase II Stormwater Permits (including Suffolk County, the Town of Brookhaven, Riverhead and Southampton, and the Villages of Sag Harbor and North Haven). Other areas may become subject to municipal stormwater permits in the future.

Even the aggressive wasteload allocations for point sources and management goals in the form of load allocations for nonpoint sources will not be enough to meet existing or proposed water quality standard for dissolved oxygen. Mechanical aeration has been added to the scenario to specific locations to bring the dissolved oxygen levels into compliance with the both existing and proposed New York water quality standards.

The Peconic Estuary Program seeks to have this TMDL fully implemented within 15 years from approval, based upon current expectations for full build-out and land acquisition programs, development and implementation of education and outreach programs, full participation in the agricultural stewardship and environmental management program, and other necessary efforts. The SCDHS also will continue its monitoring efforts in the Peconic Estuary to further document water quality conditions and trends. The Peconic Estuary Program plans to track and report on progress in implementing and achieving this TMDL at five-year intervals. Full implementation of this TMDL is expected to result in water quality standards for dissolved oxygen being met where they are not currently attained and ensure continued compliance where these standards are presently achieved.

Total Maximum Daily Load for Nitrogen in the Peconic Estuary Program Study Area, Including Waterbodies Currently Impaired Due to Low Dissolved Oxygen: the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries

I. Introduction

This section provides an overall introduction, including an overview of the Peconic Estuary and the Peconic Estuary Program, the problems associated with low dissolved oxygen and how and why it occurs and the impact it has on aquatic life, and a regulatory process ("303(d)") for identifying problems and developing plans to restore impaired waters.

A. The Peconic Estuary and the Peconic Estuary Program

The Peconic Estuary is one of 28 estuaries in the country designated by U.S. Environmental Protection Agency (EPA) as an "estuary of national significance" under Section 320 of the Federal Clean Water Act (CWA). The National Estuary Program (NEP) was established to protect and restore nationally significant estuaries threatened or impaired by pollution, development, and overuse. The Peconic Estuary was formally accepted as part of the NEP in 1992. Officially commenced in 1993, the Peconic Estuary Program (PEP) includes numerous stakeholders, representing citizen and environmental groups, businesses and industries, academic institutions, and local, county, state, and federal governments. The EPA, New York State Department of Environmental Conservation (DEC) and the Suffolk County Department of Health Services (SCDHS) are the sponsoring government agencies for the program.

The PEP Comprehensive Conservation and Management Plan (CCMP) was approved by the EPA Administrator on November 15, 2001, with the concurrence of the New York State Governor. The CCMP promotes a holistic approach to protecting, enhancing and restoring the Estuary and its watershed. Priority management topics for the Peconic Estuary are Brown Tide (a type of harmful algal bloom), nutrients, habitat and living resources, pathogens, toxic pollutants, and critical lands protection. These six priority topics, together with public education and outreach, financing, and post-CCMP management, form the basis for the CCMP action plans.

The PEP Management Conference has identified nutrient over enrichment and the resultant low dissolved oxygen levels in the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries as a priority problem needing attention. The PEP is fortunate to have an extensive water quality monitoring database, a three-dimensional water quality model with a predictive sediment submodel, as well as many related studies available on land use, zoning, groundwater quality and other topics in order to understand the mechanistic nature/behavior of the Peconic Estuary system.

B. Low Dissolved Oxygen Levels (Hypoxia)

The data collected by the PEP reveal periods of low dissolved oxygen (DO) levels during the warm weather months (generally May through September). Figure I.1 depicts the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries, where low DO levels have been and continue to be observed. These low levels of dissolved oxygen are linked to areas of limited flushing and high nutrient loadings.

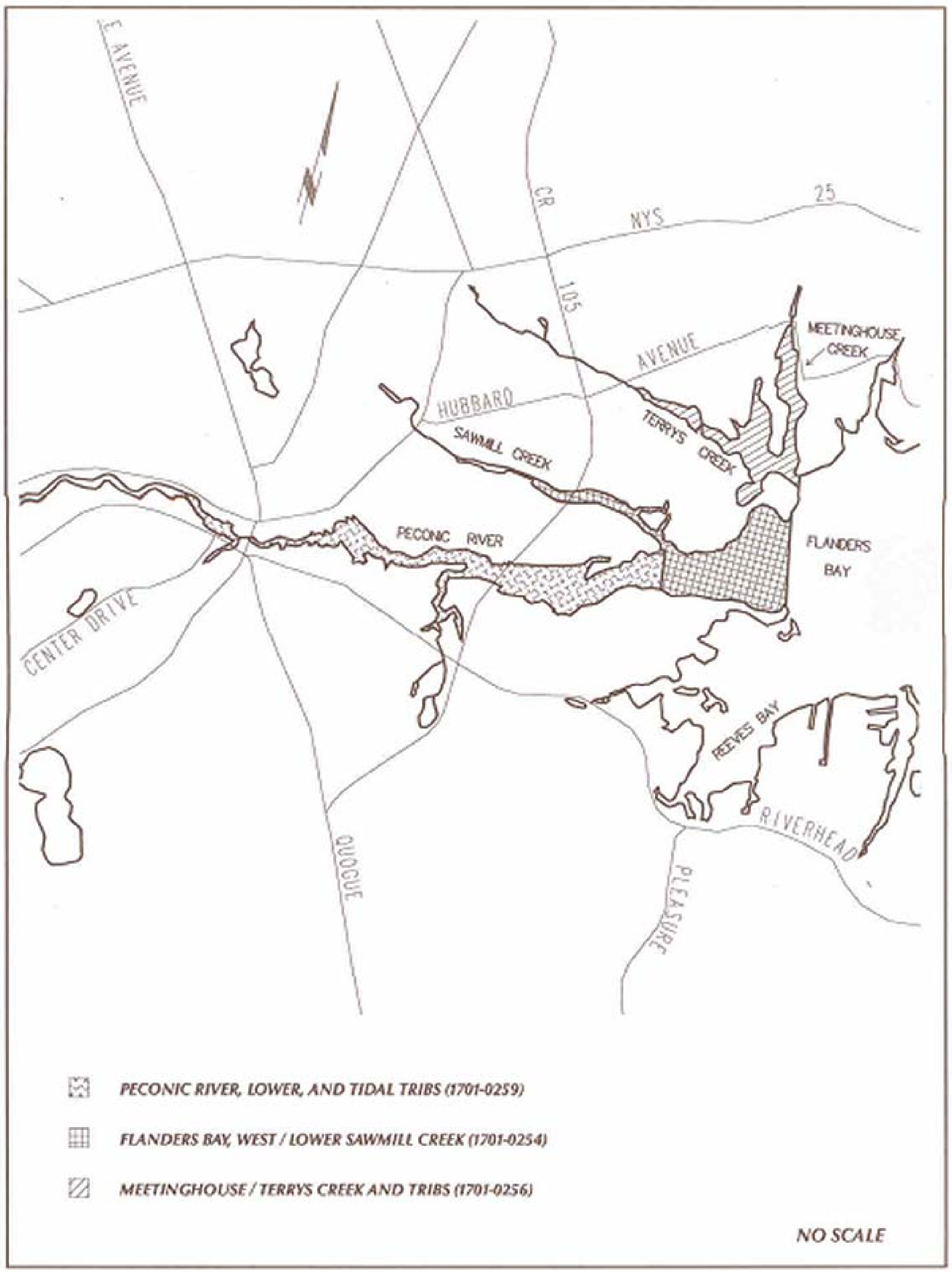


Figure I.1: Peconic Estuary waterbodies impaired due low dissolved oxygen

The chief regulators of DO concentrations in the Estuary are related to biological activity. While nitrogen is essential to a productive ecosystem, too much nitrogen fuels the excessive growth of aquatic plants, including phytoplankton and macroalgae that may, through night-time respiration, result in low dissolved oxygen levels in the water column. Night-time respiration of plants results in DO demand and can cause short-term DO depressions in the early morning hours; this is known as "diurnal" dissolved oxygen variation.

Bacterial decomposition of organic matter, including dead and dying vegetation, also results in dissolved oxygen being consumed. Most decomposition occurs in the sediments; this process is termed "sediment oxygen demand". Sedimentary decomposition also results in the recycling of nutrients, including nitrogen, back into the water column ("sediment nutrient flux"), which can further exacerbate water quality problems. Excessive oxygen demand results in dissolved oxygen concentrations being reduced to levels that are deleterious to aquatic organisms over relatively short periods of time.

The overproduction of algal biomass (and nighttime respiration), along with sediment oxygen demand, and sediment nutrient flux, accompanied by poor flushing, limited

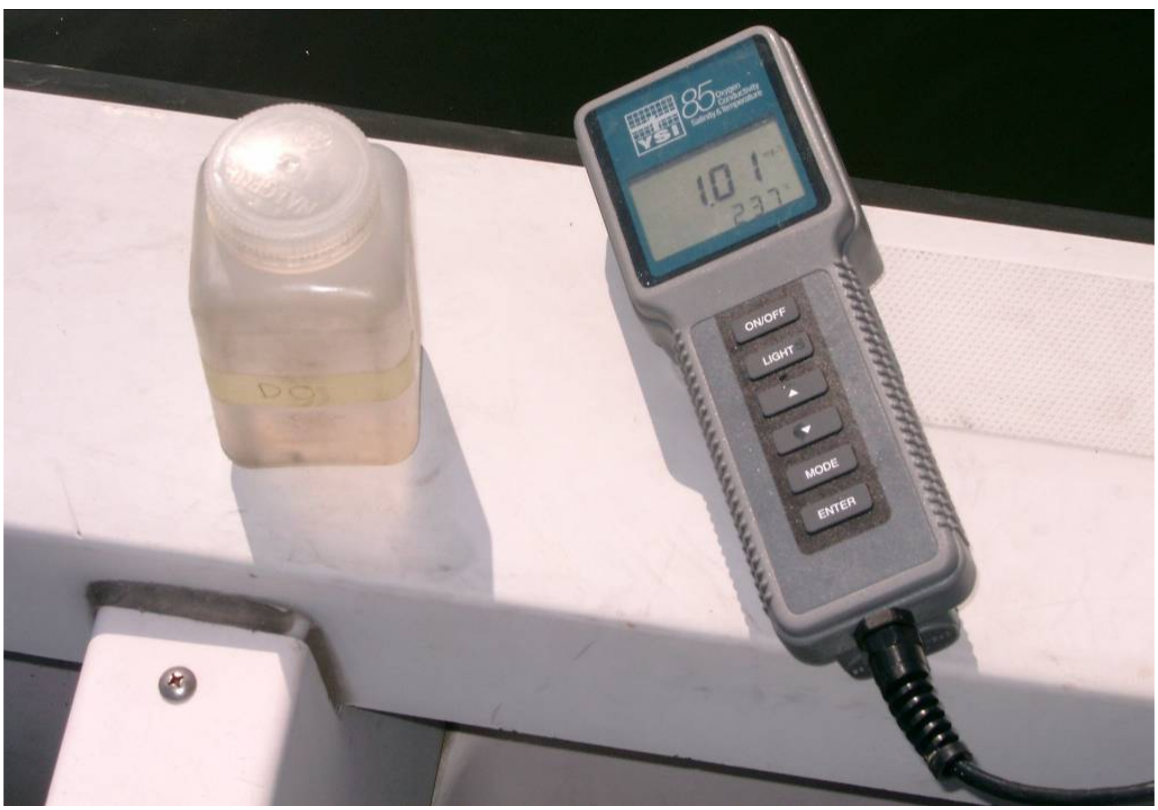


Image I.1: Measuring low levels of dissolved oxygen on a warm summer morning is not unusual in the western Peconic Estuary (Image Credit: Rick Balla, EPA, September 2005)

atmospheric exchange, and possibly naturally occurring density stratification of the water column in deeper areas, have caused DO concentrations to dip to hypoxic (DO less than 3.0 mg/L) and anoxic (that is, no dissolved oxygen) conditions in the Lower Peconic River and Meetinghouse Creek. Water temperature also contributes to the likelihood of stressful water quality conditions, as warmer water holds less dissolved oxygen. While strong winds can act to infuse and mix atmospheric oxygen into surface waters, periods of relative calmness can exacerbate low dissolved oxygen conditions. When conditions become stressful due to low DO levels, some organisms may suffocate and die, while others may flee the area.

Excessive microscopic algal growth can also discolor the water, and decrease water clarity and sunlight penetration. Reduced sunlight penetration can negatively impact submerged aquatic vegetation (SAV), especially eelgrass. Because SAV beds are important spawning and nursery habitat and serve as a refuge from predators for finfish and shellfish, factors that degrade them can have repercussions throughout the aquatic ecosystem and on commercial and recreational fisheries which humans highly value.

Excessive nitrogen inputs have impaired the function and health of the Lower Peconic River, Meetinghouse Creek/Terrys Creek and to some degree western Flanders Bay (Lower Sawmill Creek). The PEP has estimated that the load of nitrogen delivered to Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries has increased 200% since the 1950s due to increasing residential populations served by on-site disposal systems (septic systems) and a more pervasive use of highly soluble fertilizers in agricultural operations and on turf (lawns and golf courses). Point source discharges to the Estuary include sewage treatment plants (STPs) in Riverhead, Sag Harbor and Shelter Island Heights, Atlantis Marine World (the Riverhead Aquarium) and stormwater runoff covered by Municipal Separate Storm Sewer Systems (MS4) Phase II Stormwater Permits. Nonpoint sources of nitrogen to the Estuary include groundwater influx, atmospheric deposition, and stormwater runoff not covered by a permit.

In spite of the generally good water quality of the Peconic Estuary overall, eelgrass and scallop populations in particular are present at a small percentage of their former abundance. Since nitrogen loads will be managed in the process of working towards achieving DO objectives, it should also have the benefit of improving water quality conditions necessary to support other ecological objectives, such as restoring eelgrass, scallops, and hard clams. Achieving desirable and balanced loadings and ambient waterbody concentrations of nitrogen is only one aspect of what is necessary to restore these three species and others. For example, a slime mold present since the 1930s likely played a role in the decline of eelgrass, while the persistent brown tide (*Aureococcus anophagefferens*) blooms of the 1980s further contributed to losses. Eelgrass beds are also known or suspected of being adversely impacted by competition from invasive plants present in the system, predation from crustaceans and wildlife, and disturbances from boating, dredging and shellfish harvesting. Loss of genetic diversity and pesticides are also suspected of playing a role in eelgrass declines. Similar discussions can be provided for scallops and hard clams. In summary, nitrogen management is one of many objectives that needs to be pursued in order to improve the quality of estuaries, habitats, and living resources.

C. Requirements of Section 303(d)

Section 303(d)(1)(C) of the CWA and the EPA implementing regulations (40 CFR Part 130) require states to identify those waterbodies that do not meet water quality standards after application of the technology-based effluent limitations required by the CWA and to establish total maximum daily loads (TMDLs) for such waters for the pollutant of concern. The TMDL establishes the allowable pollutant loading from all contributing sources at a level necessary to achieve the applicable water quality standards. TMDLs must account for seasonal variability and include a margin of safety that accounts for uncertainty of how pollutant loadings may impact the receiving water. Once the public has had an opportunity to review and comment on the TMDL and any necessary revisions are made, it is submitted to the EPA by the state for review and approval. Upon approval, the TMDL is incorporated into the state water quality management plan and it becomes a basis for water quality permit decisionmaking and watershed management.

D. Fulfillment of Section 303(d)

To address the recognized low dissolved oxygen (hypoxia) problem, the PEP proceeded with a phased approach to nitrogen reduction and management, allowing the program to move forward in stages as more information is obtained to support more aggressive steps.

The first formal action to address hypoxia took place in 1994 with the release of the PEP Action Plan. The report announced that the nitrogen load from the Riverhead STP would not be allowed to increase beyond the amount being discharged at that time. Subsequently, DEC issued a State Pollutant Discharge Elimination System (SPDES) permit in 1996 establishing a nitrogen discharge loading limit from the Riverhead STP. The Town of Riverhead agreed to upgrade the plant to ensure continued compliance with the nitrogen limit should the plant reach its design flow/capacity. The treatment upgrade, which cost $8.1 million and included the construction of sequencing batch reactors, took place from August 1999 to May 2001. The Riverhead STP began full denitrification treatment in May 2001. This constitutes what is known as Phase I of the hypoxia management program. Descriptions of other ongoing and potential actions and programs the PEP has identified to reduce and better manage nitrogen are discussed under Implementation in this report.

The Peconic Estuary Program's CCMP contains 85 actions which are further broken down into steps; Actions N-1, N-3, N-4, and N-5 in the Nutrients Chapter directly relate to the development of a TMDL for western portions of the estuary. The CCMP recommends that a TMDL analysis be conducted based upon the listing of impaired waters on the 303(d) list (Action N-3). Accordingly, DEC evaluated these waters from a water quality point of view, and placed these waters on the 2002 303(d) list, as candidates for developing TMDLs.

This TMDL is being prepared to fulfill the recommendations of the CCMP and the requirements of Section 303(d).

II. Waterbody Name, Location and Description

This section provides waterbody and pollutant descriptions, including the Peconic Estuary and three waterbody segments that are impaired based on not attaining state dissolved oxygen standards, and the pollutant loadings affecting the impaired waterbodies.

A. The Peconic Estuary

The Peconic Estuary is situated between the north and south forks of eastern Long Island, New York, and consists of more than 100 distinct bays, harbors, and tributaries. The Peconic watershed includes those areas that contribute groundwater, surface water, and stormwater runoff to the river and estuary. The watershed has an area of 196 square miles. The Peconic Estuary Program study area includes 246 square miles of estuarine surface waters. The watershed is nearly 100 miles long from west to east and 20 miles from north to south at its widest point. The western boundary of the study area is at the headwaters of the Peconic River, just west of the William Floyd Parkway. The eastern end is an imaginary line through Block Island Sound between Plum Island and Montauk Point, beyond which lies the open sea (Figures II.1 and II.2).

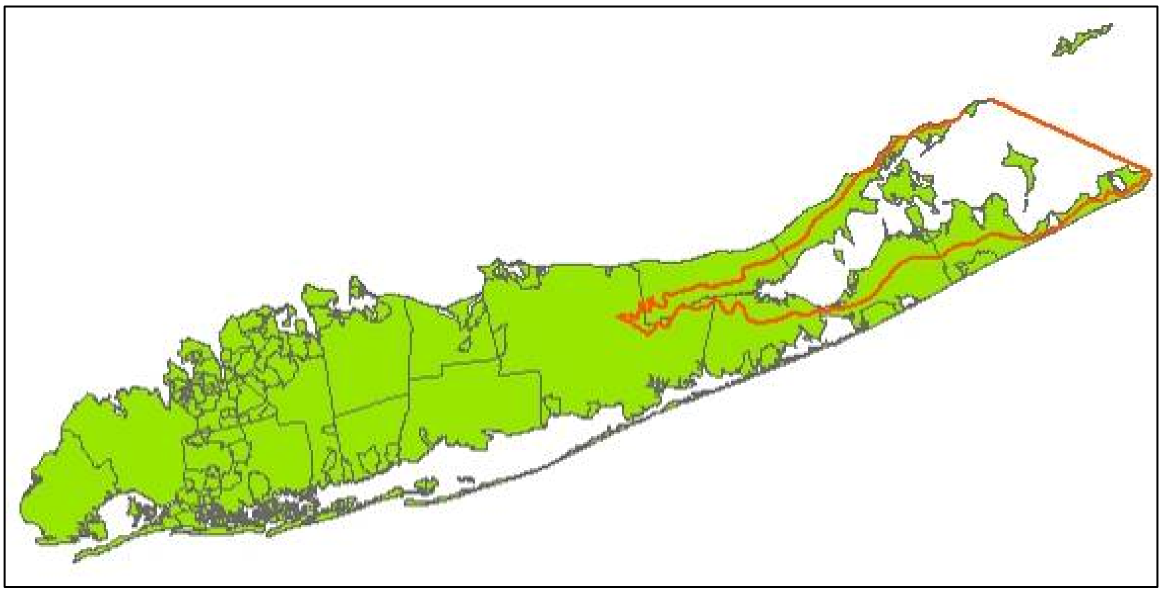


Figure II.1: Long Island and the Peconic Estuary Program Study Area (boundary outlined)

The study area includes the following municipalities: all of the Town of Shelter Island; significant portions of the Towns of Riverhead, Southold, East Hampton, and Southampton; a small portion of the Town of Brookhaven; a significant portion of the Village of Greenport, and all of the Villages of Dering Harbor, Sag Harbor, and North Haven. The entire Peconic watershed is located within Suffolk County.

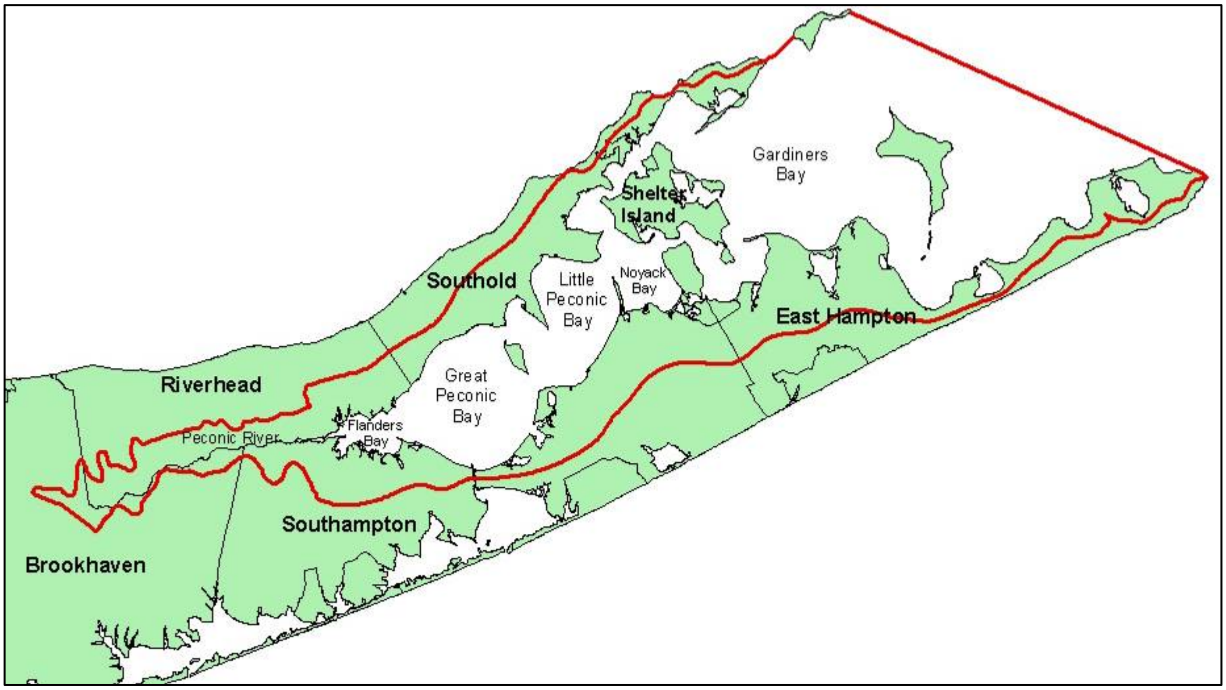


Figure II.2: Peconic Estuary Program Study Area (boundary outlined)

Of eastern Long Island's mean annual precipitation, 50% is recharged to groundwater while 1-2% results in stormwater runoff. The remainder is taken up by plants and evapotranspires. The Peconic River, the major river discharging freshwater to the Estuary, is groundwater fed and contributes approximately 13% of the freshwater to the Peconic Estuary. The largest source of freshwater input to the estuary (aside from direct precipitation on the Estuary surface) is from groundwater seepage (or underflow) directly into the Estuary. Stormwater runoff accounts for less than 4% of the total freshwater budget entering the Estuary.

The Peconic Estuary is a relatively shallow, well-mixed waterbody. The deepest areas of the Estuary are at the "races" (the relatively narrow straits that run between the north and south forks of the mainland and Shelter Island), ranging from approximately 5.5 m to 29 m [18 to 95 ft]. Flanders Bay is the most shallow of the bays in the Estuary, having a maximum depth of about 4.3 m (14 ft). The other bays that make up the Peconic Estuary range between 6 and 12 m (20 to 40 ft) deep at their centers with deeper pockets located east of Robins Island in Little Peconic Bay and southeast of Cedar Point Beach in Gardiners Bay. Water depths increase to greater than 28 m (91 ft) east of Gardiners Island.

The Estuary is not well flushed as evidenced by the salinity gradient along the main stem of the estuary. Average salinity increases rapidly from less than 24 practical salinity units (psu) at the Peconic River to approximately 27 psu in Flanders Bay, and then increases more gradually toward the east to approximately 29 psu.

B. Impaired Waterbodies on the 303(d) List

In order to fulfill certain requirements of the Federal Clean Water Act, the DEC must provide regular, periodic assessments of the quality of the water resources of the state. These assessments reflect monitoring and water quality information drawn from a number of programs and sources, both within and outside the DEC. This information has been compiled by the DEC into an inventory database of all waterbodies in the state used to record current water quality information, characterize all known and/or suspected water quality problems and issues, and track progress toward their resolution. This inventory of water quality information is the Waterbody Inventory/Priority Waterbodies List.

This nitrogen TMDL addresses the Peconic Estuary and its impaired waters (due to low dissolved oxygen): Lower Peconic River and Tidal Tributaries; Western Flanders Bay and Lower Sawmill Creek; and Meetinghouse Creek, Terrys Creek and Tributaries of the Peconic Estuary (Figure 1-1). Previously, in 2006, the State prepared and EPA approved 20 TMDLs for 25 Peconic Estuary waterbodies impaired due to pathogen contamination and impacts to shellfishing waters. Descriptions of the three DO impaired waterbodies from the New York State Priority Waterbodies List follow.

1. Lower Peconic River and Tidal Tributaries (NYS Priority Waterbodies List Segment #1701-0259)

According to the New York State Priority Waterbodies List, this segment includes the tidal portion of the Peconic River and its tributaries, spanning from the dam near Peconic Avenue to a line due south of the mouth of Sawmill Creek (see Figure I-1 and Image II.1). The entire waterbody segment spans approximately 200 acres. The boundaries of the Lower Peconic River and its tidal tributaries are shared between the Hamlet of Riverside in the Town of Southampton and the Hamlet of Riverhead in the Town of Riverhead.

Image II.1: The Tidal Peconic River, looking west. The County Route 105 bridge is in the foreground. (Image credit: Rick Balla, EPA, August 29, 2006*)*

2. Western Flanders Bay and Lower Sawmill Creek (NYS Priority Waterbodies List Segment #1701-0254)

According to the New York State Priority Waterbodies List, this segment includes the estuarine waters between a line due south of the mouth of Sawmill Creek and a line from Indian Island to the northwest boundary of Reeves Bay (Iron Point), including the tidal portion of Sawmill Creek (see Figure I-1 and Images II.2A and II.2.B). The entire waterbody segment spans approximately 100 acres. The boundary of Western Flanders Bay is shared by the Hamlet of Riverside in the Town of Southampton and the Hamlet of Riverhead in the Town of Riverhead. Sawmill Creek is situated in the Hamlet of Riverhead in the Town of Riverhead.

Image II.2A and II.2B: Sawmill Creek. Top image II.2A – Sawmill Creek looking south. Indian Island County Park is in the foreground. Sawmill Creek separates the Park from the Indian Island Golf Course. County Route 105 appears on the right. (image credit: Helen Grebe, EPA, August 29, 2006). Bottom image II.2B – Sawmill Creek (on the right) and western Flanders Bay (in the foreground and to the left) looking east. (Image credit: Rick Balla, EPA, August 26, 2004)

3. Meetinghouse Creek, Terrys Creek and Tributaries (NYS Priority Waterbodies List Segment #1701-0256)

According to the New York State Priority Waterbodies List, this segment includes the tidal portions of Meetinghouse Creek and Terrys Creek as well as their tributaries (see Figure I-1 and Image II.3). The entire waterbody segment spans approximately 200 acres. Meetinghouse Creek is situated entirely within the Hamlet of Aquebogue in the

Town of Riverhead while the boundaries of Terrys Creek are shared by the Hamlets of Aquebogue and Riverhead in the Town of Riverhead.

Image II.3: Meetinghouse Creek (on the right) and Terrys Creek (on the left). (Image credit: Helen Grebe, EPA, August 29, 2006)

C. Pollutant Loads Affecting Impaired Waterbodies

Because the Peconic Estuary is a tidal system, the quality of water outside of the impaired waters can both positively and negatively affect the quality of impaired waters. For this reason, this TMDL addresses loads from waters and watersheds outside the impaired waterbodies. Addressing waters and loads outside of the impaired waters is necessary to ensure that water quality standards are met throughout the Peconic Estuary System.

Sources of pollution resulting in impairments due to nitrogen enrichment include atmospheric deposition, on-site wastewater disposal systems, agricultural operations, turf and landscape maintenance, point sources including sewage treatment plants, and stormwater. These sources are discussed further detail in sections IV.C (Pollution Sources to Impaired Waters) and V.B (Nutrient Loading Data).

III. Applicable Water Quality Standards

This section provides an overview of nutrient issues and related standards and criteria, including a description of nutrient enrichment and its impacts, and New York State water quality standards and criteria for dissolved oxygen levels to support aquatic life uses.

A. Nutrient Enrichment and Impacts on Dissolved Oxygen
In the Peconic Estuary, nitrogen is the primary limiting nutrient for algal growth that leads to low DO levels and the subsequent non-attainment of designated uses. Nitrogen's relationship to impaired designated uses is indirect and complex, with intermediate steps of algal blooms and decomposition, low DO, poor water clarity, inhibited SAV (primarily eelgrass) growth, and stress on marine fauna. The relationship between nitrogen loading, ambient nitrogen concentration, and DO conditions is complex, often nonlinear, and typically requires calibrated and verified mathematical models to account for the controlling hydrologic, physical, chemical, and biological interactions. The PEP, based on water quality data and model runs, derived a maximum allowable water column nitrogen concentration from the relationship between nitrogen values, algal biomass, and dissolved oxygen.

Based on monitoring and modeling, the PEP has determined that reducing nitrogen loads necessary to achieve the water quality standards for DO will protect and maintain designated uses in the Peconic Estuary, especially for the 303(d) listed waterbodies. While the TMDL for nitrogen is translated from DO standards, other eutrophication-related impairments resulting from the intermediate steps of algal blooms and decomposition, poor water clarity, inhibited submerged aquatic plant growth, and stress to marine organisms have been considered, and would benefit from nitrogen load reduction.

B. New York State Water Quality Standards for Class SC waters
New York State's marine and fresh water classifications, designated best uses, and floating substances standards are contained in NYCRR, Title 6, Chapter X, Parts 701 and 703. Below are the pertinent applicable water classifications, designated best uses, and dissolved oxygen standard for the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries and other marine waters of the Peconic Estuary system.

Designated Best Usage
Class SC The best use of Class SC waters is fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

Dissolved Oxygen Standard
Class SC Dissolved oxygen shall not be less than 5.0 mg/L at any time.

C. Proposed Revisions to New York's State's DO Standard for Class SC Waters
On December 13, 2006 a public hearing was announced in the New York State Environmental Notice Bulletin, in order to give the public an opportunity to provide oral or written comment on the Department's proposal to amend portions of Parts 700 - 704 of Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (6 NYCRR). The proposed revisions are necessary to amend water quality standards based upon the most current scientific information. The marine dissolved

oxygen standard was among the items proposed for revision. As of the date of this TMDL, the proposed revisions have not yet been adopted. The proposed standard follows:

Acute: Shall not be less than 3.0 mg/L at any time.

Chronic: Shall not be less than a daily average of 4.8 mg/L at any time, except that the daily average dissolved oxygen concentration may fall below 4.8 mg/L for a limited number of days, as defined by the formula:

$$DO_i = \frac{13.0}{2.80 + 1.84e^{-0.1t_i}}$$

where DO_i = DO concentration in mg/L between 3.0 - 4.8 mg/L and t_i = time in days. This equation is applied by dividing the DO range of 3.0 - 4.8 mg/L into a number of equal intervals. DO_i is the lower bound of each interval (i) and t_i is the allowable number of days that the DO concentration can be within that interval. The actual number of days that the measured DO concentration falls within each interval (i) is divided by the allowable number of days that the DO can fall within interval (t_i). The sum of the quotients of all intervals (i ...n) cannot exceed 1.0; i.e.,

$$\sum_{i=1}^{n} = \frac{t_i(actual)}{t_i(allowed)} < 1.0$$

The DO shall not fall below the acute standard of 3.0 mg/L at any time.

In preparing this TMDL, we have considered, calculated and modeled the loads necessary to achieve both the existing and proposed water quality standards for dissolved oxygen. The analyses, loads, and load reductions necessary to achieve both the existing and proposed water quality standards are presented in this document.

IV. CWA 303(d) Listing

This section describes the impaired waters and pollutants, including the monitoring data documenting low dissolved oxygen levels in three waterbody segments, the pollutants of concern, and a brief overview of the pollution sources to the impaired waters.
There are other impaired waterbodies in the Peconic Estuary System, identified for reasons other than low dissolved oxygen and excess nitrogen. Twenty five waterbodies have been identified as impaired due to pathogen contamination. In September 2006, TMDLs were adopted and approved for twenty of these waterbody segments.

A. Use Impairments

1. Lower Peconic River and Tidal Tributaries

Monitoring data collected from 1995 to 2000 show that the water quality standard of 5 mg/L was not attained during the summer months (June 1st – September 30th) in the

Lower Peconic River (see Figure IV.I for monitoring station locations). The low dissolved oxygen levels are in the range of 2.0 - 4.9 mg/L. Three percent of the dissolved oxygen values are below 3.0 mg/L and twenty five percent of the dissolved oxygen levels are below 5.0 mg/L. In summary, state water quality standards for dissolved oxygen are frequently not attained in the Lower Peconic River.

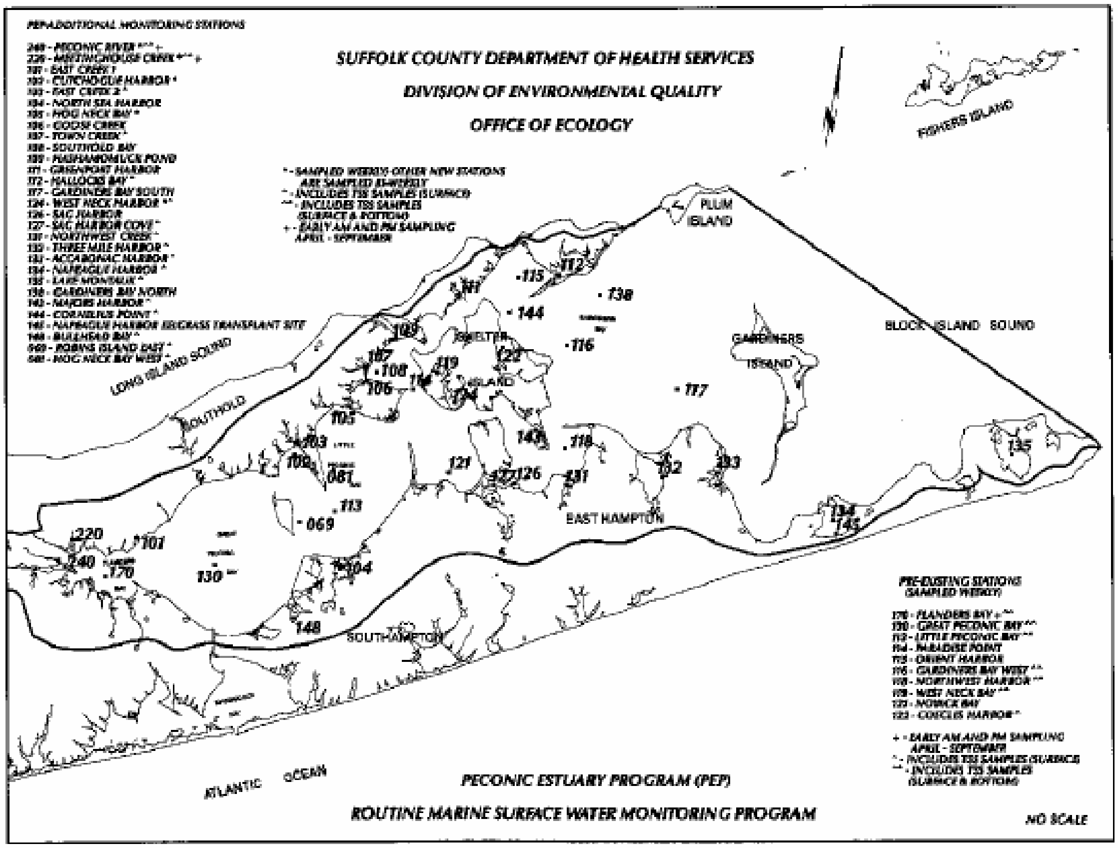


Figure IV.1: Peconic Estuary Program Routine Marine Monitoring Stations

2. Western Flanders Bay and Lower Sawmill Creek

Monitoring data collected from 1990 to 2000 show that the water quality standard of 5 mg/L was not attained during summer months in the Western Flanders Bay area (see Figure IV.1 for monitoring station locations). The low dissolved oxygen levels are in the range of 4.2 – 4.9 mg/L. The ambient data show that four percent of the DO values are below 5.0 mg/L. In summary, state water quality standards for dissolved oxygen are infrequently not attained in the Western Flanders Bay and Lower Sawmill Creek segment.

3. Meetinghouse Creek, Terrys Creek and Tributaries

Monitoring data collected from 1995 to 2000 show that the water quality standard of 5 mg/L was not attained to a greater degree than the waterbodies named above during summer months in Meetinghouse Creek (see Figure IV.1 for monitoring station locations). The low dissolved oxygen levels are in the range of 0.2 - 4.9 mg/L. The ambient data show that twenty four percent of the dissolved oxygen values are below 3.0

mg/L and fifty three percent of the DO values are below 5.0 mg/L. In summary, the lack of attainment of state water quality standards for dissolved oxygen in Meetinghouse Creek is frequent and severe.

4. Commonalities among the Impaired Waterbodies

The low dissolved oxygen levels in these three waterbody segments are attributed to the excess loadings of the nutrient nitrogen in these waterbodies in combination with other factors. The high levels of nitrogen loadings leads to the proliferation of uncontrolled algae growth resulting in the abundance of readily oxidizable organic matter during algae senescence and death, and accumulation in sediments. The organic matter then oxidizes to carbon and consumes available dissolved oxygen in the water column causing violations of the dissolved oxygen standard. Night-time respiration of aquatic plants also results in DO demand and can cause short-term DO depressions in the early morning hours (“diurnal” dissolved oxygen variation).

Based on the documented and recurring violations of the applicable dissolved oxygen standard, best usages of these waterbodies are not being attained and these waters described above are impaired. Impacts and uses that are impacted include but are not be limited to: decreased fish propagation, increased mortality of sensitive organisms, poor water clarity, reduction in commercial and sport fisheries values, reduction in wildlife habitat value, degradation of seagrass beds, impact on tourism and real estate values, and poorer aesthetics. All these uses would benefit from improved water quality resulting from nitrogen load reductions.

Based upon the impaired conditions of the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries, DEC has included these waterbodies on the 2002 Clean Water Act Section 303(d) list. These waterbodies have been listed as impaired on the State’s Priority Waterbodies List (PWL) and have been identified as not meeting the dissolved oxygen quality standard at all times and as priorities for TMDL development.

B. Pollutants of Concern

The primary pollutant contributing to low dissolved oxygen levels in the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries is nitrogen. Excess nitrogen promotes the uncontrolled growth of algae leading to the production of organic biomass. The decay of this organic matter and its accumulation in bottom sediments exerts a demand for dissolved oxygen in the water column and along with night time algal respiration results in the lowering of the DO levels and violations of the applicable water quality standard. This process is the dominant mechanism for causing low oxygen levels in Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries. The principal pollutant for these TMDL analyses, therefore, is nitrogen.

Organic carbon is also a key element in the process leading to low dissolved oxygen levels but is not a pollutant targeted for reduction in this analysis as reduction of organic carbon loadings has very little beneficial effect in improving DO levels when compared with the reduction of nitrogen.

C. Pollutant Sources to Impaired Waters

There are a number of significant sources of nitrogen that contribute to low DO in the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries. Other point sources are described later in this document:

1. One municipal wastewater treatment facility (the Riverhead STP) currently discharging less than one million gallons of treated effluent per day to the surface waters of the tidal Peconic River just west of the County Route 105 Bridge. Atlantis Marine World (the Riverhead Aquarium) also discharges a small flow and contributes a nutrient load to the tidal Peconic River.

2. Stormwater from the Towns of Riverhead and Southampton is regulated under the EPA's Phase II Stormwater Program, as are the New York State Department of Transportation and Suffolk County stormwater facilities within these towns. As of March 2003, the municipal separate storm sewer systems (MS4s) that serve these two towns were required to have a NPDES permit and a management plan that prevents polluted stormwater from being discharged into nearby water bodies and impacting water quality. The outfalls from these MS4s are considered point sources to the Peconic Estuary. The Town of Brookhaven is also regulated under the Phase II Stormwater Program, though stormwater from the Town of Brookhaven enters and contributes only to the non-tidal Peconic River upstream of the impaired segments and is included in tributary loads.

3. Nonpoint sources contribute to groundwater loads that eventually recharge surface waters, including: fertilizer losses from agricultural operations and turf grass maintenance (at residences and other developed properties, and golf courses); and onsite wastewater disposal systems from properties not connected to sewage treatment plants. Other unregulated stormwater sources also contribute to the nonpoint nutrient load.

4. Sediment nutrient flux attributed to highly organic substrates found in the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries.

5. Wet and dry atmospheric deposition directly to water surfaces and to the landscape.

6. Boundary conditions, that is, the quality of the water flushing from other waters, will influence the quality and response of impaired waterbodies.

D. Other Point Sources Outside of Impaired Waters

In addition to sources described in the above section, there are additional sewage treatment plants in the Peconic Study Area that discharge to estuarine waters outside of the impaired waters: the Sag Harbor Sewage Treatment Plant and the Shelter Island Heights Sewage Treatment Plant. As noted previously, the Villages of Sag Harbor and North Haven, the Towns of Brookhaven, Riverhead, and Southampton, the New York State Department of Transportation, and Suffolk County stormwater facilities are currently regulated under the EPA's Phase II Stormwater Program. While other municipalities within the Peconic study area (the Towns of Shelter Island, Southold, and East Hampton) are not currently covered by the Phase II regulations, they may be designated by the New York State Department of Environmental Conservation for such coverage during the second Phase II permit cycle (2008-2013). In addition, the Brookhaven National Laboratory STP, which discharges to the freshwater Peconic River is addressed as a boundary/tributary load, as is the Plum Island STP which discharges to Gardiners Bay. While the former Naval Weapon Industrial Reserve Plant (previously operated by the Grumman Corporation) in Calverton, NY also has an STP that discharges to a branch of the freshwater Peconic River, the operators have submitted engineering reports to upgrade and build a new facility discharging to groundwater outside of the Peconic Estuary study area.

V. TMDL Development

This section provides a description of the data inputs to the modeling process and ultimately the TMDL, including ambient data, nutrient loading data, and uncertainties associated with current and projected future nutrient loads.

A. Available Ambient Data

Data from the SCDHS's water quality monitoring efforts as well as data from PEP funded studies and reports were used to calibrate and validate the Peconic Estuary EFDC (Environmental Fluid Dynamics Code) three-dimensional hydrodynamic and water quality model by Tetra-Tech, Inc. The SCDHS, in part through the Peconic Estuary Program, conducts an extensive water quality sampling program in the Peconic Estuary and its watershed.

1. Routine Water Quality Monitoring Program

While the SCDHS began limited surface water quality sampling in 1976, the number of stations and samples taken in the Peconics increased through the years. Currently, monitoring is conducted every other week at 32 stations throughout the year; two surface water quality monitoring stations are located in the waters for which the nitrogen this TMDL is being developed. Water samples are tested for a suite of nitrogen components (NH_3, NO_2+NO_3, Urea, TN, TDN), phosphorus components (TP, TDP, ortho-phosphate), carbon components (TOC, DOC), silicate (SiO_3), total suspended solids (TSS), chlorophyll-a (Total and < 10 μm), coliform bacteria (Total and Fecal), and Brown Tide (*Aureococcus*). At each station, secchi depth, temperature, dissolved oxygen, salinity, and the extinction of photosynthetically active radiation at incremental depths are measured. See Figure IV.1 and Figure V.1 for additional information on the SCDHS surface water quality monitoring program sampling locations.

2.   Peconic Estuary Stream and Point Source Sampling Program
The SCDHS monitors 28 Peconic Estuary System stream and point source stations on a monthly to quarterly basis, as time permits. Eight monitoring stations are located in the waters for which the nitrogen TMDL is being developed, including sites at the Peconic River, Meetinghouse Creek, Sawmill Creek, Terrys Creek, the Crescent Duck Farm in the Meetinghouse Creek Watershed, and the Riverhead Sewage Treatment Plant.   These stations are sampled for a suite of metals and organic compounds.

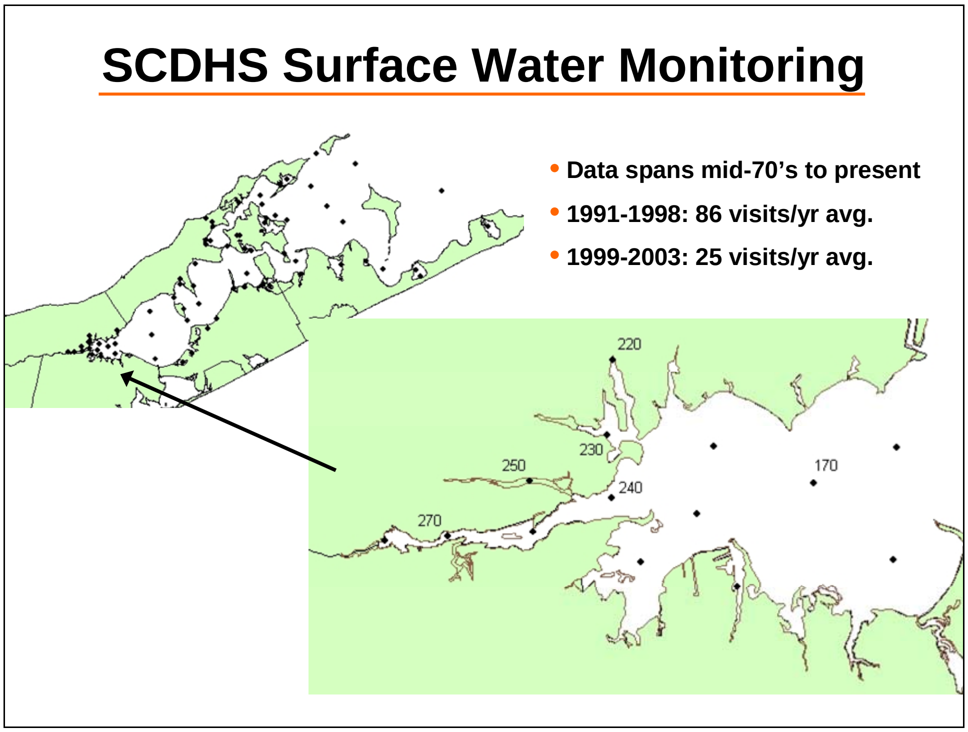


Figure V.1: Peconic Estuary Program Routine Marine Monitoring Stations

3.   Continuous Water Quality Monitoring
For the summer and fall of 2002, continuous monitoring devices (Yellow Springs Instruments (YSI)) were deployed in the tidal portion of the Peconic River (at the Route 105 Bridge), western Flanders Bay (southwest of Buoy G"9"), and eastern Flanders Bay (approximately mid-way between SCDHS station 170 at Buoy R "9" and Red Cedar Point) by the SCDHS. The devices measure and record dissolved oxygen levels, temperature, and conductivity (to calculate salinity) every 15 minutes.

4.   Groundwater Quality Monitoring Program
The SCDHS maintains a network of wells throughout the county to monitor the quality and quantity of the groundwater supply, and conduct studies and investigations of the county's hydrology. Groundwater measurement reports are periodically produced. The focus of groundwater monitoring has been on human induced loadings such as: fertilizers and pesticides use at agricultural operations, golf courses and residences; septic systems;

and chemicals (petroleum, solvents, and degreasers). In eastern Suffolk County, agricultural chemicals are the primary contaminant of concern.

B. Nutrient Loading Data

1. Overview

Nutrient loads are classified into several categories, based on geographic origin, source type, and whether it is of natural or human origin.

With regard to geographic origin, in-basin nutrient load contributions for this TMDL originating within the northwest portion of the Peconic watershed include: stormwater runoff, the Riverhead Sewage Treatment Plant and Atlantis Marine World discharges, nutrient flux from the sediments, groundwater enriched by agricultural and non-agricultural sources, and wet and dry atmospheric deposition. Although the origin of atmospheric nitrogen may be many hundreds of miles away, it is presently included in the geographic category where it is deposited. Nutrient loads from all other sources, i.e., beyond the in-basin boundaries, are considered imported loads or out-of-basin loads, and include the loadings from the freshwater portion of the Peconic River and estuarine transport from outside the Peconic Estuary System.

Nitrogen loads by source type are categorized as nonpoint and point. While the Peconic Estuary, on a regional basis, is dominated by nonpoint source impacts, there are point source discharges, including the Riverhead Sewage Treatment Plant and Atlantis Marine World which discharge to an impaired water (the Lower Peconic River), and the Sag Harbor and Shelter Island Heights STPs. The Towns of Riverhead and Southampton are both regulated under the EPA's Phase II Stormwater Program, as are the New York State Department of Transportation and the Suffolk County stormwater facilities within these towns, along with the Villages of Sag Harbor and North Haven. Further, the Town of Brookhaven is also regulated under the Phase II Stormwater Program, though stormwater from the Town of Brookhaven enters and contributes only to non-tidal Peconic River upstream of the impaired segment and is included in tributary loads. Other stormwater inputs are not currently regulated as point sources and are considered nonpoint sources. Nonpoint sources also include diffuse sources (*e.g.*, nitrogen-enriched groundwater resulting from septic systems and residual fertilizers, sediment flux, and wet and dry atmospheric deposition.

Nitrogen sources can be further subdivided into a pre- and post-colonial (*i.e.*, enriched) load. The pre-colonial or pastoral load is an estimate of the amount of nitrogen that was delivered to the estuary before European settlers colonized the area. The pre-colonial condition estimates what the natural load might have been. Human-caused loads include wastewater treatment facility outflows and nonpoint source groundwater flows from residential septic systems and residual fertilizers.

Nitrogen loads are presented as daily loads estimated for an average flow year. These loads, therefore, differ somewhat from the time variable nitrogen loads specific to the time period used in the Peconic Estuary EFDC Model employed to develop this TMDL.

Oxidizable carbon loads were also estimated for the water segments using the same categories and approach that was used for nitrogen. Carbon is of interest because it contributes to low dissolved oxygen levels in the Peconic Estuary. While nitrogen plays the dominant role in causing hypoxia, the oxidation of carbon loads is also responsible for oxygen consumption. Because source management to remove nitrogen will also remove some of the total organic carbon (TOC) load, both nitrogen and carbon reductions are considered in quantifying the potential dissolved oxygen improvements. Since the carbon reductions are incidental to the management of nitrogen, no targets for TOC reduction have been established.

2. Development of Nutrient Loading Factors

This TMDL and the nutrient loading factors that support it are based on both the extensive and detailed data bases on land uses and groundwater quality, and on the relationship between them. This involved looking at existing land uses, trends and build-out potential based on the zoning for the over 58,000 parcels of land in the Peconic Estuary Program Study Area. Special attention and consideration was given to farmland because of farmland preservation programs and also to open space acquisition because of the very significant funding that the five east end towns, the county and state along with private land trust organizations (The Nature Conservancy and the Peconic Land Trust) have assembled to acquire open space. Golf courses were addressed separately, as was developable land within the boundaries of the sewer districts. Recent work to estimate environmental implications associated with vegetative preservation requirements (i.e., clearing restrictions) and clustering requirements also factored into this analysis.

a. Existing Land Use Data

Existing land uses were categorized at the individual tax map parcel level using a standardized methodology showing 13 general land use category attributes based on assessor code data and residential density criteria. This data was then verified via field inspection, aerial photo interpretation, Real Property Tax Service Agency property data and owners list files, etc. and also manual corrections as necessary. This effort involved resolving complications such as:

- When more than one land use was found to occur on a single parcel, the primary use was determined and assigned to that parcel. Primary use was based on the relative intensity of use in comparison with the other use(s) in question. Consideration was also given to the areal extent of the use on the parcel.
- Dedicated common areas on tax map parcels in condominium/townhouse projects were classified as recreation and open space, since such areas are not available for development in the future.
- Agricultural lands that had reverted to old field habitat due to non-agricultural use were classified as vacant. Actively cultivated lands and those recently left fallow were classified as agriculture.
- All publicly owned parks and conservation lands, whether actively or passively used, were classified as recreation and open space
- The existing zoning designation of a parcel was not a factor in how that parcel was classified as to existing land use.

Given the extensive level of effort devoted to the PEP land use inventory, the Suffolk County Planning Department that prepared the inventory is confident that the incidence of errors (either judgment error (i.e., assigning the wrong classification category to a particular parcel or attribute error (i.e., the wrong classification is assigned a parcel in the GIS data base)) is very low. This work does, however, represent a static or "snapshot" view of land and does not reflect incremental changes that have occurred as a result of more recent development and open space acquisition activities. This work is documented in "Peconic Estuary Program Existing Land Use Inventory" (Suffolk County Department of Planning, January 1997).

b. Land Use Change Trends

A subsequent and related report is entitled "Peconic Estuary Program Land Use Change Analysis" (Suffolk County Department of Planning March 1998). The findings of this report included that nearly 10,500 acres of land and over 9,850 parcels in the PEP study area were converted to developed uses in the 19 year period of record studied (1976 to 1995). This amounts to a conversion rate of about 550 acres per year. By far, the greatest amount of change involved conversion to residential uses. The over 9,400 acres of additional residential development accounted for 89.9% of the total acreage change and the vast majority of the parcels (98.6%) undergoing a change in use. The report also documented 46,112 acres of residential zoned land, 650 acres of commercial zoned land and 5,136 acres of industrial zoned land available for development in the PEP watershed, for a total of 51,898 acres. This report also cited the key environmental issue for the Peconic Estuary and its watershed is how and when this available land will be utilized in the future.

c. Projections Associated with Land Available for Development

A third related report, the "Peconic Estuary Program Land Available for Development" (Suffolk County Department of Planning, April 1998), was prepared to help answer the first of two related questions of special significance to the PEP:

1) How *can* the PEP watershed be developed in the future
2) How *will* the PEP watershed be developed in the future?

The answer to the first question is a function of how land has been used in the past, what proportion of the land is available for development in the future, and the uses that are allowed on this available land as dictated by existing zoning regulations. The report answered the question of how the study area could be used in the future given the constraints of existing zoning and various assumptions. The data and information gathered anticipated the future use of assisting in quantifying pollutant loadings and the modeling of nitrogen management alternatives by the PEP, as well as the evaluation of potential land use, zoning, pollution abatement and habitat protection recommendations impacting the Peconic Estuary.

The methodology employed in the report was used to identify, map and quantify the land available for development in the PEP land use study area at the tax map scale using the PEP existing land use maps, municipal zoning maps and GIS coverages of zoning data, farmland preservation data, easement information, etc. Land available for development is defined in this report as vacant land or land that has not yet been developed to the maximum extent as permitted by municipal zoning law. Vacant parcels, agriculturally used property with intact development rights, residentially developed property capable of further residential subdivision according to zoning and a select group of "special case" properties that are not included in any of the above categories were considered as land available for development. The methodology used for land available for development assumes that every parcel so designated will be residentially, commercially or industrially developed to the fullest extent according to town or village zoning regulations. In all cases, the projected use of a parcel available for development was determined by the existing zoning classification for that particular parcel. Designating a parcel of land available for development does not connote that the parcel should necessarily be developed. It simply states that under current zoning regulations that the parcel can be developed or the existing use occurring on the parcel can be intensified. Current zoning serves as a blueprint for the type and intensity of future development one can expect within a municipality and it is used as a planning tool to assist in the identification, mapping, and quantification of the land available for development within the study area.

Land available for residential, commercial and industrial development was inventoried. The acreage and potential number of dwelling units were calculated and special consideration was given in the case of the re-development of large parcels of developed property where changes in use are likely to occur over the near term. This report documented nearly 52,000 acres (40%) of the upland acreage in the PEP study area are still available for development, and that development of residentially zoned available land under current zoning conditions has the potential for the creation of over 27,000 new dwelling units. In 1990 over 39,000 dwelling units existed in the PEP study area. Maximization of residential development according to existing zoning could result in a total of more than 66,000 dwelling units – a 69% increase in the number of dwelling units than existed in the study area in 1990. Findings were also presented for commercial and industrially zoned lands.

d. Critical Lands Protection

The "Peconic Estuary Program Critical Lands Protection Plan" (2004) identified and prioritized land available for development in the Peconic Watershed's five eastern towns for protection. As of 2001, a little more than 22% of the land was still available for development (including both vacant land as well as land that is developed but could still be subdivided under current zoning). Agricultural lands were not included in the critical lands analysis as they are being dealt with in a separate forum. The most widely used land protection tool is full fee acquisition from willing sellers. While the Community Preservation Fund (CPF), utilizing a real estate transfer fee assessed upon the buyer, is the most successful land protection program on Long Island, raising over $169 million through January 2004, it is not sufficient to keep up with the rate of development and the loss of critical landscapes, let alone the overall inventory of land that could be developed. Future CPF revenues, while still significant, could purchase less than 10% of these lands, perhaps 1800 acres. Fortunately, other programs, primary at the county and state (and potentially Federal) level can help to bridge some of the gap, together with programs of private land trust organizations and private citizens to reach perhaps a 15% acquisition threshold of available land.

The PEP Critical Lands Protection Strategy work group also recommended an expansion of the existing land use/vegetation preservation requirements in the Towns of Southampton and East Hampton and encouraged the adoption of similar land use regulations in other towns. Large amounts of land can be effectively protected without having to expend funds to actually acquire the properties, through clearing restrictions, clustering requirements, rezoning, overlay districts, easements, purchase of development rights, and overall sustainable land use practices. It is estimated that the implementation of vegetation preservation requirements (i.e., clearing restrictions) alone would protect an additional 3,183 acres in the five east end towns; acquiring an equivalent amount of land would cost an estimated $382 million. Vegetation preservation requirements can help to significantly reduce the amount of property that will be planted in turf grass at both the time of development and in the future, significantly reducing likely fertilizer inputs, among other benefits. These figures were calculated using the land available for development, assuming CPF purchase of some lands, and not considering lands already in a town overlay district already requiring vegetation preservation.

e. Land Use Trends Projections for Future Loads

Because so much of the watershed could be developed and there is corresponding likelihood for nitrogen loads (and especially nonpoint source loads) to increase, a TMDL that did not take into account future development are likely to be unsuccessful in achieving water quality standards in the short-term or ensuring that they will continue to be attained in the long-term. For this reason, it was necessary to specify a likely reasonable build-out scenario. Based on the above narratives and for the purpose of developing this TMDL, the main elements of this reasonable cumulative full build-out scenario, which will also be referred to in the practical load reduction scenario, are as follows:

- 50% of the remaining farmland is preserved
- 15% of the vacant land is protected, increased to 30% in the watersheds of the impaired waters
- 15% of subdividable land is protected, increased to 30% in the watersheds of the impaired waters
- The rest of agricultural, vacant and further subdividable land is developed with clustering and vegetation preservation requirements, with even more aggressive land use controls in the watersheds of the impaired waters

f. Groundwater Quality Assumptions for Calculating Loads

Groundwater inputs are especially significant for modeling the Peconic Estuary for the current baseline condition as well as projecting what may happen in the future in response to changing land uses. Once existing or future land uses were determined or projected, associated nutrient loadings also needed to be determined or projected. For the purpose of this TMDL, average nitrogen concentrations in the groundwater management zones ranged from 0.65 mg/L in the high quality freshwater Peconic River corridor (where there is significant protected open space and vacant land, relatively little agriculture and some sewering) to 9 mg/L in north fork zones where is a significant amount of agriculture.

- Nitrogen levels in groundwater in agricultural areas were estimated at a concentration of 13 mg/L; best management practices were estimated to be able to reduce the concentration in groundwater by 25% to 9.75 mg/L, or if aggressively managed in the watersheds of the impaired waters, by 50%.

- Nitrogen levels in groundwater in non-agricultural existing developed areas were estimated at a concentration of 6 mg/L; best management practices were estimated to be able to reduce the concentration in groundwater by 25% to 4.5 mg/L, or if aggressively managed in the watersheds of the impaired waters, by 33%.

- Nitrogen levels in groundwater in golf courses areas were estimated at a concentration of 3.58 mg/L; best management practices were estimated to be able to reduce the concentration in groundwater by 25% to 2.69 mg/L, or if aggressively managed in the watersheds of the impaired waters, by 50%.

- Nitrogen levels in groundwater from vacant and subdividable lands that are developed residentially with vegetation preservation requirements and other land use controls and best management practices were estimated at 3.75 mg/L; additional best management practices in the watersheds of the impaired waters were estimated to be able to reduce the concentration in groundwater to 3 mg/L.

- Nitrogen levels in groundwater in areas of open space and vacant lands were estimated at 1 mg/L.

- Nitrogen levels in groundwater in developed areas of sewer districts were estimated at 2 mg/L. This includes a portion of the land area in the Village of Greenport which is sewered, though the Greenport STP discharges outside of the Peconic Estuary (to the Long Island Sound).

- The above nitrogen levels in groundwater were assumed to be further reduced by 0.2 mg/L in response to the implementation of Federal Clean Air Act requirements (i.e., less nitrogen being deposited on the watershed landscape will lead to improved groundwater quality).

g. Tributary Inflows

In the western Estuary, there are 8 tributary inflows included in the model as distinct loads. These 8 tributaries (along with the location of the Riverhead Sewage Treatment Plant outfall) are depicted in Figure V.4

Table V.1: Summary of Relevant Permit Requirements, Limitations and Discharge Monitoring Data for the Sag Harbor, Shelter Island Heights and Riverhead Sewage Treatment Plants

Riverhead STP ---------------- Parameter	Permit Conditions	Discharge Monitoring Data		
		Summer Average (06/'05 to 09/'05)	1 Yr Average (03/'05 to 02/'06)	4 Yr Average (04/'02 to 02/'06)
Flow (MGD)	1.3	0.79 (min=0.766; max=0.808) 0.79 (winter average, 11/05 to 01/06)	0.81 (min=0.697; max=1.146)	0.79 (min=0.66; max=1.044)
Total Nitrogen (lbs/day)	170	71. (min=43.; max=133)	61. (min=43.; max=133)	70. (min=23.; max=141.)
Total Nitrogen concentration (mg/L) (back-calculated)	no reporting requirement	10.8	9.0	10.7

Sag Harbor STP ---------------- Parameter	Permit Conditions	Discharge Monitoring Data		
		Summer Average (06/'05 to 09/'05)	1 Yr Average (03/'05 to 02/'06)	4 Yr Average (04/'02 to 02/'06)
Flow (MGD)	0.25	0.13 (min=0.11; max=0.14) 0.06 (winter average, 11/05 to 01/06)	0.094 (min=0.06; max=0.138)	0.094 (min=0.059; max=0.14)
Total Nitrogen (lbs/day) (back-calculated)	no reporting requirement	5.5 lbs/day	4.4 lbs/day	4.8 lbs/day
Total Nitrogen concentration (mg/L)	8	2.5 (min.=2, max-3.1), 5.2 (2003) 6.6 (winter average, 11/05 to 01/06)	5.6 (min.=2, max=9.3)	6.17 (min=1.8, max=18.6)

Shelter Island Heights STP ---------------- Parameter	Permit Conditions	Discharge Monitoring Data		
		Summer Average (06/'05 to 09/'05)	1 Yr Average (03/'05 to 02/'06)	4 Yr Average (04/'02 to 02/'06)
Flow (MGD)	0.053	0.032 (min=0.025, max=0.038) 0.014 (winter average, 11/05 to 01/06)	0.021 (min=0.011; max=0.038)	0.021 (min=0.008; max=0.042)
Total Nitrogen (lbs/day) (back-calculated)	no reporting requirement	5.2	2.1	1.7
Total Nitrogen concentration (mg/L)	reporting only	19.5 mg/l, (min=5.2, max=27.4) 11.3 (winter average, 11/05 to 01/06)	12.2 mg/l (min.=5.1 max=27.4)	10.2 mg/l (min=3.8, max=27.4)

h. Point Sources/Sewage Treatment Plants
See table V.1 for a summary of relevant permit requirements, limitations and discharge monitoring data for the Sag Harbor, Shelter Island Heights and Riverhead Sewage Treatment Plants. A discussion of the Atlantis Marine World (the Riverhead Aquarium) follows.

***i.* The Sag Harbor and Shelter Island Heights STPs**
For the baseline scenario, the nitrogen loads from the Sag Harbor and Shelter Island Heights sewage treatment plants were determined by extending the existing effluent quality (i.e., 6.2 mg/L and 10.2 mg/L, respectively) for their permitted flows (0.25 and 0.053 MGD, respectively) or 13. lbs TN/day and 4.5 lbs. TN/day. The nitrogen load assigned to the Sag Harbor STP treatment plant was determined using the current permit effluent discharge concentration (8 mg/L) and the permitted flow (0.25 MGD), resulting in a calculated load of 17 lbs. TN/day. Similarly, the nitrogen load assigned to the Shelter Island Heights STP was determined by extending the existing effluent quality (10.2 mg/L) to the permitted flow (0.053 MGD), resulting in a calculated load of 5.0 lbs. TN/day.

***ii.* Riverhead Sewage Treatment Plant - Overview**
At the Riverhead Sewage Treatment Plant, the current nitrogen load being discharged, based on existing effluent quality and flows, is 70 lbs. of TN/day. For baseline model runs however, the load is 130 lbs./day which was statistically related to the estimated daily average daily loading associated with a monthly average of 170 lbs. per day for a 24-hr composite sample at a sampling frequency of one sample per week. For loads in the future, the assigned load is 40 lbs. TN/day from May 1 to September 30 and 130 lbs. TN/day rest of year. From October 1 to April 30, the load is based on the permitted flow and existing treatment. From May-September, the target load can be achieved by reducing the flow based on a beneficial effluent reuse project that will divert a portion of the flow from discharge to the nutrient sensitive Tidal Peconic River, with the balance of the flow receiving optimization of existing treatment. This is described in additional detail in the section that follows.

***iii.* Riverhead Sewage Treatment Plant – Expanded Discussion**
The Riverhead Sewage Treatment Plant presented some special challenges in this analysis due to the location of its outfall in the poorly flushed and already nutrient enriched Tidal Peconic River. State water quality standards for dissolved oxygen are not currently achieved in the area in the proximity of the outfall. The DO sag occurs in spite of the fact that there is already an advanced wastewater treatment system in place for nutrient removal and that the facility is discharging well below its permitted maximum flow and permitted nitrogen load. Numerous modeling scenarios investigating a variety of point and nonpoint source load reductions demonstrated that it is necessary to reduce this particular point source load, particularly during the critical warm weather months, in order to achieve water quality standards for dissolved oxygen.

The current SPDES permit for this facility authorizes a permitted flow of up to 1.3 million gallons per day and a maximum nitrogen loading of 170 lbs. TN/day (expressed as a monthly average based on a 24 hour composite sample and a sampling frequency of once per week). The permit does not specify concentration limits for nitrogen. If the maximum nitrogen load was discharged at the maximum permitted flow, it would translate to 15.7 mg/L.

At the present time, the Riverhead STP flow is 0.79 MGD and discharges at an average of 10.7 mg/L; this translates to a daily loading of 70 lbs. of TN/day. The discharge load and effluent quality data are based on actual STP monitoring data from April 2002 through February 2006. If the Riverhead STP was to maintain this existing effluent quality at its permitted flow of 1.3 MGD, the nitrogen load would be 116 lbs. TN/day. Additional advanced treatment technology could achieve an effluent quality of 5 mg/L; this will be referred to as the "limit of technology" for the STP. Effluent at this limit of technology would discharge 33 lbs. TN/day at the current flow or 54 lbs. TN/day at the permitted flow.

There is currently a funded project in place through which a portion of the Riverhead STP effluent flow will be beneficially reused to irrigate the adjacent county golf course during the warm weather months (May through September), thereby lessening the impact from the direct discharge to the stressed Tidal Peconic River. Both the current and maximum permitted flows from the STP exceed the projected irrigation needs at the golf course, which has been calculated to be 0.35 MGD. This project, when implemented will use the reclaimed water and reduce the direct loading of a portion of the discharged nitrogen load during the critical warm weather months.

At the permitted flow, with the existing effluent quality, and effluent diversion for beneficial reuse, the calculated load during the warm weather months would be 86 lbs. TN/day. At the current flow with the existing effluent quality, and effluent diversion for beneficial reuse, the calculated load during the warm weather months would be 40 lbs. TN/day.

If the effluent quality is improved to the limit of technology (5 mg/L), at the permitted flow and with effluent diversion for beneficial reuse, the calculated load would be 40 lbs. TN/day. At the limit of technology, the current flow and effluent diversion for beneficial reuse, the calculated load would be 18 lbs. TN/day.

The baseline scenario in the analysis that follows is based on a year-round load from the Riverhead STP of 130 lbs. TN/day. Based upon the various modeling scenarios designed to achieve state water quality standards for dissolved oxygen now and in the future (in combination with other point and nonpoint source load reductions) this TMDL is based on a discharge of 130 lbs. TN/day during the cold weather months and 40 lbs. TN/day during the warm weather months. These loads are achievable at the existing flow, continuing existing effluent quality and effluent diversion for beneficial reuse. It can alternatively be achieved for the permitted flow, at limit of technology treatment and effluent diversion for beneficial reuse.
The information in the preceding paragraphs for the Riverhead Sewage Treatment Plant is summarized in Table V.2.

Table V.2: Riverhead STP Flows, Effluent Concentrations and Nitrogen Loads Associated with Various Discharge Scenarios

Scenario Summary Description	Average Daily STP Flow (MGD)	Average Daily Effluent Concentration (mg/L)	Average Daily Nitrogen Loading (lbs./day)
Current flow at existing effluent quality	0.79	10.7	70
Permitted flow at existing effluent quality	1.3	10.7	116
Permitted flow at existing effluent quality with effluent diversion for reuse	0.95	10.7	86
Permitted flow with limit of technology effluent quality	1.3	5.0	54
Permitted flow with limit of technology effluent quality and effluent diversion for reuse	0.95	5.0	40
Current flow at existing effluent quality and effluent diversion for reuse	0.44	10.7	40
Current flow with limit of technology effluent quality	0.79	5.0	33
Current flow with limit of technology effluent quality and effluent diversion for reuse	0.44	5.0	18

Notes to Table V.2

(1) The current 4 year average from April 2002 through February 2006 flow, discharge load and effluent quality are 0.79 MGD; 70. lbs. TN/day; and 10.7 mg TN/L, respectively. All other values in this table are calculated values.

(2) Anticipated diversion for beneficial effluent reuse, irrigating the adjacent Indian Island County Golf Course, is 0.35 MGD from May 1 through September 30.

(3) The current permit allows a discharge of 1.3 MGD and 170 lbs. TN/day; there is no expressed concentration limit for nitrogen.

iv. Atlantis Marine World (the Riverhead Aquarium)

The Atlantis Marine World facility discharges to the tidal Peconic River, just west of the Riverhead STP. The permitted flow is 0.0081 MGD; there is no nitrogen loading or concentration limit in the current permit. The load assigned to this facility is 4 lb. TN/day; while this assignment is based on a limited data set from discharge monitoring reports, a limit is necessary due to the location of the discharge in the nutrient sensitive tidal Peconic River,

i. Wet and Dry Atmospheric Deposition

The Peconic Estuary Program model documentation presents atmospheric deposition rates (pre implementation of Clean Air Act Amendments) and includes wet and dry deposition of organic and inorganic nitrogen, and translates to approximately 21 kilograms per hectare (18.7 lbs./acre). Wet and dry atmospheric deposition loads are estimated to be reduced by 31.3% in response to the implementation of the Clean Air Act. This results in a direct reduction to the surface waters loads; groundwater TN contributions are projected to be reduced by 0.2 mg/L in response to the improved atmospheric deposition quality (also described/included above under “Groundwater Quality Assumptions for Calculating Loads”).

j. Stormwater Runoff

Stormwater runoff loading is treated as a point source in the model. In response to mitigation, a 15% reduction in stormwater N load is attributed to Peconic River and

Flanders Bay and a 10% reduction to east of Flanders Bay. Note that current stormwater TN loading estimates for the Peconic River and Flanders Bay is 30 lb TN/day and east of Flanders Bay is 100 lb TN/day. The stormwater loading is apportioned to each shoreline model grid cell.

Stormwater discharges from the separate storm sewer systems operated by the Villages of Sag Harbor and North Haven, the Towns of Riverhead, Southampton and Brookhaven, the New York State Department of Transportation, and Suffolk County stormwater facilities are regulated under the EPA's Phase II Stormwater Program. As of March 2003, these municipal entities were required to obtain NPDES permit coverage and to begin implementing comprehensive stormwater management programs designed to reduce and prevent the impacts of their discharges of contaminated stormwater on surface waters. Complete implementation of first permit cycle (2003-2008) municipal Phase II stormwater management programs is mandated by January 2008, at which time the second Phase II permit cycle (2008-2013) will begin. The points of discharge, or outfalls, from regulated municipal separate storm sewer systems are considered point sources to the Peconic Estuary. Other stormwater inputs are not currently regulated as point sources and are managed as nonpoint sources, but this will be reviewed in the future and may result in additional areas subject to municipal stormwater permits.

The stated stormwater load originates from municipal separate stormwater systems as well as from flows from rural and developed areas, including stormwater that directly and indirectly enters watercourses. The stated reductions of 10 % and 15% percent were determined (based upon best professional judgment) to be maximum that could be reasonably achieved.

k. Other Point Sources

In addition to the point sources described above, there are other point sources within the Peconic Estuary watershed: the Brookhaven National Laboratory, the former Naval Weapon Industrial Reserve Plant, and Plum Island STPs. The PEP model accounts for the Brookhaven National Laboratory STP discharge as a boundary load in the tributary load attributed to the Peconic River, which is expressed as a loading allocation (LA) within these TMDLs. The BNL discharge does not discharge to estuarine waters or directly to an impaired segment. The Plum Island STP discharges to an extremely well mixed area at the eastern boundary of the system and its impact on the Peconic Estuary System is considered de minimus due to its location. While the former Naval Weapon Industrial Reserve Plant (previously operated by the Grumman Corporation) in Calverton, NY has an STP that discharges to a branch of the Peconic River, the operators have submitted engineering reports to upgrade and build a new facility discharging outside of the Peconic Estuary study area. Additional discussion of these discharges is provided in the implementation section of this report.

3. Summary of Baseline Nutrient Loads and Uncertainties

In the average estimated baseline year, 5,357,364 pounds of nitrogen enters the Peconic Estuary, consisting of: 3,015,041 pounds (56%) from atmospheric deposition; 2,175,031 pounds (41%) from groundwater, 66,242 pounds (1%) from the Peconic River and seven western tidal creeks, 53,689 pounds (1%) from three sewage treatment plants, and 47,361 pounds (1%) from stormwater. It should also be noted that the model integrates stormwater into river flows. Actual loadings will vary from year to year depending on the amount and intensity of rainfall and meteorological conditions that affect water circulation and fluxes. Land development trends in the future and how humans contribute nitrogen to the landscape and to groundwater (principally from on-site disposal systems, agricultural operations, and lawn care and landscaping) will also affect nitrogen load increases or decreases. Future work may improve estimates of land based contributions and atmospheric deposition rates.

Estuaries, by their very nature, are complex and are in a constant state of change. The twice daily flooding and ebbing tides mix ocean water with freshwater from rivers, creeks, and groundwater to form a rich cradle of life. Likewise, the watershed surrounding the estuary also changes: homes are built on open space; some land is preserved in its natural state for the benefit of humans and wildlife; farmland is tilled or is left to lie fallow; an individual makes a decision about whether to apply fertilizers. The cumulative effects of natural events and human actions (or inaction) will ultimately influence the Peconics, its watershed, and everything in them. While areas with low levels of dissolved oxygen continue to exist, total nitrogen concentrations throughout the main stem of the estuary seem to be decreasing. Decreases in nitrogen concentrations in the western Peconic Estuary may possibly be due to decreases in loadings to the system, increased uptake in the food web, or some combination of these two mechanisms (and perhaps others). Decreases in loadings may be attributed to the Riverhead Sewage Treatment Plant tertiary treatment upgrade completed in May 2001and decreases in the nitrogen load contributed from the freshwater portion of the Peconic River (a marked decrease in nitrogen concentrations from the freshwater portion of the Peconic River has been seen in the past 20 years). Changes in subregional land uses and agricultural practices also may have an impact on nitrogen concentrations in groundwater (e.g., conversion of agricultural land to residential uses, and row crops to vineyards (vineyards being less heavily fertilized)). It should be noted that the roles macroalgae, sediment nutrient flux, and filter feeders play in affecting the surface water concentrations of nitrogen are believed to be significant. Ambient total nitrogen water quality levels should not be considered the only indicator of eutrophication stress. Further study is warranted to better understand where excess nitrogen is going and why DO conditions are not improving.

The tables and pie charts that follow depict nitrogen sources for the three impaired waterbody segments and for the other waters in the Peconic Estuary System, as well as a summary of the entire system by waterbody and by nitrogen source.

Table V.3: Baseline Nitrogen Load Summary for Segment 1701-259, Lower Peconic River and Tidal Tributaries

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	2,590.
Groundwater	115,672.
Little River	2,181.
Peconic River	40,146.
Stormwater	3,140.
Riverhead STP	47,353.
Total*	211,072.

*May not add due to rounding

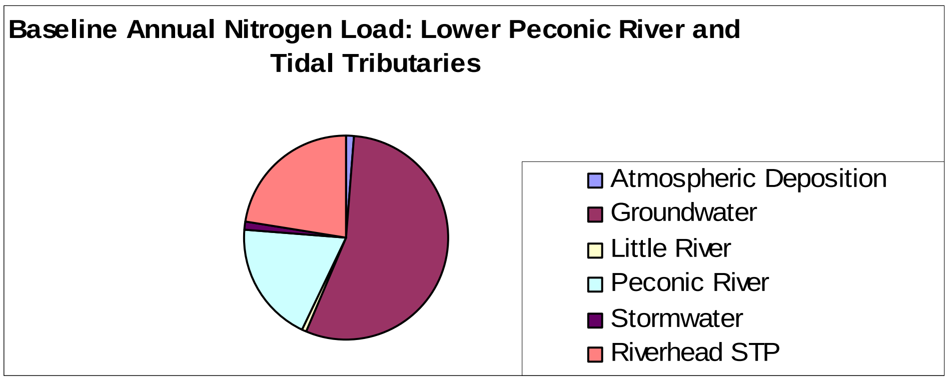


Table V.4: Baseline Nitrogen Load Summary for Segment 1701-254, Western Flanders Bay and Lower Sawmill Creek

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	2,724.
Groundwater	26,539.
Sawmill Creek	2,181.
Stormwater	1,919.
Total*	33,363.

*May not add due to rounding

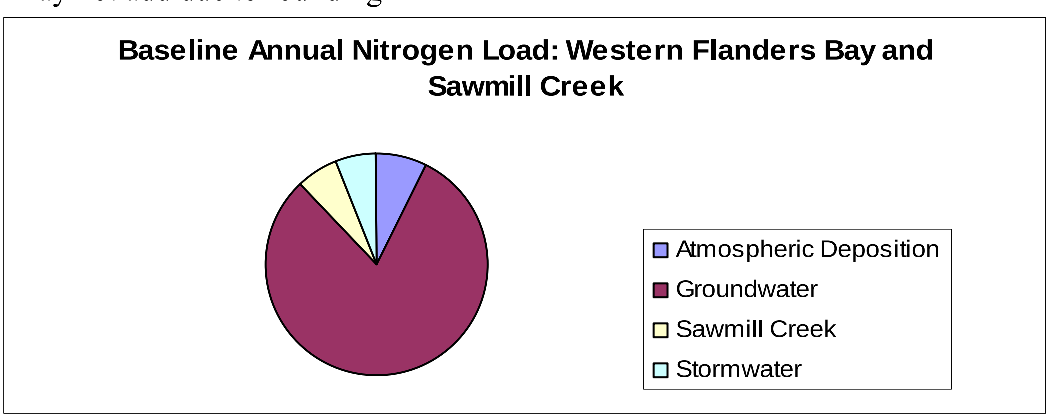


Table V.5: Baseline Nitrogen Load Summary for Segment 1701-256, Meetinghouse Creek and Terrys Creeks and Tributaries

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	1,508.
Groundwater	77,387.
Terrys Creek	1,589.
Meetinghouse Creek	17,021.
Stormwater	2,328.
Total*	99,838.

* May not add due to rounding

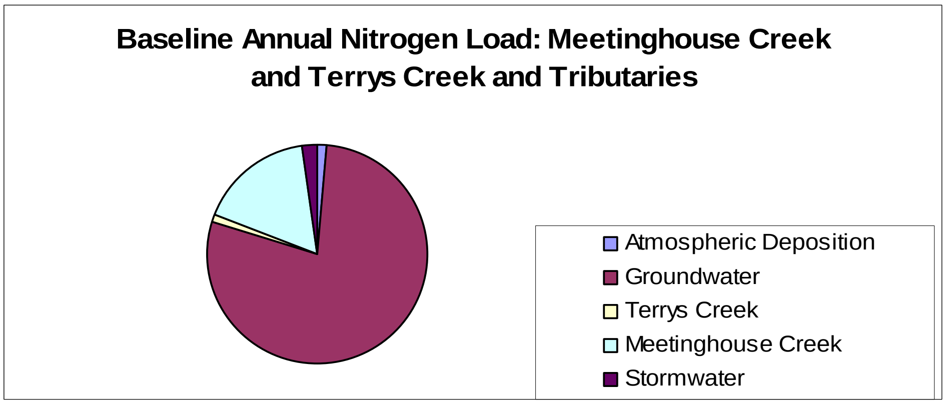


Table V.6: Baseline Nitrogen Load Summary for Flanders Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	46,490.
Groundwater	176,811.
Hubbard Creek	1,733.
Mill Creek	940.
Birch Creek	452.
Stormwater	3,541.
Total*	229,966.

*May not add due to rounding

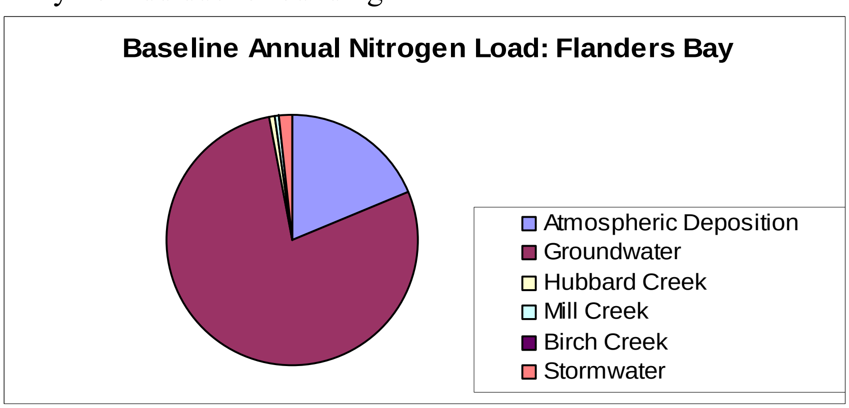


Table V.7: Baseline Nitrogen Load Summary for Great Peconic Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	379,951.
Groundwater	309,881.
Stormwater	3,252.
Total*	693,081.

*May not add due to rounding

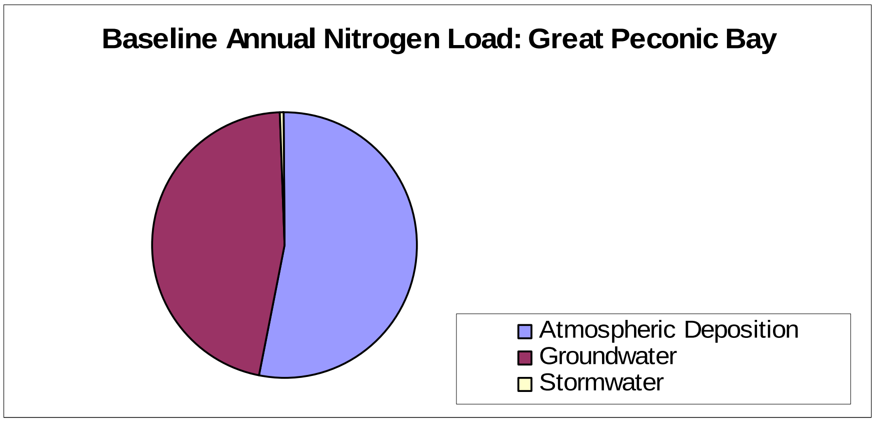


Table V.8: Baseline Nitrogen Load Summary for Little Peconic Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	251,440.
Groundwater	327,139.
Stormwater	5,990.
Total*	584,565.

* May not add due to rounding

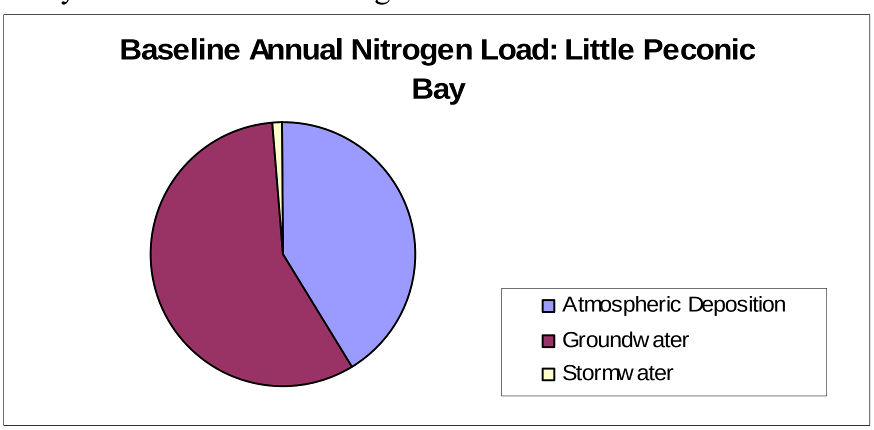


Table V.9: Baseline Nitrogen Load Summary for Shelter Island Sound

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	438,292.
Groundwater	645,275.
Sag Harbor STP	4,690.
Shelter Island Heights STP	1,646.
Stormwater	18,983.
Total*	1,108,888.

*May not add due to rounding

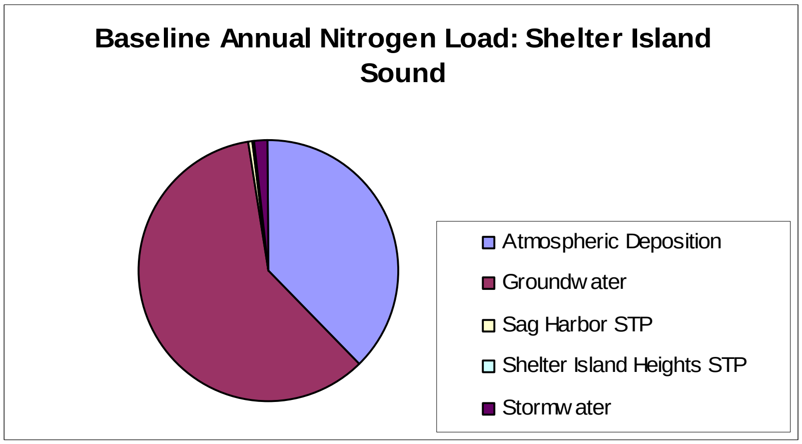


Table V.10: Baseline Nitrogen Load Summary for Gardiners Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	1,892,048.
Groundwater	496,327.
Stormwater	8,207.
Total*	2,396,587

*May not add due to rounding

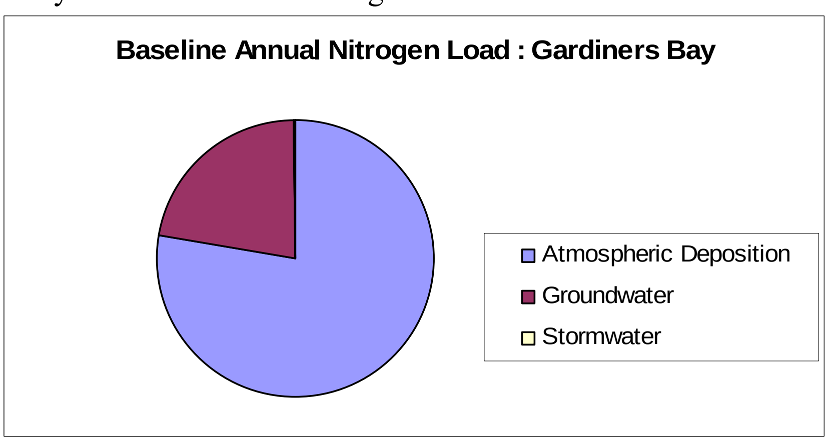
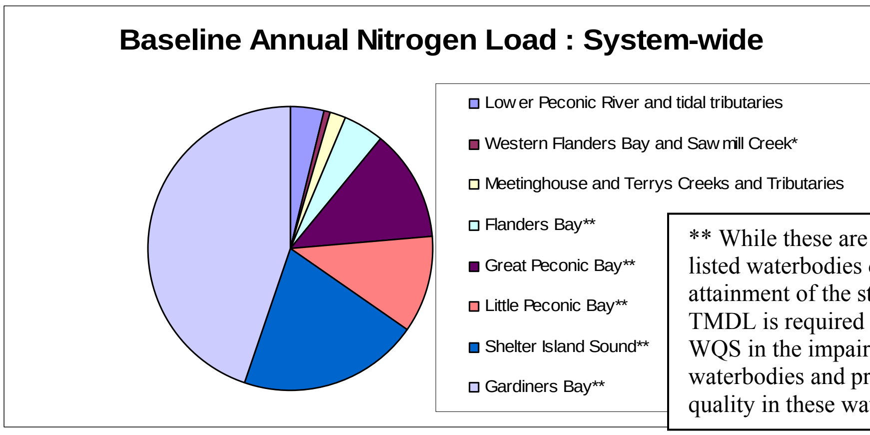


Table V.11: Baseline Systemwide Summary

Nitrogen Source	Total Annual Load TN (lbs)
Lower Peconic River and tidal tributaries	211,072.
Western Flanders Bay and Sawmill Creek	33,363.
Meetinghouse and Terrys Creeks and Tributaries	99,838.
Flanders Bay	229,966.
Great Peconic Bay	693,081.
Little Peconic Bay	584,565.
Shelter Island Sound	1,108,888.
Gardiners Bay	2,396,587.
Total*	5,357,359.

*May not add due to rounding

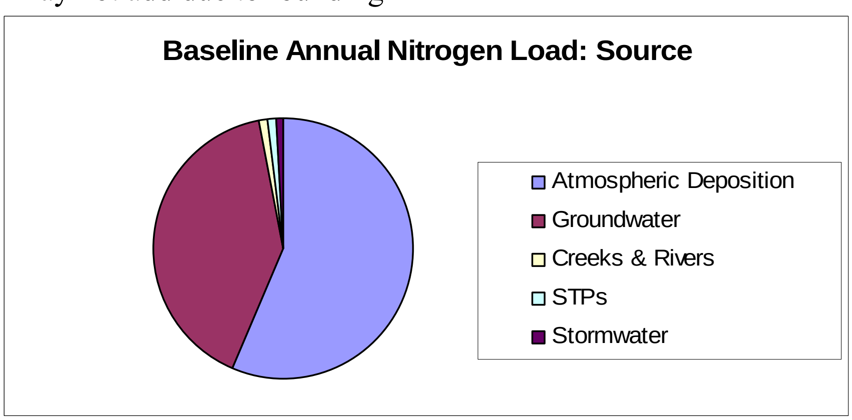


** While these are not 303(d) listed waterbodies due to non-attainment of the state DO WQS, a TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in these waterbodies.

Table V.12: Baseline Systemwide Summary by Source

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	3,015,041.
Groundwater	2,175,031.
Creeks & Rivers	66,242.
STPs	53,689.
Stormwater	47,361.
Total*	5,357,364.

*May not add due to rounding



C. Water Quality Model

Under the Peconic Estuary Program, the SCDHS, EPA, and the DEC sponsored the development of a three-dimensional, time-variable hydrodynamic and water quality model called the Environmental Fluid Dynamics Code or EFDC (Hamrick, 1992). EFDC is a public domain, open source, surface water modeling system, which includes hydrodynamic, sediment and contaminant, and water quality modules fully integrated in a single source code implementation. The kinetic processes included in the EFDC water quality model are derived from the CE-QUAL-ICM water quality model (Cerco and Cole, 1993, 1994) as described in Park et al. (1995). The water quality model also included a sediment flux processes submodel. The model incorporated advanced physical, biological, and chemical kinetics that relate nutrients to phytoplankton dynamics and DO. The model was used to help understand nutrient and oxygen dynamics in the Peconic Estuary System and to evaluate alternative nutrient management options for improving water quality.

The model used for the Peconic Nitrogen TMDL built upon the PEP model by including a much more detailed grid in the western bays in order to provide adequate resolution for resolving water quality issues in the three listed waterbodies (i.e., the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries). The vertical resolution of the model was increased from two layers in the PEP study to four layers in the TMDL effort. Also, kinetic rates in the sediment flux submodel were updated based on information from a sediment accretion study funded under PEP (Cochran et al., 2000) as well as from published data (DiToro, 2001).

The EFDC model was calibrated using an eight-year period from October 1, 1988 to September 30, 1996. The model was verified using a six-year period from October 1, 1996 to September 30, 2002. Details of the calibration and verification are documented in the hydrodynamic and water quality model reports (Tetra Tech, 2000, 2005). The 14-year period covered by the calibration and verification included all seasons of the year as well as extreme wet and dry years. Tributary loadings were determined using time-variable river flow measured at the Peconic River USGS gauge (01304500) and observed water quality data. Meteorological, hydrological, and tidal forcing conditions that influence external boundary conditions and internal circulation within the estuary have been considered and are included in the model. The EFDC model reproduced both the temporal and spatial trends in observed data and successfully simulated the 1988-2002 conditions.

Although data records indicate that the occurrence of low DO takes place from May through September, nitrogen loadings throughout the year contribute to the pool of nitrogen available for uptake by phytoplankton and for distribution to bottom sediments. The model indicated that the Riverhead STP warranted special attention to seasonal management of nitrogen due to the location of its outfall in relation to the critical DO sag point in tidal Peconic River.

A review of the biweekly monitoring data collected by SCDHS indicated that the October 2000 to September 2002 time frame was the most severe period in terms of DO observations below the New York State water quality standard of 5 mg/L. Based on this review, the period October 1, 2000 to September 30, 2002 was selected as the critical period for the TMDL model runs. Because 2000-2002 was a severe period, average year conditions would predict better water quality conditions. Thus, by using the severe conditions of 2000-2002 as the TMDL modeling period, a conservative level of nitrogen reduction is identified, thereby providing a margin of safety (MOS) for average years.

1. Water Quality Model Projections

The EFDC model was run under a range of alternative nutrient management loading scenarios to simulate the effect on DO concentrations, especially in the listed waterbodies. Of particular importance were simulations of "baseline" and "pastoral" conditions. The baseline condition consisted of existing nutrient loadings corresponding to the 2000-2002 modeling period, and provided important information on the dynamics of oxygen in western Peconic Estuary and the causes for its depression. The pastoral condition included loadings of nutrients estimated for a pristine, forested watershed that presumably existed before colonial settlement of the region. This condition provided insight into what oxygen levels may have been before intensive human uses in the Peconic Estuary watershed.

One of the advanced features of the EFDC model is the sediment processes submodel, which provides dynamic simulation of benthic nutrient fluxes and sediment oxygen demand in response to variations in external loading of organic material to the system. Model tests indicated that the sediment requires about six years to reach a new dynamic equilibrium in response to a reduction in nutrient loading to the model. Therefore, each of the alternative model simulations, including the baseline and pastoral scenarios, was run for a total of six years. In other words, the two-year simulation period (October 1, 2000 to September 30, 2002) was repeated three times with the water column and sediment conditions at the end of each run being input as initial conditions for the beginning of the next two-year run. It is important to remember that the model predicts that there will be a six-year lag time between the implementation of nutrient controls and the corresponding full response of improvements to water quality in the Estuary.

Interpretation of the monitoring data as well as the results of the water quality model led to the following conclusions:

- The monitoring data and modeling results both indicate that nitrogen, not phosphorus, is the limiting nutrient for phytoplankton growth in the western Peconic Estuary.

- The model reproduced the principal interactions among density-driven circulation, nutrient inputs, sediment nutrient flux processes, and phytoplankton abundance on an annual cycle. The spatial and temporal distributions of dissolved oxygen were also reproduced on both an annual cycle and a daily cycle in the critical western region of Peconic Estuary.

- Sediment fluxes of nutrients and sediment oxygen demand are especially important in the shallow waters of the western Estuary. The model adequately reproduced the temporal and spatial distribution of sediment flux rates that were measured in the Estuary.

- Hypoxia is defined as a reduced oxygen concentration in a water body that may lead to stressful or fatal conditions for aquatic organisms. Hypoxic conditions for the TMDLs are considered as DO concentrations less than 3.0 mg/L, which is the acute DO criterion in the proposed New York water quality standard. The extent of hypoxia was estimated by using the model results to calculate a volume-day unit of measure (acre-feet-days) for each of the three impaired waters (see Table V.3).

- The chief regulators of DO concentrations in the Estuary are related to biological activity. While nitrogen is essential to a productive ecosystem, too much nitrogen fuels the excessive growth of aquatic plants, including phytoplankton and macroalgae that may, through night-time respiration and ultimate decomposition (including accumulations in bottom sediments), result in low dissolved oxygen levels in the water column. Night-time respiration of plants in combination with other routes of oxygen demand (especially sediment oxygen demand) can cause short-term DO depressions in the early morning hours (diurnal dissolved oxygen variation).

- In Table V.3, the column labeled "Worst Case Scenario" shows the hypoxic volume-days assuming DO is less than 3.0 mg/L at all locations and all times. The hypoxic volume-days total for baseline conditions is about 2% of the worst-case scenario total. However, this is somewhat misleading because hypoxic conditions may only need to exist for a short period of time (e.g., one or two hours) to be fatal to some aquatic organisms.

- For pastoral conditions, the DO concentration in all waters is greater than the 3.0 mg/L hypoxic threshold at all times.

The pastoral scenario is sensitive to the methods used to estimate loadings to the Peconic Estuary. The elimination of point source loads from sewage treatment plants in the Peconic Estuary is straightforward. However, pastoral estimates are not as easily made for nutrient loads from natural forested areas in the watershed and groundwater underflow loads. For this TMDL analysis, atmospheric deposition during pastoral times was estimated to be 31.3% less than present day levels, which only represents the projected improvement that will occur with implementation of Clean Air Act pollution controls. The rationale behind this assumption is that air quality in pastoral times should have been at least as good as the projected quality due to Clean Air Act improvements.

Ultimately, the full achievement of designated uses and water quality standards will be the result of actions on several fronts, including the preservation of open space and ensuring that where future development does occur, it results in lower loading rates of nitrogen to groundwater than current existing development practices. Existing sources of nitrogen need to be reduced, including from wet and dry atmospheric deposition, agricultural operations, stormwater (both regulated/permitted flows and flows not currently subject to regulation/permitting), residential lawn care and gardens, golf courses and turf in other commercial and institutional settings. Loadings from sewage treatment plants and other point sources must also be managed. Based on the modeling effort, implementation of this TMDL (including mechanical aeration where and if necessary) will achieve New York State Water Quality Standards for dissolved oxygen, including the diurnal DO variation that has been discussed previously.

Table V.3: Hypoxic Volume-Days in 303(d) Impaired Waters of Western Peconic Estuary

Waterbody ID	Waterbody Name	Hypoxic Volume-Days (ac-ft-days)				
		Worst Case Scenario	Baseline Condition	Practical Load Reduction Scenario	PLR plus Mechanical Aeration	Pastoral Condition
1701-0259	Tidal Peconic River and tributaries	313,697.	12,036.	192.	0.00	0.00
1701-0254	Sawmill Creek and Western Flanders Bay	303,510	1,891	1.50	0.00	0.00
1701-0256	Meetinghouse Creek and Terrys Creek	130,039	1,175.	5.09	0.00	0.00
	Total	747,246	15,102	199.	0.00	0.00
		Percent Reduction from Baseline Condition				
1701-0259	Tidal Peconic River and tributaries	-	0.00%	98.40%	100.00%	100.00%
1701-0254	Sawmill Creek and Western Flanders Bay	-	0.00%	99.92%	100.00%	100.00%
1701-0256	Meetinghouse Creek and Terrys Creek	-	0.00%	99.57%	100.00%	100.00%
	Total	-	0.00%	98.68%	100.00%	100.00%

2. Development of Nitrogen Reduction Plans

The EFDC model of Peconic Bay was used to simulate the effects of reducing nitrogen loading on DO concentrations in the estuary. Of particular interest were the “practical load reduction” (PLR) scenario and the “PLR plus mechanical aeration” scenario. The PLR scenario included nutrient loading at projected growth and reductions described above in V.B.2, Nutrient Loading Factors, for controllable sources within the Peconic Estuary watershed. In the western portion of Peconic Estuary, aside from the regulated MS4s, there is one STP (Riverhead) and eight tributary inflows included in the model (see Figure V.4 and Tables V.4 and V.5). The small Atlantis Marine World facility also discharges to the tidal Peconic River. There are a number of groundwater management zones for which nitrogen concentrations were estimated (see Figures V.3 and V.5 and Table V.6). Monthly-varying groundwater flows into the Peconic Estuary were estimated from a study by the USGS (Schubert, 1998). Estimated reductions in groundwater nitrogen loads were based on management measures placed on land uses within the groundwater management zones.

Table V.4: SPDES Permit Limits for Peconic Estuary Sewage Treatment Plants

Facility SPDES ID	Baseline Condition		Practical Load Reduction Scenario (Oct-Apr)		Practical Load Reduction Scenario (May-Sep)	
	Flow (mgd)	TN (lb/day)	Flow (mgd)	TN lb/day)	Flow (mgd)	TN (lb/day)
Riverhead NY0020061	1.300	130	1.300	130	0.950	40
Sag Harbor NY0028908	0.250	13	0.250	17	0.250	17
Shelter Island NY0021814	0.053	4.5	0.053	5	0.053	5

Note: there were no STP discharges in the pastoral scenario

Table V.5: Tributary TN concentrations for the baseline, pastoral, and practical load reduction scenarios

Tributary	Flow ratio to Peconic River USGS gage	TN Concentration (mg/L)		
		Baseline Condition	Pastoral Scenario	Practical Load Reduction Scenario
Peconic River	1.0160	0.65	0.3	0.38
Meetinghouse Creek	0.0957	7.00	0.3	4.19
Hubbard Creek	0.0439	0.65	0.3	0.38
Mill Creek	0.0238	0.65	0.3	0.38
Birch Creek	0.0114	0.65	0.3	0.38
Terrys Creek	0.0290	0.65	0.3	0.38
Sawmill Creek	0.0402	0.65	0.3	0.38
Little River	0.0552	0.65	0.3	0.38

Table V.6: Groundwater TN concentrations for the baseline, pastoral, and practical load reduction scenarios

Groundwater Management Zone	Area (acres)	Baseline Condition (mg/L)	Pastoral Scenario (mg/L)	Practical Load Reduction Scenario (mg/L)
Montauk (MONT)	8,515	4.00	0.3	3.06
Gardiners Bay South (GB-S)	15,998	4.00	0.3	3.04
Little Peconic South (LP-S)	15,090	4.00	0.3	2.89
Great Peconic South (GP-S)	10,001	4.00	0.3	3.11
South Fork Inland (SF-I)	3,177	3.00	0.3	2.54
South Fork Central (SF-C)	1,777	3.00	0.3	2.27
North Fork Central (NF-C)	1,798	8.00	0.3	4.37
North Fork Inland (NF-I)	1,409	8.00	0.3	3.89
Peconic River East (PR-E)	6,884	5.00	0.3	2.95
Great Peconic North (GP-N)	7,011	9.00	0.3	5.23
Little Peconic North (LP-N)	9,357	9.00	0.3	5.91
Gardiners Bay North (GB-N)	3,202	9.00	0.3	5.21
Shelter Island (SHE)	7,173	3.00	0.3	2.26
Meetinghouse Creek (MC)	1,236	9.00	0.3	4.19

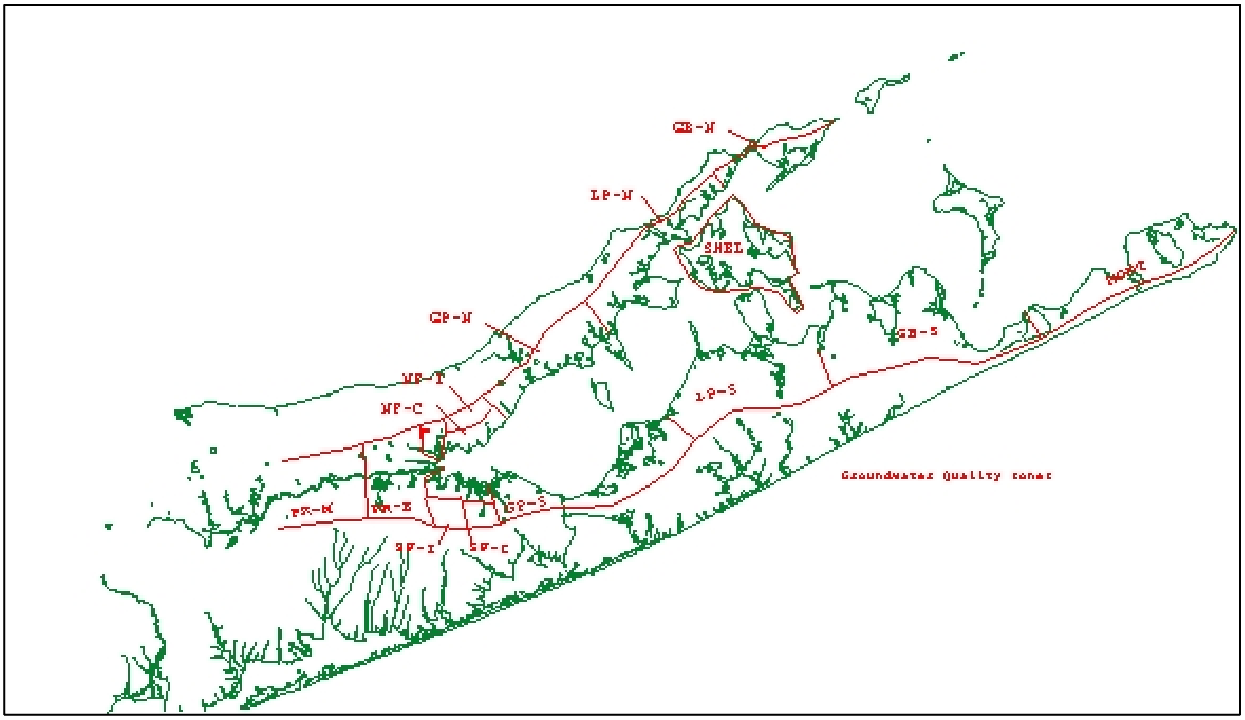


Figure V.3: Peconic Estuary Study Area Groundwater Management Zones

The practical load reduction scenario includes the reasonable cumulative full build-out scenario [50% of remaining farmland is preserved; 15% of vacant land is protected (30% in Meetinghouse Creek (MC) and Peconic River–East (PR-E) groundwater management zones); 15% of subdividable land is protected (30% in MC and PR-E); rest of agricultural, vacant and further subdividable land is developed with clustering and vegetation preservation requirements (i.e., clearing restrictions)]. This scenario also includes:

1) A 25% total nitrogen (TN) reduction from all protected agricultural parcels (50% reduction in the MC and PR-E groundwater management zones)
2) A 25% TN reduction from golf course parcels (50% reduction in MC and PR-E)
3) A 25% TN reduction from existing development (non-agricultural) parcels (33% reduction in MC and PR-E)
4) A 37.5% TN reduction from the existing agricultural land, vacant land, and further subdividable land that is then developed with clustering and vegetation preservation requirements (50% reduction in MC and PR-E)
5) A 31.3% TN reduction in atmospheric deposition and groundwater TN contributions reduced by 0.2 mg/L in response to the improved atmospheric deposition quality
6) Currently permitted effluent quality extended to permitted flow for Sag Harbor Sewage Treatment Plant (*i.e.*, 8 mg TN/liter) permitted flow of 0.25 million gallons per day (MGD))
7) Existing effluent quality extended to permitted flow for Shelter Island Heights Sewage Treatment Plant (*i.e.*, 10.2 mg TN/liter based on 4-yr average of DEC discharge monitoring records from April 2002 to February 2006 and permitted flow of 0.053 MGD)

8) At Riverhead Sewage Treatment Plant, the load is 40 lb TN/day from May 1 to September 30 and 130 lb TN/day rest of year. From May-September, a flow of 0.95 MGD will be employed to reflect permitted flow conditions (1.3 MGD) less the effluent projected to be used irrigating the adjacent golf course (0.35 MGD). From October 1 to April 30, a flow of 1.3 MGD will be employed.
9) At Atlantis Marine World, this 0.0081 MGD design flow facility is assigned a load of 4 lbs. TN/day.
10) Stormwater runoff loading is treated as a point source in the model. In response to mitigation, a 15% reduction in stormwater N load is attributed to Peconic River and Flanders Bay and a 10% reduction to east of Flanders Bay. Note that current stormwater TN loading for the Peconic River and Flanders Bay is 30 lb TN/day and east of Flanders Bay is 100 lb TN/day. The stormwater loading is apportioned to each shoreline model grid cell.

The practical load reduction plus mechanical aeration scenario is identical to the practical load reduction scenario described above except that mechanical aeration is added to specific locations in the impaired waters to bring the dissolved oxygen levels into compliance with the both existing and proposed New York water quality standards. Model results indicated that about 7,180 lb/day of oxygen will need to be added to the impaired waters during critical summer months (May 1 to September 30) to attain the existing DO standard of 5.0 mg/L. The estimated cost of mechanical aeration to attain the existing DO standard is up to $2,300,000 for initial capital expenses and up to $189,000 for annual operating costs. To attain the proposed DO standard, 980 lb/day of DO will need to be added during the summer period. The estimated cost of mechanical aeration to attain the proposed DO standard is up to $330,000 for initial capital expenses and up to $27,000 for annual operating costs.

Using the EFDC model simulations, the following improvements to water quality in the 303(d) impaired waters were projected for the practical load reduction scenario and practical load reduction plus mechanical aeration scenario:

- For the practical load reduction scenario, the total hypoxia measured in volume-days is reduced by more than 98% from the baseline condition (see Table V.1).

- For the practical load reduction scenario with mechanical aeration, the DO concentrations in all waters are above the hypoxic threshold at all times, therefore hypoxia is reduced by 100% from the baseline condition.

As a result of these analyses, this TMDL includes overall nitrogen reduction targets of 34.3% for the winter period (October 1 to April 30) and 43.4% for the summer period (May 1 to September 30) from loads associated with the cumulative full build-out scenario without load reductions. Even greater reductions would be required in a worst case cumulative full build-out scenario (i.e., less vacant and further subdividable land is protected, vacant and further subdividable land that is developed is developed without clustering requirements or vegetation preservation requirements (clearing restrictions).

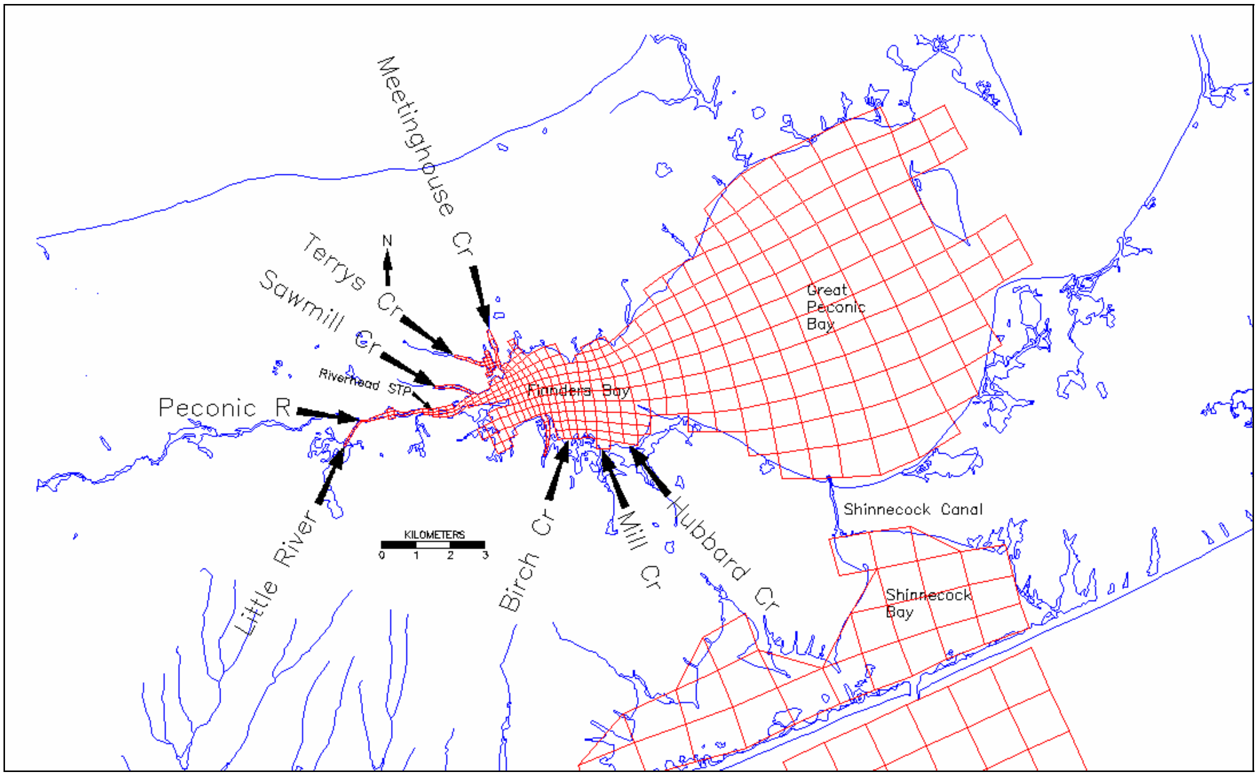


Figure V.4: Locations of tributary and STP inflows in western Peconic Estuary

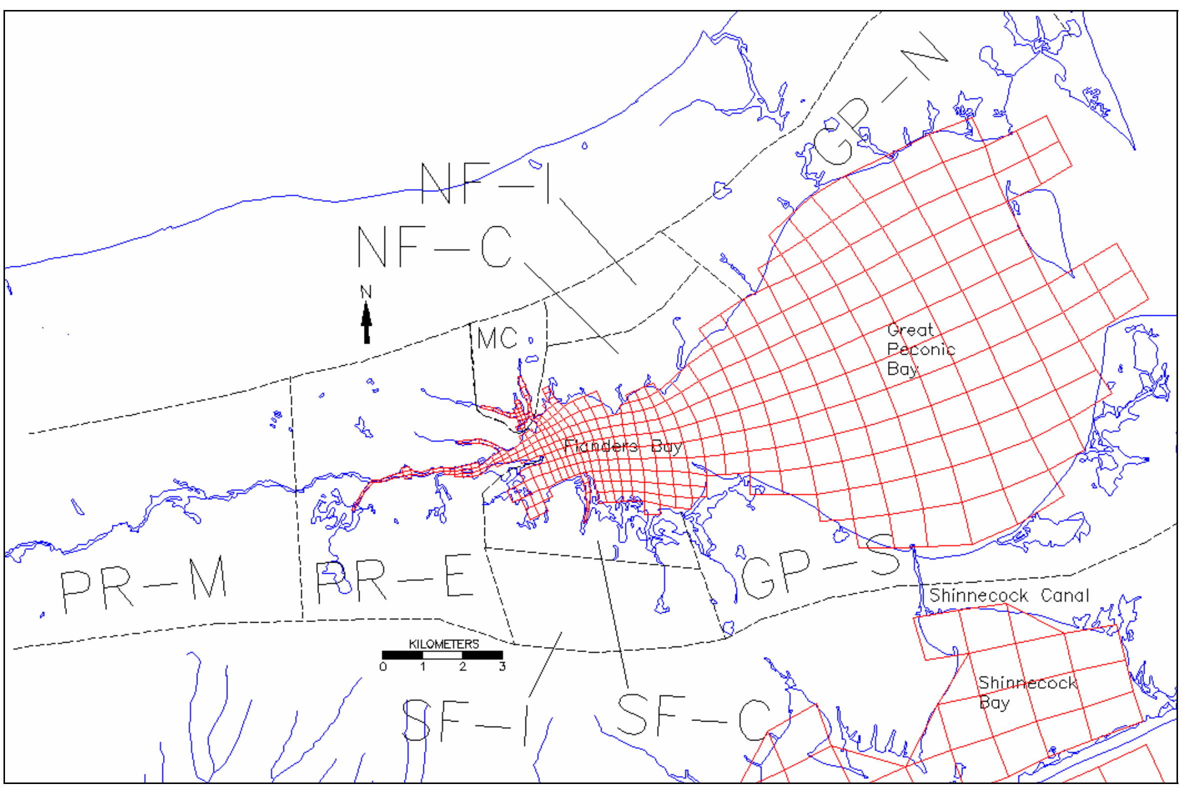


Figure V.5: Locations of groundwater management zones in western Peconic Estuary

VI. TMDL/WLAs/LAs for Nitrogen

This section describes the total maximum daily load, wasteload allocations and loading allocations for the Peconic Estuary to address impairments due to non-attainment of the state water quality standards for dissolved oxygen, discussion and details on the allocation of loads, mechanical aeration, margin of safety, critical conditions, seasonal variations, and an overall summary.

Section 303(d) of the Clean Water Act requires the establishment of TMDLs that will result in attainment of water quality standards. As the term implies, TMDLs are typically expressed as maximum daily loads. However, as specified in 40 CFR 130.2(I), TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. As discussed in Section V.C. of this document, nitrogen loadings throughout the year contribute to the pool of nitrogen available in the Peconic Estuary for uptake by phytoplankton. Also, the magnitude of the range of daily dissolved oxygen concentration is dependent on the abundance of phytoplankton as well as the strength of sediment oxygen demand, which leads to depressed DO levels in the pre-dawn and early morning hours. The hypoxia resulting from the decay of phytoplankton is due to both long-term nitrogen loadings and daily or short-term nitrogen-oxygen dynamics. Therefore, the Peconic Estuary nitrogen TMDL is expressed in terms of both a daily average nitrogen load and a daily maximum nitrogen load based on model simulations of the October 2000 to September 2002 period. In addition, the TMDL is further categorized into seasonal loads for a summer period (May 1 to September 30), which is the critical season for hypoxia, and a winter period (October 1 to April 30).

For the three 303(d) listed impaired waters, the practical-load-reduction (PLR) scenario targets a nitrogen reduction of 37.5% for the winter period (October 1 to April 30) and 42.3% for the summer period (May 1 to September 30). Although the PLR scenario is predicted to greatly reduce hypoxia and minimize impacts on aquatic life, there were some areas of the western Peconic Estuary that continued to experience DO concentrations below both the existing and proposed water quality standards for a short period of time, though the PLR scenario meets the proposed DO standard in one of the two model years. It is however necessary for this TMDL to identify additional actions for achieving water quality standards, namely, the use of mechanical aeration in those areas experiencing contraventions of the DO standards. This TMDL is expressed as the sum of the PLR nitrogen targets, the addition of oxygen via mechanical aeration, and an implicit margin of safety. Model predictions indicated that mechanical aeration was not necessary to achieve DO water quality standards during the winter period.

TMDL (winter) = 37.5% nitrogen reduction from all sources + margin of safety

TMDL (summer) = 42.3% nitrogen reduction from all sources + oxygen from mechanical aeration + margin of safety

The pollutant reductions and resultant DO improvements from each of these components are identified in sections A through C that follow. Implementation of management actions, measures, practices and controls lead to the specified loads not being exceeded are predicted to result in attainment of water quality standards in each of the three impaired waters of western the Peconic Estuary. The water quality model was used to assess the degree to which mechanical aeration could provide the remaining improvement in DO needed to achieve water quality standards. The margin of safety provided in the analysis is discussed in Section C.

A. Allocation of Sources

Seasonal nitrogen loads categorized by source for the three impaired 303(d) waterbodies (see Figure VI.1), as well as Flanders Bay, Great Peconic Bay, Little Peconic Bay, Shelter Island Sound and Gardiners Bay for the baseline and TMDL scenarios, are summarized in Tables VI.1 through VI.8. The summer daily average load was calculated during the May 1 to September 30 periods of the 2-year model simulation. The summer maximum daily load is the largest of the daily loads during the May 1 to September 30 periods of the 2-year simulation. The winter daily average load was calculated during the October 1 to April 30 periods of the 2-year model simulation.

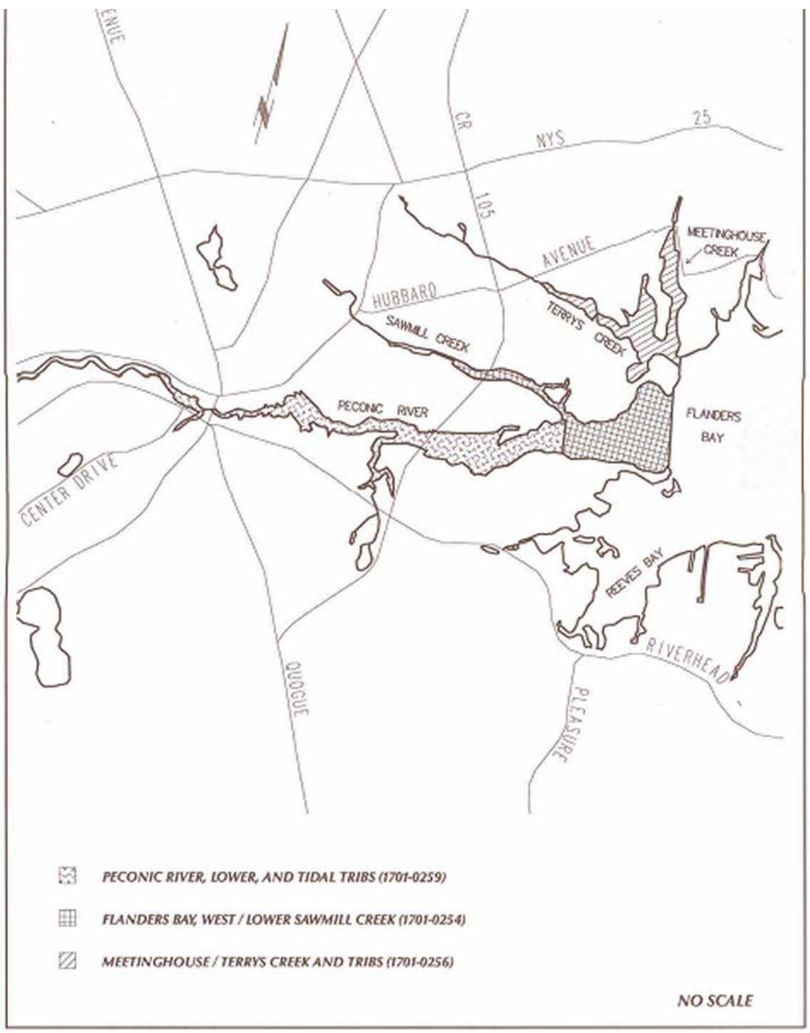


Figure VI.1: Locations of waterbodies on 303(d) list impaired for nitrogen and low DO

The winter maximum daily load is the largest of the daily values during the October 1 to April 30 periods of the two-year simulation. The locations of the tributary inflows to the water quality model were shown previously in Figure V.4. The groundwater management zones used to develop nitrogen loads for the water quality model were shown in Figures V.3 and V.5. A description of the practical-load-reduction (PLR) scenario was provided in Section V.C.2.

River loads include some regulated stormwater discharge from MS4s, and the requirement for 15 % reduction applies to the MS4s discharging to these rivers. Also, the stormwater load estimates includes some unregulated stormwater from private property to surface water that were not separated out in the model analysis. Both the MS4 loads to the rivers and the overestimation in the stormwater (WLA) are minimal and tend to balance each other out.

Consistent with the recommendations in EPA's November 15, 2006 memo, "Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, (April 25, 2006) and Implications for NPDES Permits," the TMDL/WLAs/LAs have also been expressed as daily loads. As noted in the guidance, "EPA does not believe that the Friends of the Earth decision requires any changes to EPA´s existing policy and guidance describing how a TMDL´s wasteload allocations are implemented in NPDES permits." Water quality-based effluent limits (WQBELs) in NPDES permits that implement wasteload allocations in approved TMDLs must be "consistent with the assumptions and requirements of any available wasteload allocation for the discharge" 122.44(d)(1)(vii)(B). These provisions do not require that effluent limits in NPDES permits be expressed in a form that is identical to the form in which the wasteload allocation for the discharge is expressed in a TMDL. The permit writer has the flexibility to express the effluent limitation using a time frame appropriate to the water body, pollutant, and the applicable water quality standard. In addition, allocations based on monthly, seasonal or annual timeframes may be used to guide management measures and implementation efforts because they are related to the overall loading capacity of the waterbody, while the daily expressions represent day to day snapshots of the total loading capacity based on ambient conditions.

In presenting the daily average and maximum daily stormwater loads, the baseline and TMDL values as presented in Tables V1.1 through V1.8 are the same. This simplification is reflective of the way stormwater nitrogen loads are provided as an input to the model (the stormwater loading is apportioned to each shoreline model grid cell), that stormwater presents a relatively small contribution in relation to the sources (especially groundwater, and particularly to co-occurring wet weather inputs associated with groundwater and wet atmospheric deposition), and the relatively even and diffuse distribution of stormwater inputs (either as discrete conveyances or as diffuse overland flow) across the Estuary and its shoreline. Future efforts could potentially result in more refined apportionments and precision regarding daily average and maximum daily stormwater loads than can presently be derived and appear as part of this TMDL.

Similarly, the model runs were simplified by using constant seasonal loadings for point sources. The model runs have shown that the dissolved oxygen response integrates nitrogen loading over a period of days. The hypoxia resulting from night time respiration and the decay of phytoplankton is due to both long-term nitrogen loadings and daily or short-term nitrogen-oxygen dynamics. Thus imposition of a daily maximum load for the Riverhead STP is not critical, and the warm weather 40 lbs/day limit for the Riverhead STP may be incorporated into the SPDES permit as a monthly average.

Table VI.1: Nitrogen load summary for segment 1701-259, Lower Peconic River and Tidal Tributaries

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	6.47	97.68	4.44	67.1	31.3%	31.3%
Groundwater (LA)	318.	331.	184	191.	42.2%	42.3%
Little River (LA)	5.87	18.92	3.43	11.07	41.5%	41.5%
Peconic River (LA)	108.	348.	63.16	204.	41.5%	41.5%
Stormwater (WLA)	9	9	7	7	15.0%	15.0%
Riverhead STP (WLA)	130.	130.	130.	130**.	0.0%	0.0%
Atlantis Marine World (WLA)	***	***	4	4		
Total*	577.	934.	396.	614.	31.4%	34.3%
Sum of October 1 to April 30 WLAs*	1396	139	141	141		
	May 1 to September 30					
Atmospheric Deposition (LA)	7.96	152.	5.48	104.	31.3%	31.3%
Groundwater (LA)	315.	331.	182.	191.	42.2%	42.3%
Little River (LA)	6.12	13.90	3.59	8.14	41.5%	41.5%
Peconic River (LA)	113.	256.	65.89	150.	41.5%	41.5%
Stormwater (WLA)	9	9	7	7	15.0%	15.0%
Riverhead STP (WLA)	130.	130.	40.	40**.	69.5%	69.5%
Atlantis Marine World (WLA)	***	***	4	4		
Total*	580.	891.	308.	504.	47.0%	43.4%
Sum of May 1 to September 30 WLAs*	139	139	51	51		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** As noted in the text, this daily maximum will not be used as the basis for permit limits.
******* The discharge from Atlantis Marine World was not included in the baseline analysis.

Table VI.2: Nitrogen load summary for segment 1701-254, Western Flanders Bay and Lower Sawmill Creek

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	6.80	103.	4.66	70.62	31.3%	31.3%
Groundwater (LA)	72.82	75.77	42.72	44.46	41.3%	41.3%
Sawmill Creek (LA)	5.87	18.92	3.43	11.07	41.5%	41.5%
Stormwater (WLA)	5.26	5.26	4.47	4.47	15.0%	15.0%
Total*	90.75	203.	55.29	131.	39.1%	35.6%
Sum of October 1 to April 30 WLAs*	5.26	5.26	4.47	4.47		
	May 1 to September 30					
Atmospheric Deposition (LA)	8.38	160.	5.76	110.	31.3%	31.3%
Groundwater (LA)	72.56	75.77	42.55	44.46	41.3%	41.3%
Sawmill Creek (LA)	6.12	13.90	3.59	8.14	41.5%	41.5%
Stormwater (WLA)	5.26	5.26	4.47	4.47	15.0%	15.0%
Total*	92.31	255.	56.36	167.	38.9%	34.5%
Sum of May 1 to September 30 WLAs*	5.26	5.26	4.47	4.47		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.

Table VI.3: Nitrogen load summary for segment 1701-256, Meetinghouse Creek and Terrys Creek and Tributaries

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	3.76	56.96	2.60	39.14	31.3%	31.3%
Groundwater (LA)	213.	221.	99.40	103.	53.3%	53.3%
Terrys Creek (LA)	3.08	9.94	1.80	5.81	41.6%	41.5%
Meetinghouse Creek (LA)	45.80	148.	27.41	88.42	40.2%	40.1%
Stormwater (WLA)	6.38	6.38	5.41	5.41	15.0%	15.0%
Total*	272.	442.	137.	242.	49.7%	45.2%
Sum of October 1 to April 30 WLAs*	6.38	6.38	5.41	5.41		
	May 1 to September 30					
Atmospheric Deposition (LA)	4.64	88.61	3.19	60.87	31.3%	31.3%
Groundwater (LA)	211.	221.	98.56	103.	53.3%	53.3%
Terrys Creek (LA)	6.12	13.90	3.59	8.14	41.5%	41.5%
Meetinghouse Creek (LA)	47.78	109.	28.6	64.97	40.1%	40.1%
Stormwater (WLA)	6.38	6.38	5.41	5.41	15.0%	15.0%
Total*	228.	330.	139.	243.	51.5%	46.1%
Sum of May 1 to September 30 WLAs*	6.38	6.38	5.41	5.41		

Note: LA denotes load allocation; WLA denotes wasteload allocation

*** May not add up due to rounding.**

Table VI.4: Nitrogen load summary for Flanders Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	116.	1755.	79.75	1206.	31.3%	31.3%
Groundwater (LA)	486.	506.	297.	309.	38.9%	38.9%
Hubbard Creek (LA)	4.66	15.05	2.73	8.8	41.6%	41.5%
Mill Creek (LA)	2.53	8.16	1.47	4.77	41.6%	41.5%
Birch Creek (LA)	1.21	3.91	0.70	2.29	41.6%	41.5%
Stormwater (WLA)	9.70	9.70	8.25	8.25	15.0%	15.0%
Total*	620.	2298.	390.	1539.	37.2%	33.0%
Sum of October 1 to April 30 WLAs*	9.70	9.70	8.25	8.25		
	May 1 to September 30					
Atmospheric Deposition (LA)	143.	2730.	98.25	1876.	31.3%	31.3%
Groundwater (LA)	482.	505.	294.	307.	38.9%	38.9%
Hubbard Creek (LA)	4.86	11.07	2.84	6.47	41.5%	41.5%
Mill Creek (LA)	2.64	6.01	1.54	3.50	41.6%	41.6%
Birch Creek (LA)	1.28	2.88	0.75	1.67	41.6%	41.5%
Stormwater (WLA)	9.70	9.70	8.25	8.25	15.0%	15.0%
Total*	644.	3265.	406.	2204.	36.9%	32.5%
Sum of May 1 to September 30 WLAs*	9.70	9.70	8.25	8.25		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

Table VI.5: Nitrogen load summary for Great Peconic Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	949	14342.	652.	9853.	31.3%	31.3%
Groundwater (LA)	833.	1098.	531.	689.	36.3%	37.3%
Stormwater (WLA)	9	9	8	8	10.0%	10.0%
Total*	1791.	15449.	1191.	10550	33.5%	31.7%
Sum of October 1 to April 30 WLAs*	9	8.9	8	8		
	May 1 to September 30					
Atmospheric Deposition (LA)	1169.	22313.	803.	15329.	31.3%	31.3%
Groundwater (LA)	871.	1088.	554.	684.	36.4%	37.1%
Stormwater (WLA)	9	9	8	8	10.0%	10.0%
Total*	2049.	23410.	1365.	16021.	33.4%	31.6%
Sum of May 1 to September 30 WLAs*	9	9	8	8		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

Table VI.6: Nitrogen load summary for Little Peconic Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	628.	9491.	431.	6520.	31.3%	31.3%
Groundwater (LA)	873.	1191.	589.	793.	32.5%	33.4%
Stormwater (WLA)	16.41	16.41	14.76	14.76	10.0%	10.0%
Total*	1517.	10698.	1035.	7328.	31.8%	31.5%
Sum of October 1 to April 30 WLAs*	16	16	15	15		
	May 1 to September 30					
Atmospheric Deposition (LA)	774.	14766.	531.	10144.	31.3%	31.3%
Groundwater (LA)	929.	1188.	626.	793.	32.6%	33.2%
Stormwater (WLA)	16	16	15	15	10.0%	10.0%
Total*	1719.	15971.	1172.	10952.	31.8%	31.4%
Sum of May 1 to September 30 WLAs*	16	16	15	15.76		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

Table VI.7: Nitrogen load summary for Shelter Island Sound**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	1094.	16544.	752.	11366.	31.3%	31.3%
Groundwater (LA)	1733.	2276.	1205.	1567	30.2%	30.9%
Sag Harbor STP (WLA)	13	13.	17	17***	0.0%****	0.0%****
Shelter Island Heights STP (WLA)	4.5	4.5	5	5***	0.0%****	0.0%****
Stormwater (WLA)	52	52	46	46	10.0%	10.0%
Total*	2897.	18890.	2026.	13002.	30.1%	31.2%
Sum of October 1 to April 30 WLAs*	69	69	69	69		
	May 1 to September 30					
Atmospheric Deposition (LA)	1348.	25740.	926.	17683.	31.3%	31.3%
Groundwater (LA)	1816.	2267.	1260	1562.	30.3%	30.9%
Sag Harbor STP (WLA)	13	13	17	17***	0.0%****	0.0%****
Shelter Island Heights STP (WLA)	4.5	4.5	5	5***	0.0%****	0.0%****
Stormwater (WLA)	52	52	47	472	10.0%	10.0%
Total*	3234.	28076.	2255.	19314.	30.2%	31.2%
Sum of May 1 to September 30 WLAs*	69	69	69	69		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.
*** As noted in the text, this daily maximum will not be used as the basis for permit limits.
**** The TMDL reflects current or proposed permit requirements; the baseline represents current discharge characteristics for these facilities.

Table VI.8: Nitrogen load summary for Gardiners Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	4724.	71420.	3245.	49066.	31.3%	31.3%
Groundwater (LA)	1330.	1607.	958.	1141.	28.0%	29.0%
Stormwater (WLA)	22	22	20	20	10.0%	10.0%
Total*	6076.	73050.	4223.	50227.	30.5%	31.2%
Sum of October 1 to April 30 WLAs*	22.	22	20	20.		
	May 1 to September 30					
Atmospheric Deposition (LA)	5821.	111113.	3999.	76335.	31.3%	31.3%
Groundwater (LA)	1401.	1636.	1009.	1165.	28.0%	28.8%
Stormwater (WLA)	22	22	20	204	10.0%	10.0%
Total*	7244.	112772.	5028.	77521.	30.6%	31.3%
Sum of May 1 to September 30 WLAs*	22	22	20	20		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

B. Mechanical Aeration

The use of non-treatment alternatives may be considered as a method of achieving water quality standards when technology-based treatments are not sufficient to achieve standards [40 CFR 125.3(f)]. Such techniques must be the preferred environmental and economic method of achieving standards after consideration of alternatives such as advanced waste treatment and other technologies.

As demonstrated by this TMDL, the practical load reductions and technology-based treatment requirements are not sufficient to *fully* achieve DO standards in all locations of the Peconic Estuary. Therefore, this TMDL identifies the use of a non-treatment alternative (mechanical aeration) to achieve the DO water quality standards. In order to achieve the existing DO water quality standard of 5.0 mg/L, a total of 3,280 kg/day (7,181 lb/day) of oxygen was distributed to the bottom layer at various grid cells in the water quality model (see Table VI.9). To attain the proposed DO standard, 445 kg/day (980 lb/day) of oxygen was added by mechanical aeration to the grid cells listed in Table VI.10. For the modeling simulation, oxygen was added at a continuous rate from May 1 to September 30, and was turned off for the remainder of the year. Note that the aeration was not needed for one of the two modeled years to meet the proposed standard.

Table VI.9: Location and magnitude of DO added to achieve the existing water quality standard

1701-0259		1701-0254		1701-0256		(not on 303(d) list)	
Tidal Peconic River and tributaries		Sawmill Creek and Flanders Bay West		Terrys Creek and Meetinghouse Creek		Western Flanders Bay	
Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)
[12,17]	70	[27,20]	40	[26,27]	10	[32,19]	30
[12,18]	60	[27,21]	60	[27,27]	20	[32,20]	30
[12,19]	20	[27,22]	30	[28,27]	20	[32,21]	30
[12,23]	50	[27,23]	20	[29,24]	10	[33,16]	80
[13,23]	50	[27,24]	30	[29,27]	10	[33,17]	70
[14,23]	40	[27,25]	20	[30,24]	10	[33,18]	60
[15,22]	20	[28,20]	40	[30,25]	30	[33,19]	30
[15,23]	30	[28,21]	60	[30,26]	20	[33,20]	30
[15,24]	30	[29,19]	40	[30,27]	30	[33,21]	40
[16,23]	20	[29,20]	40	[30,28]	10	[33,22]	30
[17,23]	50	[29,21]	40	[31,25]		[33,23]	30
[18,23]	70	[30,19]	10	[31,26]	30	[34,18]	30
[19,22]	50	[30,20]	40	[31,27]	30	[34,19]	30
[19,23]	30	[30,21]	40	[31,28]	20	[34,20]	20
[20,22]	40	[30,22]	30	[31,29]	10	[35,18]	20
[20,23]	30	[31,19]	10	[31,30]	30	[35,19]	30
[21,21]	40	[31,20]	30	[32,26]	30	[35,20]	20
[21,22]	40	[31,21]	30	[33,24]	40	[36,17]	20
[21,23]	30	[31,22]	40	[33,25]	40	[36,18]	30
[22,21]	40			[33,26]	30	[36,19]	20
[22,23]	40			[33,27]	30	[37,18]	30
[23,21]	40			[33,28]	40	[38,18]	30
[23,22]	30			[33,29]	70	[39,18]	20
[23,23]	40			[33,30]	20		
[24,21]	30						
[24,22]	50						
[25,21]	40						
[25,22]	50						
[26,20]	40						
[26,21]	40						
[26,22]	50						
Subtotal	1,260	Subtotal	650	Subtotal	590	Subtotal	760
Total	3,260						

Table VI.10: Location and magnitude of DO added to attain the proposed water quality standard

1701-0259		1701-0254		1701-0256		(not on 303(d) list)	
Tidal Peconic River and tributaries		Sawmill Creek and Flanders Bay West		Terrys Creek and Meetinghouse Creek		Western Flanders Bay	
Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)
[12,17]	55	[27,20]		[26,27]		[32,19]	
[12,18]	55	[27,21]		[27,27]		[32,20]	
[12,19]	15	[27,22]		[28,27]	5	[32,21]	
[12,23]	25	[27,23]		[29,24]		[33,16]	
[13,23]	30	[27,24]	5	[29,27]		[33,17]	
[14,23]	15	[27,25]		[30,24]		[33,18]	
[15,22]	10	[28,20]		[30,25]		[33,19]	
[15,23]	5	[28,21]		[30,26]		[33,20]	
[15,24]	10	[29,19]		[30,27]		[33,21]	
[16,23]	10	[29,20]		[30,28]		[33,22]	
[17,23]	10	[29,21]		[31,25]		[33,23]	
[18,23]	25	[30,19]		[31,26]		[34,18]	
[19,22]	15	[30,20]		[31,27]		[34,19]	
[19,23]	10	[30,21]		[31,28]		[34,20]	
[20,22]	10	[30,22]		[31,29]	5	[35,18]	
[20,23]	10	[31,19]		[31,30]	15	[35,19]	
[21,21]	10	[31,20]		[32,26]		[35,20]	
[21,22]	10	[31,21]		[33,24]		[36,17]	
[21,23]	10	[31,22]		[33,25]		[36,18]	
[22,21]	10			[33,26]		[36,19]	
[22,23]	10			[33,27]		[37,18]	
[23,21]	10			[33,28]	10	[38,18]	
[23,22]	10			[33,29]	10	[39,18]	
[23,23]	5			[33,30]	5		
[24,21]	5						
[24,22]							
[25,21]							
[25,22]							
[26,20]							
[26,21]							
[26,22]							
Subtotal	390	Subtotal	5	Subtotal	50	Subtotal	0
Total	445						

C. Margin of Safety

A TMDL must include a margin of safety (MOS) to account for lack of knowledge concerning the relationship between pollutant loads and water quality. EPA guidance explains that the MOS may be incorporated into the conservative assumptions used in the analysis (an implicit MOS) or it may be expressed in loading set aside as a separate component of the TMDL (an explicit MOS). An implicit MOS is used in this TMDL through conservative assumptions in the analysis such as using the critical 2000 - 2002 period as the baseline condition and assuming the Riverhead STP continuously discharges both flow and load at fully permitted levels for the TMDL scenario.

An important component in the implicit MOS assumption was the use of 2000-2002 as the baseline period. This time period was the most severe period of hypoxia on record based on analysis of monitoring data from 1988 to 2002. Model simulations of reduced nitrogen predicted water quality conditions that would result from the same physical conditions that existed during the 2000-2002 period. Thus, it can be expected that average year conditions would see even better improvements in water quality conditions given the same nitrogen reductions. In other words, since the baseline period used the severe conditions that existed in 2000-2002, a margin of safety (MOS) is provided for average years.

Another implicit MOS assumption was the use of continuous flow and load discharges for the Riverhead STP throughout the simulation period. It is unlikely this facility would discharge at its maximum allowable load continuously for the entire two-year period. The water quality model simulations predicted the amount of nitrogen that would need to be reduced from the Riverhead STP discharging continuously at maximum permitted load. This provides a margin of safety for the more typical condition where the Riverhead STP discharges at less than maximum permitted load.

D. Critical Conditions

Hypoxia in western Peconic Estuary typically occurs from mid-May through September. Minimum hourly DO concentrations simulated by the EFDC water quality model during the summer hypoxic period were used in this TMDL as the basis to assess actions necessary to attain water quality standards. The alternative management scenarios were run for a 24-month period beginning on 10/1/2000 and ending on 9/30/2002, which corresponds to hydrologic water years 2001 and 2002. This critical period was chosen based on the analysis of water quality sampling data within the three listed waterbodies having dissolved oxygen concentrations less than the existing 5.0 mg/L water quality standard. (see Table VI.11).

E. Seasonal Variations

Accounting for seasonal variations in pollutant loading and water quality is an important factor in the TMDL analyses. This requires including seasonal variations in the modeling analysis, identifying a critical period for achieving water quality standards, and basing the TMDLs on the critical conditions. As discussed in Section V.C, the water quality model was calibrated and validated using ambient monitoring data over a 14-year period from

Table VI.11 Inventory of DO samples below water quality criteria in 303(d) waters of Peconic Estuary

Year	Number of DO samples less than 5.0 mg/L
1989	14
1995	51
1996	136
1997	100
1998	40
1999	29
2000	19
2001	21
2002	20*

* Continuous monitoring devices deployed in the tidal Peconic River during the summer and fall of 2002 documented water quality conditions every 15 minutes and resulted in thousands of data points where the DO level was less than 5.0 mg/L. These continuous monitoring device data are not reflected in this table, however, due to difficulties in comparing these results to the routine water quality monitoring data set.

October 1988 to September 2002. This period covers all seasons of the year as well as actual extreme hydrological and meteorological conditions. Tributary loads, groundwater loads, and sewage treatment plant loads were included in based on available time-variable data. Water year 2001 was relatively wet followed by a relatively dry water year 2002, which is important to satisfy the seasonality aspect of the Peconic Estuary nitrogen TMDL. The hydrograph of freshwater inflow from the Peconic River during the 24-month simulation period is shown in Figure VI.2.

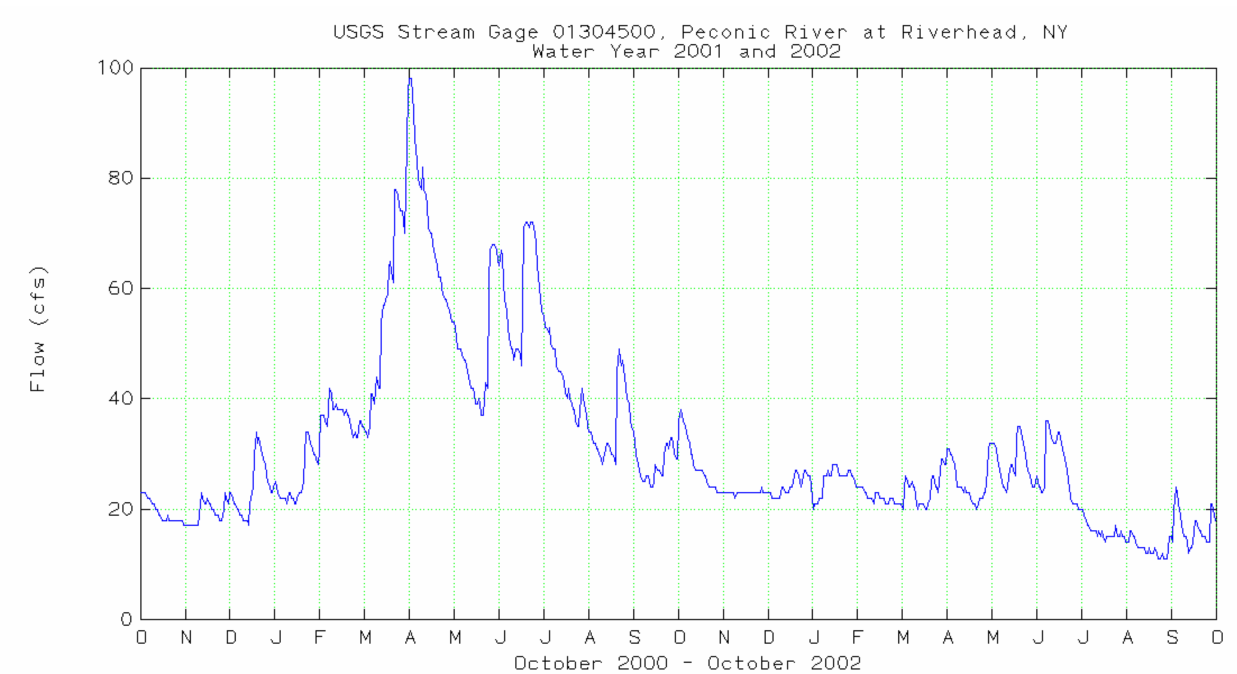


Figure VI.2: Streamflow at Peconic River USGS gage for model simulation period

F. Summary

Based on the modeling results, the New York State DO water quality standards in the western Peconic Estuary would be attained through implementation of the nutrient reduction and mechanical aeration actions outlined in this TMDL. Improvements in the hourly minimum DO from nitrogen management would result in an addition of 2.36 mg/L of DO above the baseline condition at the critical grid cell in tidal Peconic River. Mechanical aeration would improve the hourly minimum DO at the critical grid cell by an additional 2.64 mg/L. The critical grid cell [18,23] is located about 0.23 miles west of the Riverhead STP discharge. The incremental improvement in DO at the critical grid cell for the cumulative impact of each of five management alternatives is shown in Table VI.12. The two largest incremental improvements in DO among the nitrogen management alternatives result from implementation of land use management measures, actions, practices and controls to reduce groundwater nitrogen loads and from practical load reduction controls on the Riverhead STP. Despite significant gains due to applying the PLR controls, mechanical aeration is still required to attain the existing water quality standard for DO of 5.0 mg/L as well as the proposed water quality standards.

Table VI.12: Incremental improvements in DO at critical grid cell [18,23] in tidal Peconic River

Run ID	Cumulative Management Action for Reducing Nitrogen	Lowest Daily Average DO		Lowest Hourly Minimum DO	
		DO (mg/L)	Incremental Improvement In DO (mg/L)	DO (mg/L)	Incremental Improvement In DO (mg/L)
01g	Baseline condition	1.496	-	0.003	-
15h1	Atmospheric deposition reduced by 31.3%	1.649	0.153	0.034	0.031
15h2	Groundwater loads improved to PLR	2.575	0.926	1.156	1.122
15h3	Stormwater and Tributaries improved to PLR	2.787	0.212	1.586	0.043
15h	Riverhead STP improved to PLR	3.423	0.636	2.363	0.777
15i	Mechanical aeration	6.175	2.752	5.005	2.642

VII. Implementation

This section describes programs and actions that are in place that directly or indirectly impact nitrogen loads or the impacts nitrogen has on the Peconic Estuary, including those waters impaired due to low dissolved oxygen. Further, it describes enhancements to those programs and other new or related initiatives that could be put in place to further reduce the nitrogen load or otherwise reduce that impact that excess nitrogen has on the Peconic System. The Peconic Estuary Program seeks to have this TMDL fully implemented within 15 years from approval, based upon current expectations for full build-out and land acquisition programs, development and implementation of education and outreach programs, full participation in the agricultural stewardship/agricultural environmental management program, and other necessary efforts. Full implementation of this TMDL is expected to result in water quality standards for dissolved oxygen being met where they are not currently attained and ensure continued compliance where these standards are presently achieved.

A. Summary of Nutrient Load or Impact Reduction Mechanisms for the Peconic Nitrogen TMDLs

1. Atmospheric Deposition

Atmospheric deposition represents a significant load and through existing Federal Clean Air Act (CAA) authorities, a significant load reduction (31.3%) is scheduled through the implementation of controls over the next decade and beyond. The loads and reductions are important locally and regionally. There are several New York State initiatives, which will probably result in further reductions in nitrogen emissions:

- Adoption of low-emission-vehicle standards for NOx and CO_2
- Adoption of the Regional Greenhouse Gas Initiative
- Initiation of the collaborative Renewable Energy Portfolio

Reductions in air emissions beyond those currently called for in the CAA has not yet been evaluated by the PEP in terms of the cost, impact, or benefit/feasibility. Monitoring reductions is possible through the National Atmospheric Deposition Monitoring (there is a wet deposition monitoring station in the Peconic Watershed).

2. Open Space Preservation/Critical Lands Protection

Open space acquisition is critically important in reducing future loads. There are town (Community Preservation Fund (CPF)), county and state open space acquisition programs, described in detail in the PEP CCMP. Open space acquisition programs with an emphasis on parcels in nitrogen impaired/stressed sub-watersheds could strengthen efforts to protect the overall system and individual waterbody segments that are impaired or threatened. A related effort would be to emphasize the use of transfer of development rights (TDR) credits in a manner that reduces nitrogen loadings, particularly in nitrogen stressed areas. The PEP, with The Nature Conservancy (TNC) has identified priority parcels in nitrogen stressed waters; while this information is known to be used by the towns, county and state in making acquisition decisions and potentially TDR decisions, government agencies could formally adopt nitrogen stress considerations into acquisition program and TDR program considerations. The TNC (through PEP-funded critical lands protection tracking effort) tracks acquisitions at the various levels of government.

3. Agricultural Nutrient Management

The Long Island Agricultural Stewardship Program, based on the Agricultural Environmental Management Program, should be fully implemented to reduce nutrient losses to groundwater and runoff. The Long Island Agricultural Stewardship has begun to develop and implement a voluntary management plan that addresses groundwater and surface water protection based on appropriately using nitrogen fertilizers (and pesticides registered for use on Long Island). The Agricultural Stewardship Program developed thirteen environmental risk assessment worksheets for Long Island growers modeled after the New York State Agricultural Environmental Management (AEM) Program. Worksheet topics include nutrients, pesticides, soil, irrigation, water, and well management. These worksheets are part of the AEM five-step program. Other important aspects of the stewardship program include providing information on Best Management

Practices and conducting various pilot projects to evaluate practices to reduce nitrogen (and pesticide) loading into the groundwater. It is also necessary to conduct research and demonstration projects in support of this effort. The Agricultural Stewardship Program tracks local demonstration projects and research, and (confidentially) grower participation. See also Appendix C of this document that includes an implementation highlight discussion and other information (Agricultural Demonstration Projects and Research Summary).

Because the agricultural load of nitrogen is estimated to be an important source of the loads in the Peconic Estuary watershed, achieving the target loads specified in the TMDL depends on significant reductions from agricultural operations. Reductions would be attempted by a voluntary, incentive-based approach to adopting management practices that reduce nitrogen losses. The level of reduction necessary to achieve the targeted loads, particularly in the currently impaired waterbodies, approaches what could be reasonably anticipated from adopting practices. Achieving the target reduction can also be achieved by converting to crops or cropping practices that result in less nitrogen losses. The Suffolk County Soil and Water Conservation Districts is encouraged to implement the AEM program on farms in the watershed that will lead to identification and implementation of management practices to reduce nitrogen loads. These practices would be eligible for state or federal funding and because they address a water quality impairment associated with this TMDL, should score well. Appendix H of the PEP CCMP (see: http://www.peconicestuary.org/CCMP_PDF/AppendixH.pdf) includes the Peconic Estuary Program's detailed Agricultural Environmental Management Strategy. This report goes beyond the traditional approach of describing best management practices to also discuss farm and crop insurance and other innovations that also reduce nitrogen loads. A subsequent report based on that effort is contained in "A Strategy to Develop and Implement the Suffolk County Agricultural Stewardship Program - A Report of the Agricultural Environmental Management Task Force for Nitrogen and Pesticide Load Reduction - Final Report" (May 26, 2004) (see: http://peconicestuary.org/AgForceRpt.pdf)

4. Sewage Treatment Plants/Surface Water Discharges under SPDES

An important milestone in the efforts to manage nitrogen and improve water quality has been the installation of advanced treatment (nutrient removal) at the Riverhead and Sag Harbor STPs. The current advanced treatment at the Riverhead STP has reduced the TN concentration in the effluent. Nutrient limits will be imposed in STP permits (beyond initial "no net increase" based requirements) at the Riverhead, Sag Harbor and Shelter Island Heights STPs, potentially expressed in lbs/day as a monthly average of 24-hr composite samples at a sampling frequency of one sample per week; currently, the Riverhead STP is the only facility with a mass-based nitrogen limit (expressed in lbs/day, as a monthly average). Further reducing the impact from the Riverhead STP will be achieved by using a portion of the Riverhead STP effluent flow to seasonally irrigate the adjacent the County-owned Indian Island Golf Course. New York State Clean Air/Clean Water Bond Act money has been allocated for full scale implementation of this beneficial reuse project.

It might also be worthwhile to investigate additional Riverhead STP land application options, including parkland and agricultural operations (particularly plants grown for ornamental horticultural purposes). The relocation or extension of the Riverhead STP outfall to an area with more flushing might also be considered in the future. While this was previously determined not feasible, at some point, a re-evaluation may be appropriate.

The Atlantis Marine World discharge is a small flow (0.0081 MGD) to the nutrient sensitive tidal Peconic River. The permit for the Atlantis Marine World will be reviewed upon renewal to set discharge limits.

5. Requirements for New Development

The proposed implementation initiatives for new development include: revising zoning to reduce development densities; imposing vegetation preservation requirements (i.e., clearing restrictions) to maintain existing vegetation and reduce potential lawn areas; requiring the establishment of a suitable soil base (perhaps up to 12 inches) where lawn areas are to be established; encouraging cluster development to reduce lawn areas; and evaluating the potential for centralized on-site disposal systems (OSDSs) with nitrogen removal. Sustainable development/redevelopment and other so called "smart growth" techniques, where applicable, can also help do reduce vehicle miles driven and associated air deposition of nitrogen, by encouraging mixed use development.

6. Turf and Landscape Management (for Existing and New Development)

The Peconic Estuary Program implementation initiative for this source includes: developing turf/landscaping recommendations for homeowners to eliminate or minimize fertilizer loses to groundwater or to stormwater. At a development density of one dwelling unit per acre, studies have shown that approximately 50% of the TN loading to groundwater comes from fertilizer applications. The PEP will pursue the implementation of an aggressive education and outreach program regarding residential fertilizer use. Immediate plans include determining residential yard care practices that have beneficial environmental impacts or minimize pollution of ground and surface water resources based on nitrogen loadings, as well as developing incentives, including ones to: eliminate fertilizer application to frozen ground, and establishing labeling or signage requirements at retail establishments to inform consumers of the appropriateness of the range of fertilizer application practices. Some materials have already been prepared and are being distributed. The PEP plans to develop a recommended turf/landscaping protocol for homeowners using commercial landscapers. The PEP also plans to implement targeted programs for commercial and industrial properties; for governmental and quasi-governmental properties (schools, libraries, etc., and for all other properties (places of worship, not-for-profits, etc.). Finally, with local governments, the PEP will investigate creating real property tax incentives for eliminating/reducing turf coverage or eliminating/reducing fertilizer use.

7. Individual On-site Wastewater Disposal Systems (OSDS)

The primary focus here is to ensure existing systems work properly (which may perhaps include regular pumping/removal of solids), that there are no illegal or illicit interconnections, there is no discharges to surface waters) and that new systems are properly sited and work properly. Potential enhancements include ensuring systems operate properly upon property transfer and to investigate new OSDS nutrient removal technologies. Finally, as an alternative, it may be necessary in the future to investigate needs for traditional sewering, and microsewering. Traditional OSDS achieve roughly a 51% reduction in TN from ~75mg/L to 38.2 mg/L (from LI 208 Study).

8. Stormwater
Municipal separate storm sewer systems (MS4s) regulated under the Phase II Stormwater Program will be required to meet the waste load reductions as described below in the section on Reasonable Assurances. Other stormwater inputs are not currently regulated as point sources and are considered nonpoint sources. There are numerous programs, plans and initiatives in place across the east end town to address and mitigate stormwater flow and impacts on surface waters.

9. Golf Courses
There is a program and plan in place to reduce nutrient losses from golf course operations. There is also the opportunity for further enhancements to that effort, including using "fertigation" and improved compost management, etc. The "fertigation" opportunity associated with the beneficial reuse of a portion of the Riverhead STP effluent at the County owned Indian Island Golf Course needs to be evaluated/pursued to potentially reduce if not eliminate fertilizer applications at the Indian Island Golf Course.

B. Other Implementation Considerations

1. Other STPs
While the former Naval Weapon Industrial Reserve Plant (previously operated by the Grumman Corporation) in Calverton, NY has an STP that discharges to a branch of the freshwater Peconic River, the operators have submitted engineering reports to upgrade and build a new facility discharging to groundwater outside of the Peconic Estuary study area. New York State Clean Air/Clean Water Bond Act funding has been allocated for a portion of this relocation project (which also includes advanced wastewater treatment for the 0.150 MGD flow). Confirmation of the Calverton STP relocation outside of the Peconic Estuary Study Area is needed to implement these TMDLs.

There is advanced treatment for nutrient removal at the Brookhaven National Laboratory Sewage Treatment Plant (BNL STP) that discharges to the freshwater Peconic River. The PEP model accounts for the BNL STP discharge essentially as included within the boundary load in the tributary load attributed to the Peconic River, which is expressed as a loading allocation (LA) within this TMDL. The BNL STP does not discharge to estuarine waters or directly to an impaired segment. The BNL STP discharge is to the free flowing (though previously channelized) freshwater Peconic River on U.S. Department of Energy owned property. Downstream of the BNL STP discharge, the River widens into essentially a wetland ecosystem, before returning once again to a channelized watercourse. At the Laboratory boundary, this branch of the Peconic River is not a perennial watercourse, particularly during periods with little or no precipitation.

The groundwater-fed Peconic River emerges again downstream, joins up with other branches, becoming a perennial watercourse. After intermediary impoundments and four dams, the River is tidal, approximately 11 miles from the BNL STP discharge (and 8 miles from the Laboratory boundary).

Presently, the average flow from the BNL STP is 0.37 MGD and the average total nitrogen concentration is 7 mg/L, which translates to a load of 20 lbs./day of nitrogen. This reflects advanced treatment for nutrient removal that is in place at the facility. It is likely that environmental fate, transport and attenuation mechanisms result is a significantly smaller nitrogen load actually being delivered to what ultimately enters the tidal Peconic River, though this calculation has not been made. This evidenced by the observed good water quality and relatively small nitrogen load associated with the freshwater Peconic River. The permitted flow for the BNL STP discharge is 2.3 MGD with a total nitrogen limit of 10mg/L; if the facility was to discharge at it the maximum flow and nitrogen limit it would discharge 191 1bs./day of nitrogen. Because of the intermittent nature of the steam, the permit also includes an ammonia limit of 2.0 mg/l. At the present time, there are no known plans in place to increase the flow or load from the BNL STP from the current effluent quality conditions. The modeling scenarios, including the baseline scenario, for this TMDL did not include any load greater than that which is currently discharged from the BNL STP (20 lbs./day). When this permit is next renewed, treatment performance and permit limits will be reviewed. Such a review could consider environmental fate, transport and attenuation mechanisms associated with the current or any increased BNL STP load and mechanisms to keep the load from increasing, including additional treatment, beneficial reuse (i.e., irrigation), and discharge to groundwater outside of the groundwater contributing area of the Peconic Estuary.

2. Groundwater Discharges (under SPDES)

Regulatory agencies should continue to evaluate the performance of the Crescent Duck Farm treatment plant that discharges to groundwater in the Meetinghouse Creek watershed. The PEP could investigate needs for nutrient removal technologies for certain (i.e., flow based) other SPDES-permitted groundwater discharges.

3. In-place Highly Enriched Bay Bottom Sediments

Through the PEP there is a plan to investigate the accelerated remediation, through removal or other means, of nutrient enriched bay bottom sediments. Meetinghouse Creek is a priority remediation area for consideration.

4. Shellfish & Habitat Restoration

Efforts under this heading include the proposed evaluation of shellfish restoration efforts, the restoration of eelgrass beds, and macroalgae harvesting as a means of sequestering or removing nitrogen. The state of science for these measures is unknown for applicability to TMDLs.

5. Boundary Conditions

This includes at least maintaining and ultimately improving water quality at the Long Island Sound interface. Similarly, the manipulation of the Shinnecock Locks to introduce additional flushing was previously determined not feasible, but a re-evaluation in the future may be appropriate.

6. Other Sources/Mechanisms

Other initiatives that address nitrogen load reductions include the established Vessel Waste No Discharge Area, and existing programs preserving and protecting wetlands and buffers to mitigate direct stormwater runoff. There is also the potential for improving domestic and wild animal and livestock waste management, and local or larger scale groundwater remediation efforts.

VIII. Reasonable Assurances

This section describes and explains the reasonable assurances for achieving wasteload allocations for point sources and load allocations for nonpoint sources, with an expanded discussion of Phase II stormwater regulations and current and continuing nonpoint source management programs/efforts.

A. Overview/Discussion

When a TMDL is developed for waters impaired by point sources only, the issuance of a National Pollutant Discharge Elimination System (NPDES) permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with "the assumptions and requirements of any available wasteload allocation" in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement water quality standards.

EPA's August 1997 TMDL Guidance also directs EPA Regional Offices to work with States to achieve TMDL load allocations in waters impaired only by nonpoint sources. However, EPA cannot disapprove a TMDL for nonpoint source-only impaired waters, which do not have a demonstration of reasonable assurance that load allocations (LAs) will be achieved, because such a showing is not required by current regulations.

B. Point Sources

Point source loads will be addressed consistent with the WLAs and TMDL contained in this report and the accompanying text, including the discussion in the implementation section.

Table VIII.1: Surface Water Discharges to Fresh and Estuarine Waters of the Peconic Estuary System

Facility Name	State Pollutant Discharge Elimination System (SPDES) Permit Number
Riverhead Sewer District Sewage Treatment Plant	NY0020061
Village of Sag Harbor Wastewater Treatment Plant	NY0028908
Shelter Island Heights Property Owners Corp. Sewage Treatment Plant	NY0021814
Atlantis Marine World & Riverhead Foundation for Marine Research	NY0226459
Brookhaven National Laboratory	NY0005835
Plum Island Animal Disease Center Sewage Treatment Plant	NY0008117
Calverton Enterprise Park (Former Naval Weapons Industrial Reserve Plant)	NY0025453

Additional information regarding the implementation of Phase II Stormwater Regulations is contained in the section below.

C. Implementation of Phase II Stormwater Regulations
NYSDEC has expanded its permitting program to include a new federally mandated program to control stormwater runoff and protect waterways.

According to the federal law, commonly known as Stormwater Phase II, permits will be required for stormwater discharges from Municipal Separate Storm Sewer Systems (MS4s) in urbanized areas and for construction activities disturbing one or more acres. To implement the law, the NYSDEC has developed two general SPDES permits, one for MS4s in urbanized areas and one for construction activities. Operators of regulated small MS4s seeking authorization to discharge stormwater in compliance with the federal Clean Water Act are required to apply for and secure coverage under the SPDES General Permit for Municipal Separate Storm Sewer Systems. Operators of regulated MS4s and construction activities must have obtained either a SPDES or a general permit no later than March 10, 2003 or prior to the commencement of construction.

Regulated MS4 municipalities are required to develop, implement and enforce a stormwater management program (SWMP). The SWMP must describe the Best Management Practices (BMPs) for each of the minimum control measures:
1. Public education and outreach program to inform the public about the impacts of the stormwater on the receiving water quality.
2. Public involvement and participation.
3. Illicit discharge detection and elimination.
4. Construction site stormwater runoff control program for sites disturbing one or more acres.
5. Post-construction runoff control program for new development and redevelopment sites disturbing one or more acres.
6. Pollution prevention and good housekeeping operation and maintenance program.

Operators must have developed the initial SWMP prior to March 10, 2003 and have provided adequate resources to fully implement the SWMP no later than five years from the issuance date of the MS4 permit. Each of the regulated MS4s in this TMDL (see table below) has developed an initial SWMP and has coverage under the general permit (GP-02-02). An MS4 may modify its SWMP at any time, although any changes to a SWMP shall be reported to the NYSDEC in the MS4's annual report. MS4s are required to make steady progress toward full implementation.

Table VIII.2: Stormwater Permits in the Peconic Estuary

Permittee	SPDES #	Date Notice of Intent (NOI) Submitted
Town of Riverhead	NYR20A020	03/04/2003
Town of Southampton	NYR20A454	03/04/2003
Village of Sag Harbor	NYR20A095	02/27/2003
Village of North Haven	NYR20A500	12/15/2003
Suffolk County	NYR20A180	03/25/2003
NYSDOT	NYR20A288	03/10/2003
Town of Brookhaven	NYR20A411	05/08/03

A SWMP is designed to reduce the discharge of pollutants to the maximum extent practicable (MEP) to protect water quality and to satisfy the appropriate water quality requirements of the Environmental Conservation Law and the Clean Water Act. MEP is a technology-based standard established by Congress in the Clean Water Act. Since no precise definition of MEP exists, it allows for maximum flexibility on the part of MS4 operators as they develop their programs. If stormwater is being discharged to a 303(d)-listed segment of a water body, the SWMP must ensure there is no resulting increase in the pollutant of concern to the receiving waters. Where required to meet water quality standards, NYSDEC enforces additional requirements based on WLAs determined through a TMDL. The MS4 must review applicable TMDLs to see if they include requirements for control of stormwater discharges. If an MS4 is not meeting the TMDL stormwater allocations, it must, within six (6) months of the TMDL approval, modify its SWMP to ensure that reduction of the pollutant of concern specified in the TMDL is achieved. Modifications must be considered for each of the six minimum measures. The revised management program must include an updated schedule for implementation.

The MS4s that discharge to the Peconic Estuary System are owned and operated by the municipalities located around the system. Accordingly, all municipalities identified in the TMDL have submitted an application to gain coverage under New York's SPDES General Permit for Municipal Separate Storm Sewer Systems.

NYSDEC will continue to work with these municipalities to identify funding sources and to evaluate locations and designs for stormwater control BMPs throughout the watershed. Under the State's Environmental Protection Fund (EPF), $10.8 million were made available in 2005 (update) through an application process to assist communities in implementing the Stormwater Phase II regulations and for non-agricultural nonpoint source abatement and control projects.

Currently, the Towns of East Hampton, Southold and Shelter Island are not part of an MS4 area. In order to implement pathogen TMDLs, the Towns of the East Hampton and Southold would be designated as regulated MS4s after approval of TMDLs by EPA.

This TMDL does not invoke additional requirements set forth in the SPDES General Permit for Stormwater Discharges from Construction Activity, Permit No. GP-02-01, applicable to facilities satisfying Condition A of Part III.A.1.b.(1) for construction sites discharging to these waterbodies.

D. Information Regarding Nonpoint Source Management Programs/Efforts
As discussed in the Implementation section this document, the east end towns, Suffolk County, and New York State along with the Peconic Estuary Program and its many stakeholders have made and continue to make significant strides in developing and implementing programs and projects to reduce point and nonpoint source loads of nitrogen. These include:

- Supporting open space acquisition programs at all levels of government, and recommending that parcels of land in nitrogen stressed sub watersheds be priorities for acquisition.
- Supporting existing and proposed local government initiatives to preserving existing vegetation of parcels being developed, subdivided or re-developed, which among other ecological benefits can serve to limit the size of intensively managed landscapes now and in the future.
- Supporting using the effluent from the Riverhead Sewage Treatment Plan to irrigate and "fertigate" the adjoining County owned Indian Island Golf Course and supporting the allocation of funding to pilot test and fully implement this project.
- Working cooperatively with the 34 golf courses east of the William Floyd Parkway to reduce the amount of nitrogen that makes its way into groundwater and surface waters through improved management practices, and providing funding to develop plans for individual courses.
- Supporting the construction of a groundwater discharging treatment plant at the Corwin Duck Farm on Meetinghouse Creek to treat processing waters from that operation.
- Implementing the requirements of the Vessel Waste No Discharge Zone for the entire Peconic Estuary to eliminate this pollution source, and working with marine engine retailers to encourage boaters to purchase low emission/clean marine engines that are now on the market.
- Working with the agricultural community to reduce the nitrogen load from agriculture, including funding a county agricultural stewardship coordinator and staff to work to secure funding to develop and implement the necessary farm plans to achieve that goal.
- Developing recommendations and regulatory elements for reducing impacts associated with landscaping practices on residential, commercial, and public properties (i.e., eliminating or reducing fertilizer inputs); securing funding to develop and carry out

education and outreach program aimed at working with property owners/managers and commercial landscapers.
- Working with governments at all levels to implement projects to reduce direct and indirect stormwater inputs from road and highway drainage systems.
- Investigating opportunities to reduce nutrient loadings from on-site wastewater disposal systems ("septic systems" or "cesspools"), such as advanced treatment and micro-sewering, and pursuing feasible innovations and alternatives.
- Providing funding to investigate the feasibility for removing in-place and highly nutrient enriched bottom sediments.
- Supporting and funding efforts to reestablish eelgrass beds and the reverse trends responsible for the decline of existing beds.
- The allocation of significant funding for projects aimed at restoring commercially important shellfish (scallops and hard clams) through seeding and the establishment of spawner sanctuaries.
- Plans to further investigate other opportunities to reduce, manage or otherwise understand other nutrient inputs (i.e., wet and dry atmospheric deposition).

E. Monitoring and Reporting

The SCDHS also will continue its monitoring effort in the Peconic Estuary to continue to document water quality conditions and trends.

The Peconic Estuary Program seeks to have this TMDL fully implemented within 15 years from approval, based upon current expectations for full build-out and land acquisition programs, development and implementation of education and outreach programs, full participation in the agricultural stewardship/agricultural environmental management program, and other necessary efforts. The Peconic Estuary Program plans to track and report on progress in implementing and achieving this TMDL at five-year intervals. Full implementation of this TMDL is expected to result in water quality standards for dissolved oxygen being met where they are not currently attained and ensure continued compliance where these standards are presently achieved.

IX. Public Participation

EPA, DEC and SCDHS have worked together to prepare this TMDL to meet the requirements of Section 303(d) of the Clean Water Act. A notice was published in the Environmental Notice Bulletin (ENB) on July 18, 2007. The ENB publication announced the availability of the DRAFT TMDL document for comment and provided contact information for accessing the DRAFT TMDL Document and information on the scheduled public meeting. The public was given 30 days to submit comments to the DEC. The deadline for submitting comments to DEC for consideration was August 17, 2007. During the public comment period DEC received 7 sets of comments. Responses were provided in a Reponses to Public Comments Document and comments were considered in finalizing the TMDL.

DEC worked with the Peconic Estuary Program to make this document available to the public, local agencies, and stakeholders for their review and feedback through various email and letter correspondences. These correspondences announced the July 18, 2007 ENB publication and provided the file transfer protocol (ftp) website where the DRAFT TMDL document could be obtained and information on the scheduled public meeting. Several hard copies of the DRAFT TMDL document were also mailed. The stakeholders notified included, but were not limited to, the Towns of Riverhead, Southampton, East Hampton, Southold, Shelter Island and Brookhaven; the Villages of Sag Harbor, North Haven, Dering Harbor, and Greenport; the Brookhaven National Laboratory, Riverhead, Sag Harbor, and Shelter Island Heights STPs; other stakeholders involved in the Peconic Estuary Program and its committees and members.

DEC held one (1) public meeting to discuss and answer questions on the proposed TMDL on August 2, 2007 at the Cornell Cooperative Extension Education Center, First Floor Conference Room, 432 Griffing Avenue, Suite 100 Riverhead, NY 11901-3071, at 1pm. Staff from the DEC, EPA, SCDHS and PEP were present at this meeting; 25 stakeholders attended. DEC and EPA personnel discussed issues related to water quality standards, nitrogen as the pollutant which contributes to the causes of low DO levels, and development of the TMDL as a vehicle address water quality impairments and preserve water quality in the remaining waters of the Peconic Estuary.

X. References

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Schubert, C.E. 1998. Areas Contributing Ground Water to the Peconic Estuary, and Groundwater Budgets for the North and South Forks, Shelter Island, and Eastern Suffolk County, New York. Water Resources Investigation Report 97-4136. U.S. Geological Survey, Coram, NY.

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Tetra Tech. 2005. Refinements to the Three-dimensional Hydrodynamic and Water Quality Model of Peconic Estuary, Draft Report. Prepared for Peconic Estuary Program, County of Suffolk, Department of Health Services, Office of Ecology, Riverhead, NY. Prepared by Tetra Tech, Inc., Fairfax, VA. March 2005.

Other References

Suffolk County Department of Health Services, December 2002. Impacts of Agriculture on Shallow Groundwater in Suffolk County NY.

XI. Glossary

Algae: Any organisms of a group of chiefly aquatic microscopic nonvascular plants; most algae have chlorophyll as the primary pigment for carbon fixation. As primary producers, algae serve as the base of the aquatic food web, providing food for zooplankton and fish resources. An overabundance of algae in natural waters is known as eutrophication.

Anoxic: Aquatic environmental conditions containing zero or little dissolved oxygen. See also anaerobic.

Assimilative capacity: The amount of contaminant load (expressed as mass per unit time) that can be discharged to a specific stream or river without exceeding water quality standards or criteria. Assimilative capacity is used to define the ability of a water body to naturally absorb and use waste matter and organic materials without impairing water quality or harming aquatic life.

Bacterial decomposition: Breakdown by oxidation, or decay, of organic matter by heterotrophic bacteria. Bacteria use the organic carbon in organic matter as the energy source for cell synthesis.

Best management practices (BMPs): Methods, measures, or practices that are determined to be reasonable and cost-effective means to meet certain generally nonpoint source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.

Biochemical oxygen demand (BOD): The amount of oxygen per unit volume of water required to bacterially or chemically oxidize (stabilize) the oxidizable matter in water. Biochemical oxygen demand measurements are usually conducted over specific time intervals (5, 10, 20, 30 days). The term BOD generally refers to the standard 5-day BOD test.

Brown Tide: A harmful algal bloom of the microscopic alga Aureococcus anophagefferens. In 1985, severe brown tides were first reported in the Peconic Estuary of eastern Long Island, New York, in Narragansett Bay, Rhode Island and possibly in Barnegat Bay, New Jersey. Since then, brown tide has intermittently occurred with variable intensity in Barnegat Bay and in the bays of Long Island.

Calibration: Testing and tuning of a model to a set of field data not used in the development of the model; also includes minimization of deviations between measured field conditions and output of a model by selecting appropriate model coefficients.

Designated use: Uses specified in water quality standards for each waterbody of segment regardless of actual attainment

Discharge permit (NPDES): A permit by the U.S. EPA or a state regulatory agency that sets specific limits on the type and amount of pollutants that a municipality or industry can discharge to a receiving water; it also includes a compliance schedule for achieving those limits. The permit process was established under the National Pollutant Discharge Elimination System (NPDES), under provisions of the Federal Clean Water Act

Dissolved oxygen (DO): The amount of oxygen that is dissolved in water. It also refers to a measure of the amount of oxygen available for biochemical activity in a waterbody and as indicator of the quality of that water.

Drainage basin: A part of the land area enclosed by a topographic divides from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as watershed, river basin, or hydrologic unit.

Effluent: Municipal sewage or industrial liquid waste (untreated, partially treated, or completely treated) that flows out of a treatment plant, septic system, pipe or other conduit.

Estuary: Brackish-water area influenced by the tides where the mouth of the river meets the sea.

Eutrophication: Enrichment of an aquatic ecosystem with nutrients (nitrates, phosphates) that accelerate biological productivity (growth of algae and weeds) and an undesirable accumulation of algal biomass.

Eutrophication model: Mathematical formulation that describes the advection, dispersion, and biological, chemical and geo-chemical reactions that influence the growth and accumulation of algae in aquatic ecosystems. Models of eutrophication typically include one or more species groups of algae, inorganic and organic nutrients (N, P), organic carbon, and dissolved oxygen.

Hydrodynamic model: Mathematical formulation used in describing circulation, transport, and deposition processes in receiving water.

Hypoxia: The aquatic environmental conditions of reduced oxygen concentration in a water body that may lead to stressful or fatal conditions for aquatic organisms.

Loading, load, loading rate: The total amount of material (pollutants) entering the system from one source or multiple sources; measured as a rate in weight per unit time.

Load allocation (LA): The portion of receiving water's total maximum daily load that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.

Margin of safety (MOS): A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant load and the quality of the receiving waterbody. This uncertainty can be caused by insufficient or poor-quality data or a lack of knowledge about the water resource and pollution effects.

Mathematical model: A system of mathematical expressions that describes the spatial and temporal distribution of water quality constituents resulting from fluid transport and the one, or more, individual processes and interactions within some prototype\aquatic ecosystem. A mathematical water quality model is used as the basis for TMDL evaluations.

Nonpoint source pollution: Pollution that is typically not released through pipes but rather originates from multiple sources over a relatively large area. Nonpoint sources can be attributed to activities or land or water uses including: onsite disposal systems (septic systems), agricultural and forestry operations, lawn care, boating, and wet and dry atmospheric deposition. Nonpoint source pollution may reach surface waters via ground water.

Nutrient: A primary element necessary for the growth of living organisms. Nitrogen, and phosphorus, for example, are nutrients required for phytoplankton growth.

Nutrient limitation: Deficit of nutrient (e.g., nitrogen and phosphorus) required by microorganisms in order to metabolize organic substrates.

Point source: Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities.

Three-dimensional (3-D) model: Mathematical model defined along three spatial coordinates (length, width, and depth) where the water quality constituents are considered to vary over all three spatial coordinates.

Waste load allocation (WLA): The portion of a receiving water's total maximum daily load that is allocated to one of its existing or future point sources of pollution.

Water quality: The biological, chemical, and physical conditions of a waterbody; a measure of the ability of a waterbody to support beneficial uses.

Water quality criteria (WQC): Water quality criteria are composed of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.

Water quality standard (WQS): A law or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular waterbody, and an antidegradation statement.

Watershed: The area of land from which rainfall (and/or snowmelt) drains into a stream or other waterbody. Watersheds are also sometimes referred to as drainage basins. Ridges of higher ground generally form the boundaries between watersheds.

XII. Acronyms

ac-ft-days – acre-feet-days
BMP – best management practice
BNL – Brookhaven National Laboratory
CCMP - Comprehensive Conservation and Management Plan
CFR – Code of Federal Regulations
CPF – Community Preservation Fund
CWA - Federal Clean Water Act
DEC - New York State Department of Environmental Conservation
DO - dissolved oxygen
EFDC - Environmental Fluid Dynamics Code
ENB – Environmental Notice Bulletin
EPA - U.S. Environmental Protection Agency
EPF – Environmental Protection Fund
ft - feet
ftp - file transfer protocol
GIS - geographic information system
lb (or lbs.) - pounds
LA - load allocation
L-O-T or LOT – limit of technology
m - meters

MC – Meetinghouse Creek [groundwater management zone]
MEP – maximum extent practicable
mg/L - milligrams per liter
MGD or mgd – million gallons per day
MOS - margin of safety
MS4 – Municipal Separate Storm Sewer System
N - nitrogen
NOI – Notice of Intent
NEP - National Estuary Program
NPDES - National Pollutant Discharge Elimination System
NYSCRR New York State Codes, Rules and Regulations
NYSDOT – New York State Department of Transportation
P - phosphorus
PEP - Peconic Estuary Program
PLR – practical load reduction
PR-E – Peconic River – East [groundwater management zone]
psu - practical salinity units
PWL - Priority Waterbodies List
SAV - submerged aquatic vegetation
SCDHS - Suffolk County Department of Health Services
SPDES - State Pollutant Discharge Elimination System
STP - sewage treatment plant
SWMP – stormwater management plan
TMDL – total maximum daily load
TN – total nitrogen
TOC - total organic carbon
USGS – U.S. Geological Survey
WLA – wasteload allocation
WQBELs - water quality-based effluent limits
YSI - Yellowbird Springs Instruments

XIII. Links to Relevant Documents and Web Sites

A Strategy to Develop and Implement the Suffolk County Agricultural Stewardship Program - A Report of the Agricultural Environmental Management Task Force for Nitrogen and Pesticide Load Reduction - Final Report (May 26, 2004)
http://peconicestuary.org/AgForceRpt.pdf

Peconic Estuary Program Comprehensive Conservation and Management Plan (November 2001)
http://www.peconicestuary.org/CCMP.html

Appendix H (Agricultural Environmental Management Strategy) of the Peconic Estuary Program Comprehensive Conservation and Management Plan (November 2001)
http://www.peconicestuary.org/CCMP_PDF/AppendixH.pdf

FINAL REPORT for Peconic Bay Pathogens TMDL (September 2006)
http://www.epa.gov/waters/tmdldocs/NY-2006-Pathogens-Peconic_Bay-TMDLDoc.pdf

San Joaquin River Dissolved Oxygen Aeration Project Draft Engineering Feasibility Study, Prepared for: The California Bay-Delta Authority; Prepared by: HDR Engineering, Inc., Folsom, CA, July 2004.
http://www.sjrdotmdl.org/library_folder/apdxa.pdf

Peconic Estuary Nitrogen TMDL

Cumulative Impact Graphics

January 5, 2007

Cumulative Impacts

- The following graphics show the cumulative impacts of various management alternatives on total nitrogen and dissolved oxygen along transects in the western Peconic Estuary. Model results for 6 runs are shown on each graphic:
  - 01g: Baseline run (i.e., existing conditions)
  - 15h1: atmospheric deposition of nitrogen reduced by 31.3%
  - 15h2: groundwater nitrogen concentration reduced to practical load reduction scenario concentrations
  - 15h3: tributary and stormwater nitrogen reduced
  - 15h: STP loads reduced to practical load reductions with spray irrigation used during summer months (May 1 – Sep 30)
  - 15i: same as 15h except mechanical aeration was used to add oxygen to achieve existing 5.0 mg/L DO water quality standard
- These runs are summarized in the following table

Summary of Alternative Management Scenarios

Scenario	WWTPs	Atmospheric Deposition	Groundwater	Peconic River and Tributaries	Stormwater Runoff
01g	Flow and load at existing permit limits (Riverhead STP TN =130 lb/day)	Nitrogen from atmospheric deposition at existing levels	Nitrogen at existing concentrations	Nitrogen loads at existing levels	Nitrogen from stormwater loads at existing levels
15h1	Flow and load at existing permit limits (Riverhead STP TN =130 lb/day)	Nitrogen from atmospheric deposition reduced by 31.3%	Nitrogen at existing concentrations	Nitrogen loads at existing levels	Nitrogen from stormwater loads at existing levels
15h2	Flow and load at existing permit limits (Riverhead STP TN =130 lb/day)	Nitrogen from atmospheric deposition reduced by 31.3%	Nitrogen at Practical Load Reduction Scenario concentrations	Nitrogen loads at existing concentrations	Nitrogen from stormwater loads at existing levels
15h3	Flow and load at existing permit limits (Riverhead STP TN =130 lb/day)	Nitrogen from atmospheric deposition reduced by 31.3%	Nitrogen at Practical Load Reduction Scenario concentrations	Nitrogen loads at Practical Load Reduction Scenario concentrations	Nitrogen from stormwater loads reduced by 15% in Peconic River and Flanders Bay; reduced by 10% east of Flanders Bay
15h	Flow and load at limit-of-technology with spray irrigation (Riverhead STP TN=40 lb/day)	Nitrogen from atmospheric deposition reduced by 31.3%	Nitrogen at Practical Load Reduction Scenario concentrations	Nitrogen loads at Practical Load Reduction Scenario concentrations	Nitrogen from stormwater loads reduced by 15% in Peconic River and Flanders Bay; reduced by 10% east of Flanders Bay

Note: Scenario 15i is the same as 15h except mechanical aeration was used to add oxygen to achieve the existing 5.0 mg/L DO water quality standard.

Key to Figures

- Figure 1: location and river miles for Peconic River to Robbins Island transect
- Figure 2: locations and river miles for Meetinghouse Creek, Terrys Creek, and Sawmill Creek transects
- Figures of lowest daily-average bottom DO: this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the bottom layer at each grid cell along the transect.
- Figures of lowest daily-average surface DO; this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the surface layer at each grid cell along the transect.

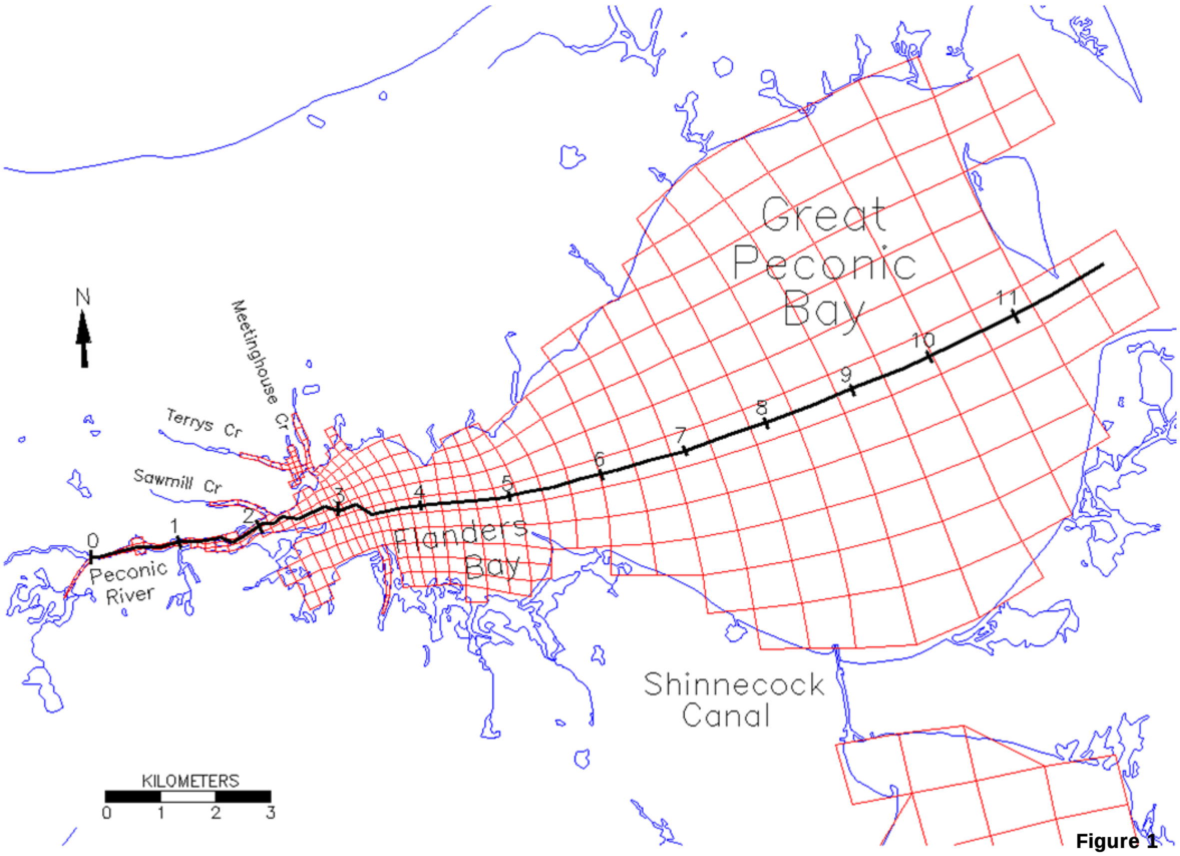


Figure 1

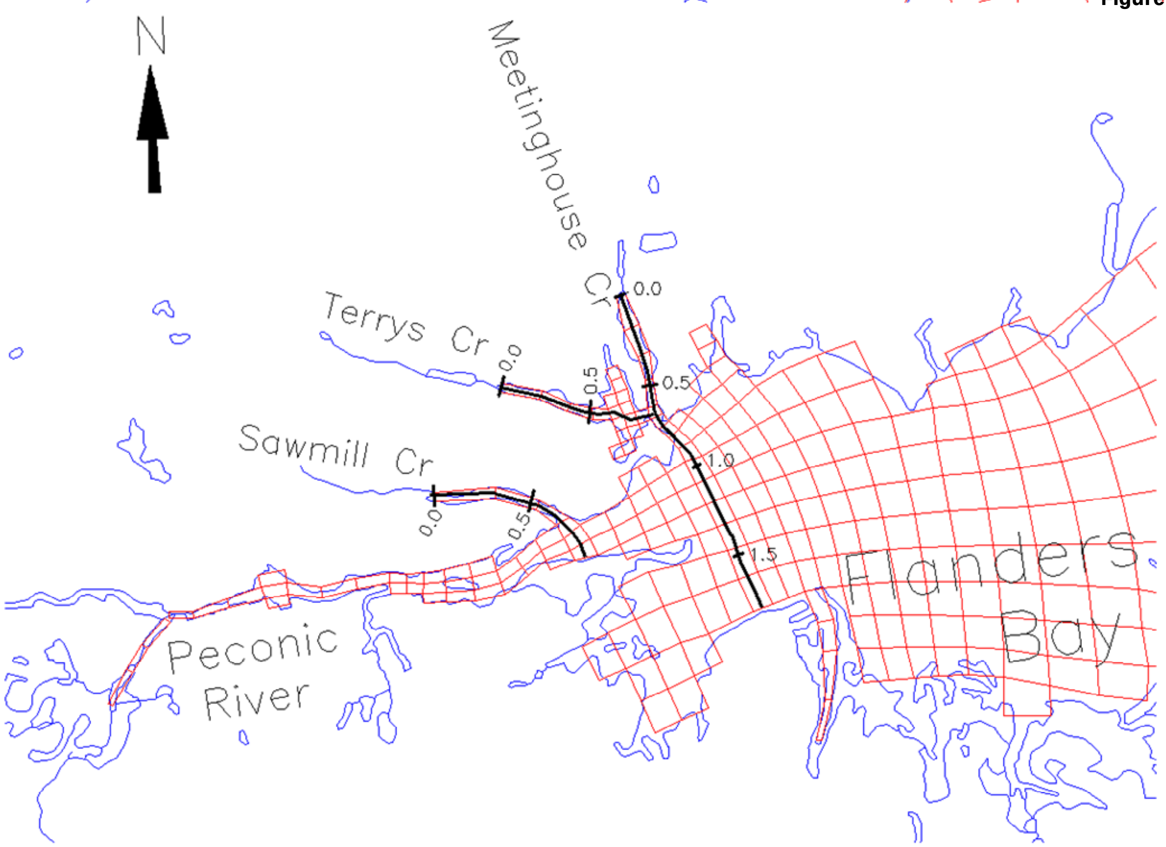
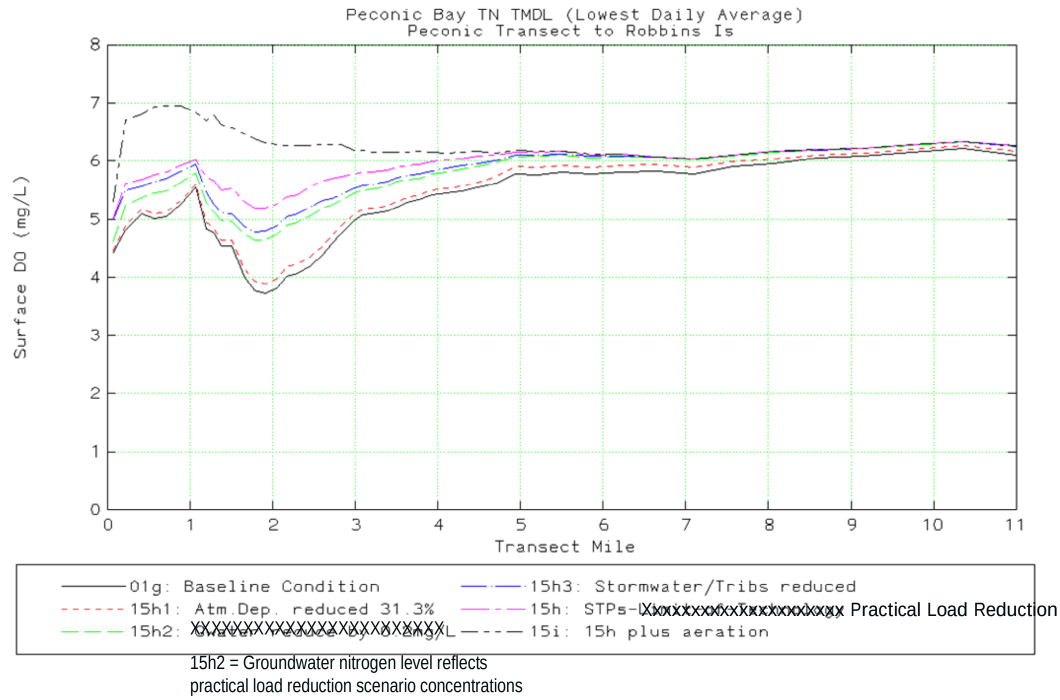
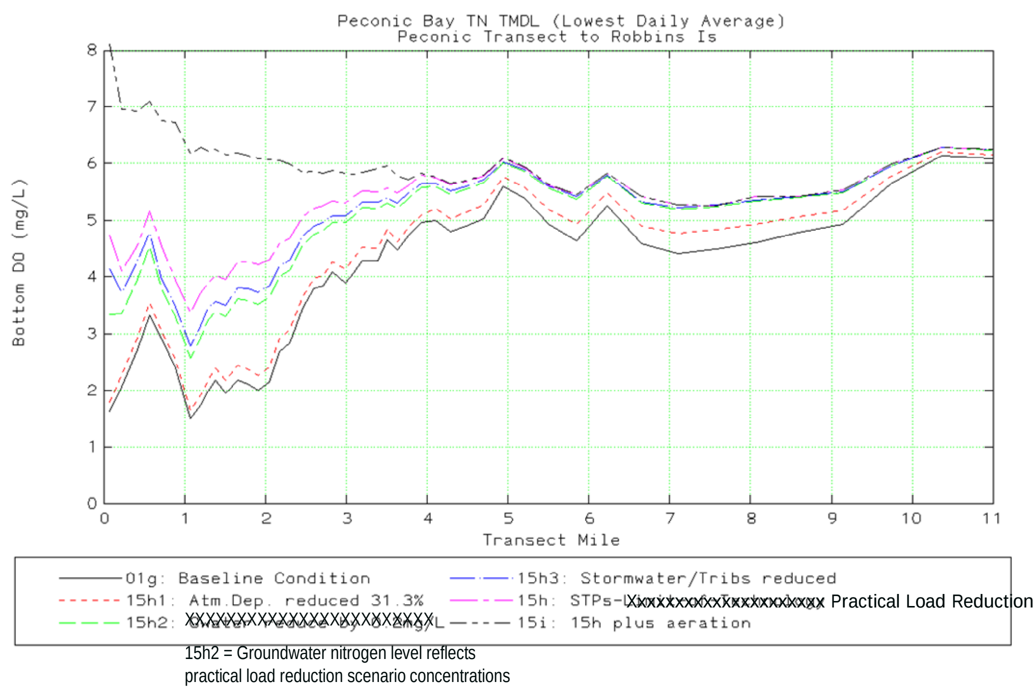


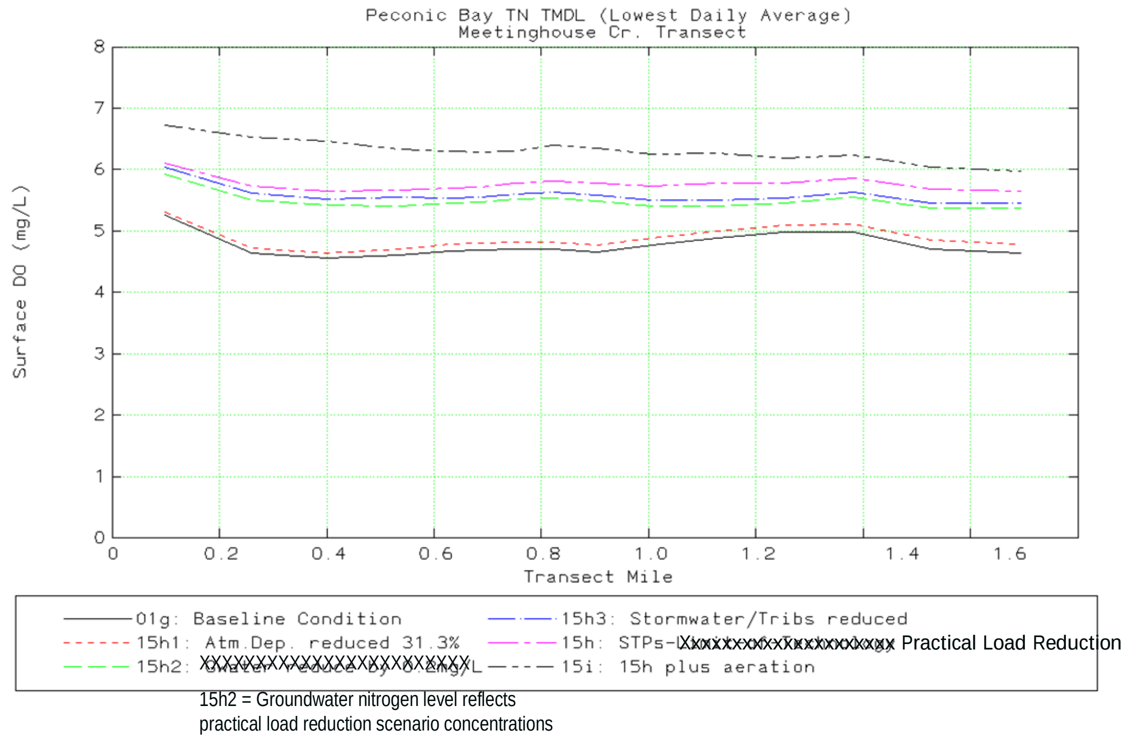
Figure 2



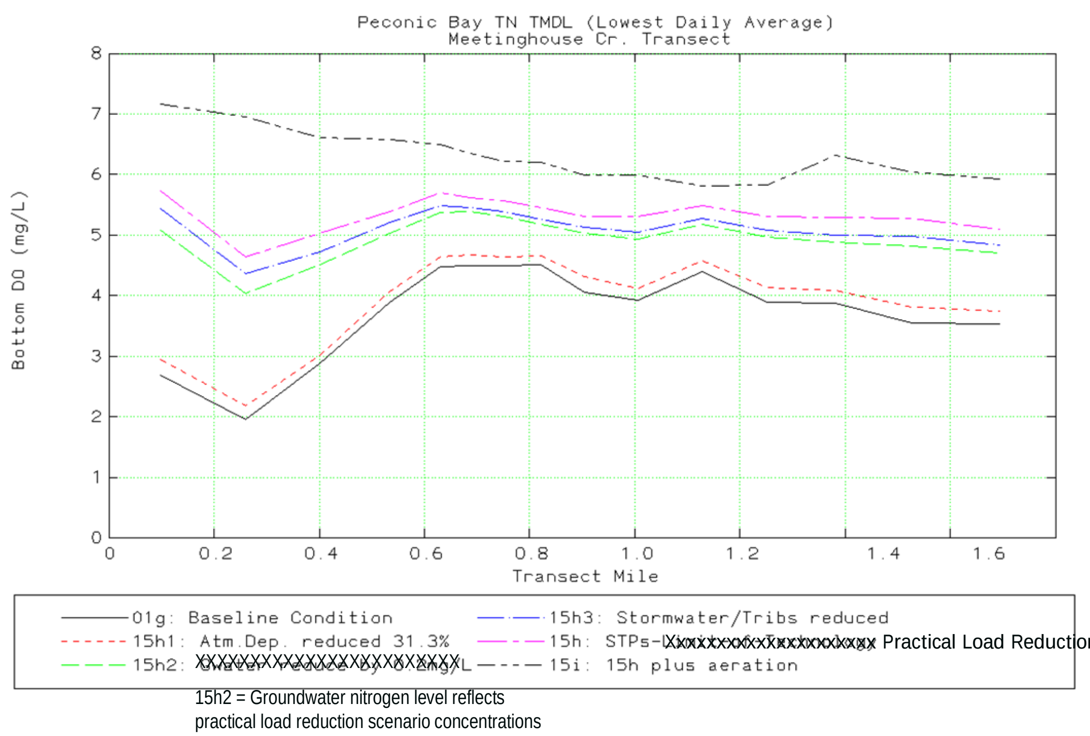
Appendix A, Figure A.3: Peconic River to Robbins Island Transect - Lowest daily-average surface DO; this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the surface layer at each grid cell along the Peconic River to Robbins Island Transect.



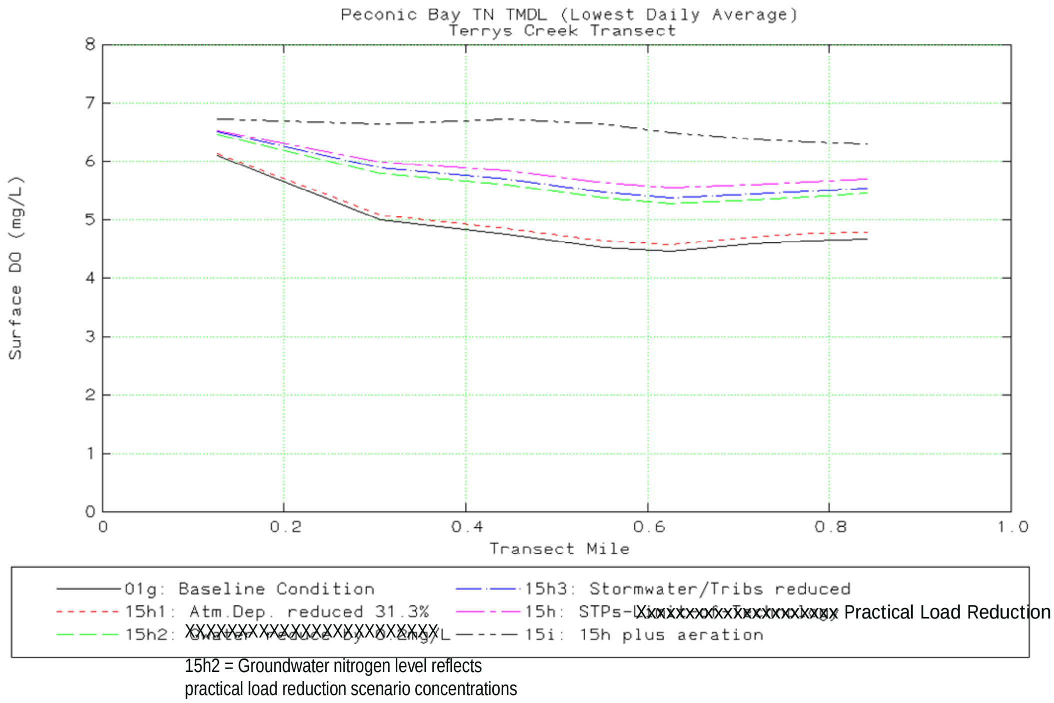
Appendix A, Figure A.4: Peconic River to Robbins Island Transect - Lowest daily-average bottom DO, this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the bottom layer at each grid cell along the Peconic River to Robbins Island Transect.



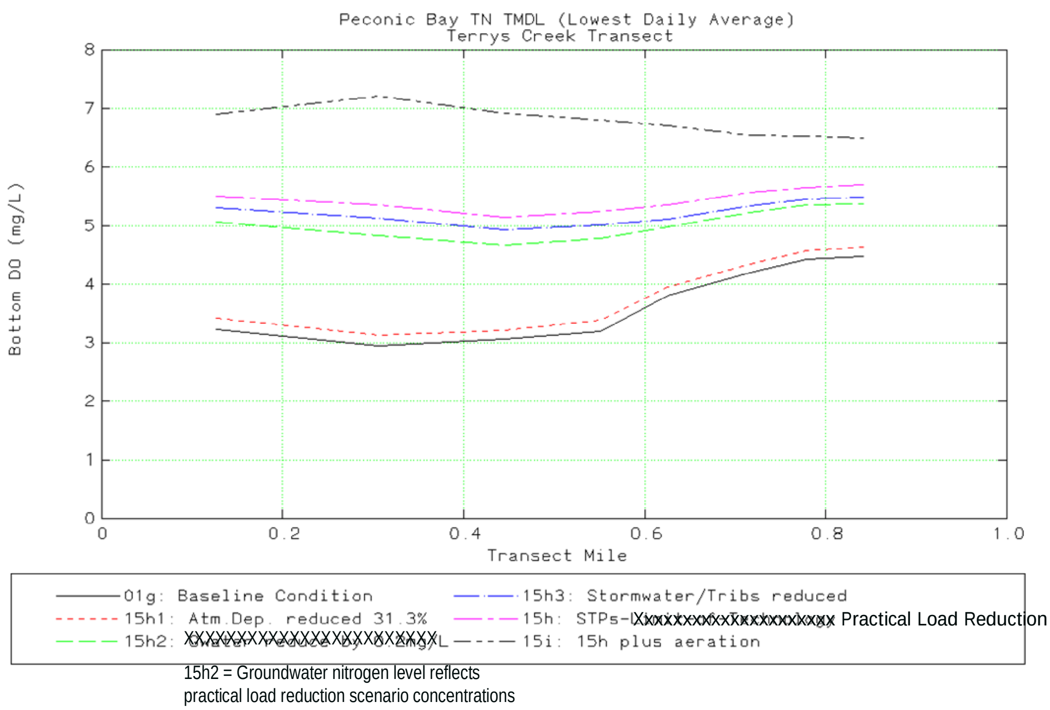
Appendix A, Figure A.5: Meetinghouse Creek Transect - Lowest daily-average surface DO; this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the surface layer at each grid cell along the Meetinghouse Creek Transect.



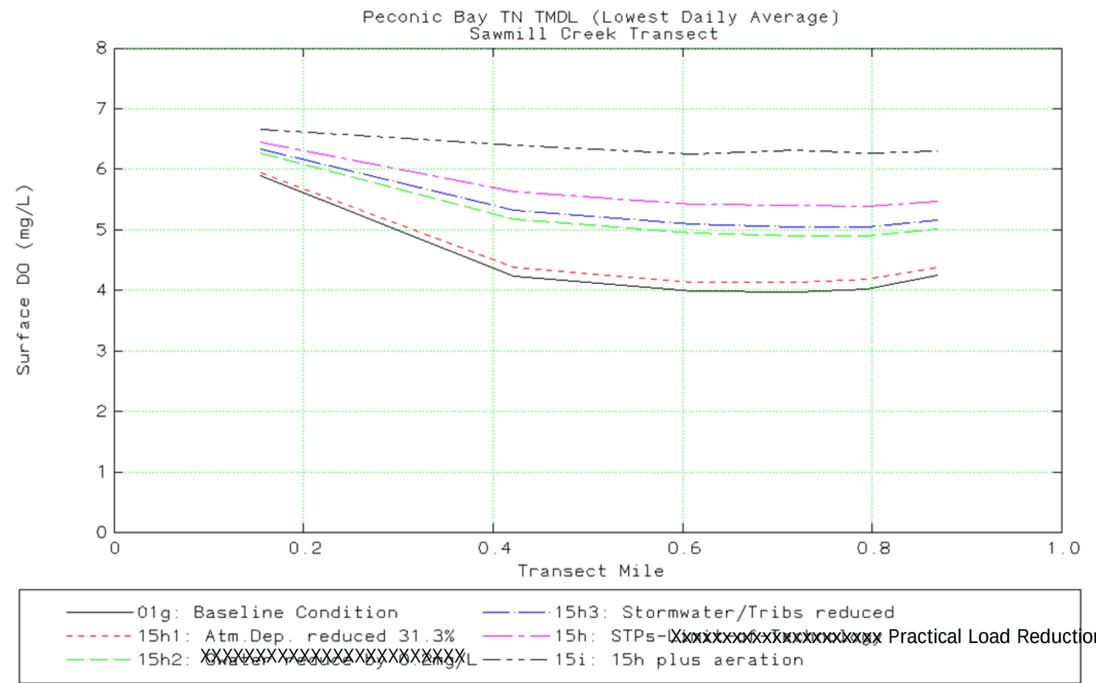
Appendix A, Figure A.6: Meetinghouse Creek Transect - Lowest daily-average bottom DO, this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the bottom layer at each grid cell along the Meetinghouse Creek Transect.



Appendix A, Figure A.7: Terrys Creek Transect - Lowest daily-average surface DO; this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the surface layer at each grid cell along the Terrys Creek Transect.

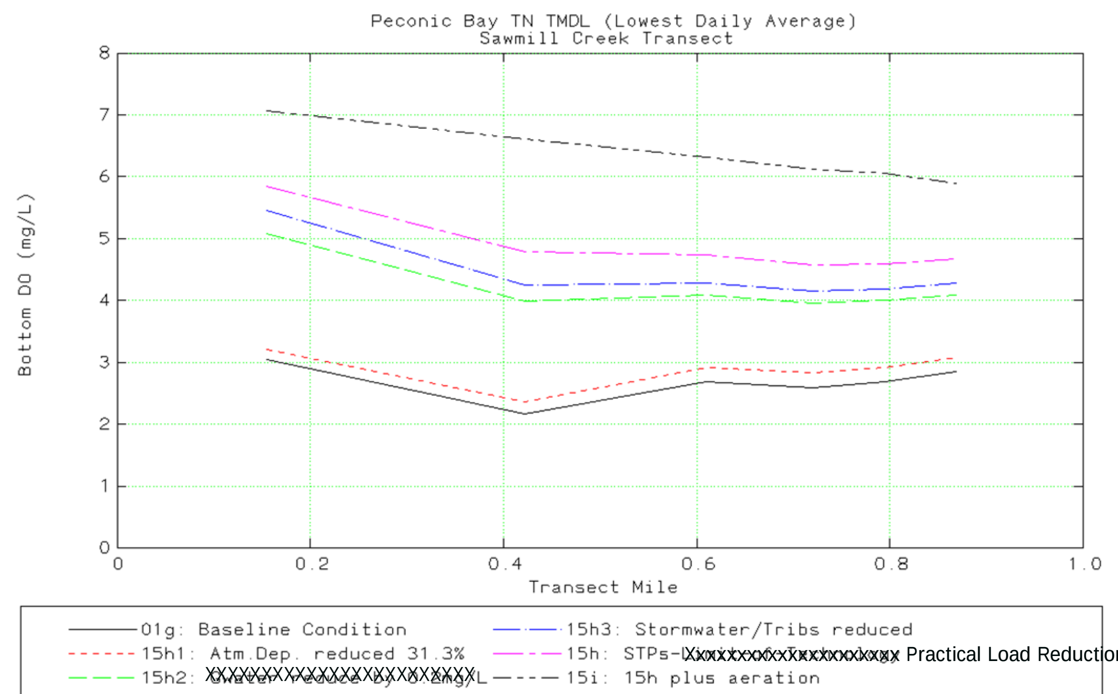


Appendix A, Figure A.8: Terrys Creek Transect - Lowest daily-average bottom DO, this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the bottom layer at each grid cell along the Terrys Creek Transect.



15h2 = Groundwater nitrogen level reflects practical load reduction scenario concentrations

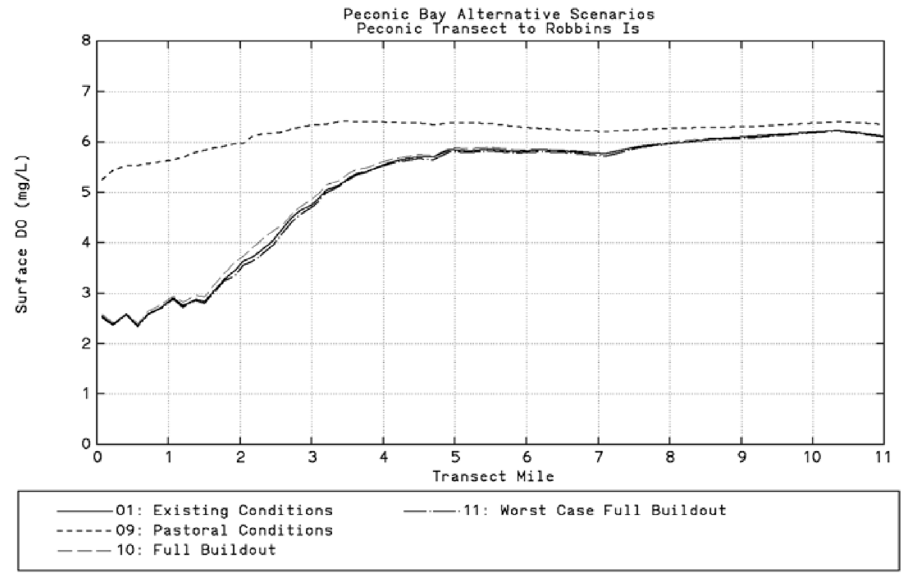
Appendix A, Figure A.9: Sawmill Creek Transect - Lowest daily-average surface DO; this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the surface layer at each grid cell along the Sawmill Creek Transect.



15h2 = Groundwater nitrogen level reflects practical load reduction scenario concentrations

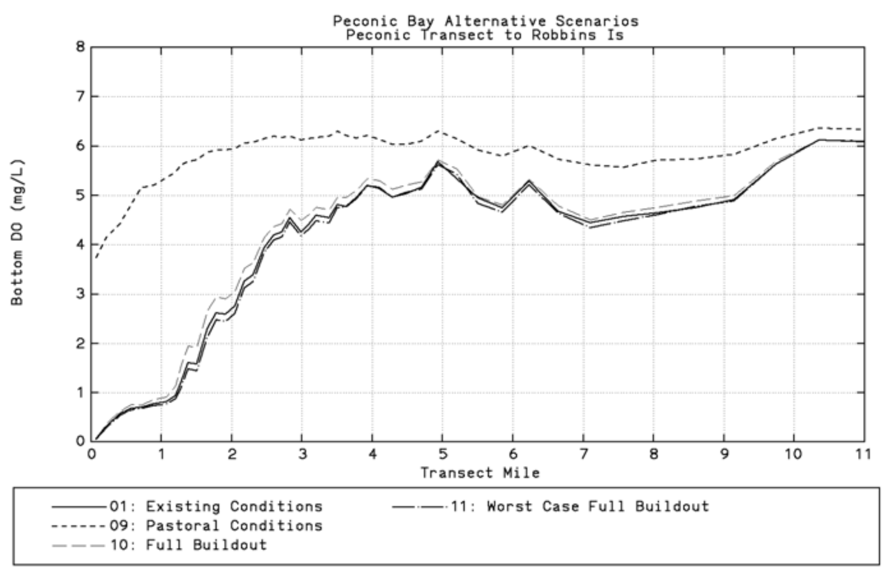
Appendix A, Figure A.10: Sawmill Creek Transect - Lowest daily-average bottom DO, this is the lowest of the 730 daily-average DO concentrations from the 2-year model run for the bottom layer at each grid cell along the Sawmill Creek Transect.

Full Build-out and Worst Case Full Build-out Scenarios



- **Scenario #10.** Full Build-Out – 50% of remaining farmland is preserved; 15% of open space is protected; 50% of subdividable land is protected and the other half is developed with mandatory clustering and clearing restrictions.
- **Scenario #11.** Worst Case Full Build-Out – 100% of all agricultural parcels (preserved and unpreserved) remain in agricultural use; 85% of vacant land is developed; 100% of subdividable land is subdivided

Full Build-out and Worst Case Full Build-out Scenarios



- **Scenario #10.** Full Build-Out – 50% of remaining farmland is preserved; 15% of open space is protected; 50% of subdividable land is protected and the other half is developed with mandatory clustering and clearing restrictions.
- **Scenario #11.** Worst Case Full Build-Out – 100% of all agricultural parcels (preserved and unpreserved) remain in agricultural use; 85% of vacant land is developed; 100% of subdividable land is subdivided

Appendix B-1: NYS DEC 303(d) listing

(MW6.1e) GB..FB,FB-111	* Flanders Bay, West/Lower Sawmill Cr (1701-0254)	Suffolk	Estuary	SC	D.O./Oxygen Demand	Urb/Storm Runoff	2002
(MW6.1e) GB..FB-110	* Meetinghouse/Terrys Creeks and tribs (1701-0256)	Suffolk	Estuary	SC	D.O./Oxygen Demand	Agric (sediment beds)	2002
(MW6.2) GB..FB-112 (portion 1)	* Peconic River, Lower, and tidal tribs (1701-0259)	Suffolk	Estuary	SC	D.O./Oxygen Demand	Urb/Storm Runoff	2002

Appendix B-2: Information on Groundwater Management Zones & Nutrient Loading Factors

TMDL Management Alternative Scenarios			5	6	7	8	10	11	13	14
GW Management Zone	Total Acres in Each Zone	Current/Baseline GW Loadings in Model (mg/l)	Loading from Zone with 25% Ag reduction (13 mg/l to 9.75 mg/l)	Loading from Zone with 25% Non-Ag Reduction (6 mg/l to 4.5, 4 mg/l to 3, gc from 3.58 to 2.69)	Loading from Zone with 25% Reduction in ag and non-ag sources (excluding open space)	Loading from Zone with 50% Reduction in ag and non-ag sources (excluding open space)	Full Build Out	Worst Case Full Build Out	GW #'s for Cumulative Improvements - Existing Conditions, inc. 0.2 mg/l reduction from atm dep.(still have to account for STP effluent out of system May-Sept and 31.3% reduction in NOx Atm.	GW #'s for Cumulative Improvements - Full Build Out, inc. 0.2 mg/l reduction from atm. dep. (still have to acct for STP effluent out of system and 31.3% reduction in NOx Atm Dep.)
Shelter Island (SHE)	7,172.97	3	2.9	2.35	2.28	1.56	3.13	3.38	2.08	2.38
South Fork Inland (SF-I)	3,177.06	3	3.0	2.88	2.88	2.76	3.22	3.22	2.66	2.83
South Fork Central (SF-C)	1,776.95	3	3.0	2.52	2.52	2.05	3.08	3.11	2.32	2.58
Peconic River Middle (PR-M)*	4,679.02	0.65	0.6	0.6	0.6	0.5	0.6	0.7	0.54	0.52
Peconic River East (PR-E)	6,884.02	5	4.81	4.51	4.32	3.64	4.88	5.18	4.12	3.98
North Fork Inland (NF-I)	1,409.47	8	7.39	7.73	8.20	5.47	6.53	8.09	8.00	4.50
North Fork Central (NF-C)	1,797.92	8	6.52	7.51	6.02	4.05	6.18	8.35	5.82	4.37
Montauk (MONT)	8,515.18	4	3.98	3.71	3.69	3.38	4.07	4.13	3.49	3.59
Little Peconic South (LP-S)	15,090.26	4	3.86	3.21	3.07	2.13	4.05	4.34	2.87	3.03
Little Peconic North (LP-N)	9,356.84	9	8.47	8.19	7.66	6.32	8.61	9.44	7.46	6.34
Great Peconic South (GP-S)	10,001.38	4	4.00	3.32	3.32	2.64	4.28	4.38	3.12	3.33
Great Peconic North (GP-N)	7,010.52	9	7.90	8.32	7.22	5.43	7.72	9.34	7.02	5.55
Gardiners Bay South (GB-S)	15,997.73	4	3.98	3.22	3.20	2.40	4.16	4.32	3.00	3.24
Gardiners Bay North (GB-N)	3,202.20	9	8.30	8.69	7.98	6.97	8.11	9.13	7.78	6.85
Meetinghouse Creek (MC)	1,236.24	9	7.97	8.34	7.31	5.61	7.87	9.52	7.11	5.61
TOTAL	97,308									

* although located upstream of USGS gauge and out of model domain (accounted for in stream flow loading inputs to model) it may be good to vary this loading in the management alternative runs. PR-M estimations were calculated as a ratio of PR-E.

Build Out Potential According to Groundwater Management Zones

Residential Properties***

Sewer District	GW Management Zone	Total Acres in Each Zone	Vacant & Developed but Subdividable Parcels								SEWER Vacant and Developed but Subdiv. (a subset of Vacant & Developed but Subdividable Parcels)				Developed & Not Subdividable		SEWER Developed	Protected		Agricultural	
			Total Existing # of lots	Total Acreage	Sewer District Total Acreage	Total # of Potential Additional Lots	Total Acreage of Additional Lots* (Vacant)	Total Acreage of Additional Lots** (Developed but Subdividable)	Overall Total Acreage of Additional Lots	Developed Acreage - LB (4 mg/l)	SEWER District Total Acreage of Additional Lots (Vacant)	SEWER District Total Acreage of Additional Lots (Developed but Subdividable)	SEWER District Overall Acreage of Additional Lots	SEWER Acreage Developed (2 mg/l)	Total # of Lots	Total Acreage (6 mg/l)	SEWER Total Acreage (3 mg/l)	Total # of Lots	Total Acreage	Total # of Lots	Total Acreage
	Shelter Island (SHE)	7,172.97	1,009	2,241.48		1,168	427.47	547.07	974.54	1266.94					2,234	2,158		115	2,462	10	156
	South Fork Inland (SF-I)	3,177.06	114	378.06		61	268.64	0.00	268.64	109.42					156	180		178	2,619	-	-
	South Fork Coastal (SF-C)	1,776.95	326	178.95		140	43.64	28.29	71.93	107.02					1,053	494		55	1,104	-	-
	Peconic River Middle (PR-M)	4,679.02	263	760.83		625	344.94	77.92	422.86	337.97					479	1,163		21	171	63	2,242
Riverhead	Peconic River East (PR-E)	6,884.02	104	914.38		974	351.69	134.13	485.82	428.56	38.32	25.41	63.73	124.29	3,731	2,281	798	159	3,089	15	409
	North Fork Inland (NF-I)	1,409.47	52	106.47		65	17.40	28.74	46.14	60.33					233	215		1	20	41	1,068
	North Fork Coastal (NF-C)	1,797.92	250	400.92		501	122.72	102.60	225.32	175.60					1,112	476		18	102	44	819
	Montauk (MONT)	8,515.18	831	1,019.18		436	264.92	138.08	403.00	616.18					2,346	1,249		191	6,195	26	52
Sag Harbor	Little Peconic South (LP-S)	15,090.26	1,930	4,700.12		1,349	1171.04	712.60	1883.64	2816.48	0.00	0.00	0.00	0.93	6,794	5,694	30	484	3,329	65	658
Greenport	Little Peconic North (LP-N)	9,356.84	1,062	2,715.84		1,615	1080.08	471.79	1551.87	1163.97	6.40	6.92	13.32	21.50	5,372	4,405	285	123	705	106	1,531
	Great Peconic South (GP-S)	10,001.38	1,694	2,990.33		1,480	921.63	476.20	1397.83	1592.50					3,586	2,895		377	3,161	4	14
	Great Peconic North (GP-N)	7,010.52	663	1,620.17		767	529.91	335.08	864.99	755.18					3,542	2,603		59	267	113	2,374
	Gardiners Bay South (GB-S)	15,997.73	2,779	4,141.37		1,331	720.26	1093.87	1814.13	2327.24					7,580	6,713		683	4,904	7	78
	Gardiners Bay North (GB-N)	3,202.20	234	400.20		120	80.26	67.96	148.22	251.98					793	499		51	1,609	38	694
	Meetinghouse Creek (MC)	1,236.24	89	428.24		538	87.80	139.93	227.73	200.51					348	412		2	4	16	392
	TOTAL	97,307.76	11,400	22,996.54		11,170	6432.40	4354.26	10786.66						39,359	31,437		2,517	29,741	548	10,487
	PR-M (Brookhaven/Non-PE)		N/A	N/A		N/A									608	496		517	3,065	-	-

* These vacant acreages were calculated by taking the vacant properties that had subdivision potential and subtracting the acreage of one lot.

** Properties that already have development have the potential to be completely cleared. For these scenarios: 1) Properties not already located in an Overlay District where clearing restricitons were in place, were assumed to have 50% of the lot still in a natural state. Therefore, these developed but subdividable acreages were calculated by taking the developed but subdiviable acreages and dividing by two. 2) Properties which are located in an Overlay District (within the Towns of East Hampton or Southampton and within Ground Water Management Zones: South Fork Inland; South Fork Central; Peconic River East; Montauk; Little Peconic South; Great Peconic South; or Gardiners Bay South) have clearing restrictions in place. In order to calculate acreages for these developed but subdividable totals, the amount of allowable clearing under the Overlay District regulations was removed from the total acreage.

*** Properties were put into the management zone in which the majority of the acreage was located

Build Out Potential According to Groundwater Management Zones

Golf Course Properties

GW Management Zone	Subdividable Golf Courses on CLPS				Golf Courses not on CLPS	
	Total Existing #	Total Acreage		Total # of Potential	Total # of Lots	Total Acreage
Shelter Island (SHE)	3	155.49		90	0	0
South Fork Inland (SF-I)	-	-		-	0	0
South Fork Central (SF-C)	-	-		-	0	0
Peconic River Middle (PR-M)	6	342.19		17	0	0
Peconic River East (PR-E)	-	-		-	3	190.641
North Fork Inland (NF-I)	-	-		-	0	0
North Fork Central (NF-C)	-	-		-	0	0
Montauk (MONT)	-	-		-	0	0
Little Peconic South (LP-S)	3	709.14		516	0	0
Little Peconic North (LP-N)	-	-		-	0	0
Great Peconic South (GP-S)	9	933.63		3,380	1	7.419
Great Peconic North (GP-N)	4	134.49		73	1	11.86
Gardiners Bay South (GB-S)	4	161.36		88	0	0
Gardiners Bay North (GB-N)	-	-		-	0	0
TOTAL	29	2,436.30		4,164	5	209.92

Build Out Potential According to Proposed Sewer Districts

Residential Properties

			Vacant & Developed but Subdividable CLPS Parcels						Developed & Not Subdivid		Protected		Agricultural	
	Sewer District	Total in each zone	Total Existing # of lots	Total Acreage	Total # of Potential Additional Lots	Total Acreage of Additional Lots* (Vacant)	Total Acreage of Additional Lots** (Developed but Subdividable	Overall Total Acreage of Additional Lots	Total # of Lots	Total Acreage	Total # of Lots	Total Acreage	Total # of Lots	Total Acreage
PR-E Zone	Riverhead		252.00	188.02	143	38.32	25.41	63.73	1697	797.5	12	77.563	4	61.985
LP-S Zone	Southampton		4.00	0.925	0	0	n/a	0	171	29.744	4	2.957	0	0
LP-N	Southold		68.00	34.82	44	6.4	6.92	13.32	791	285.07	11	208.51	0	0
	TOTAL		**324.00**	**223.765**	**187**	**44.72**	**32.33**	**77.05**	**2659**	**1112.314**	**27**	**289.03**	**4**	**61.985**

* These vacant acreages were calculated by taking the vacant properties that had subdivision potential and subtracting the acreage of one lot.

** Properties that already have development have the potential to be completely cleared. For these scenarios: 1) Properties not already located in an Overlay District where clearing restricitons were in place, were assumed to have 50% of the lot still in a natural state. Therefore, these developed but subdividable acreages were calculated by taking the developed but subdiviable acreages and dividing by two. 2) Properties which are located in an Overlay District (within the Towns of East Hampton or Southampton and within Ground Water Management Zones: South Fork Inland; South Fork Central; Peconic River East; Montauk; Little Peconic South; Great Peconic South; or Gardiners Bay South) have clearing restrictions in place. In order to calculate acreages for these developed but subdividable totals, the amount of allowable clearing under the Overlay District regulations was removed from the total acreage.

TMDL Management Alternatives

GW Management Zone	Total Acres in Each Zone	Current/Baseline GW Loadings in Model (mg/l)	Calculated GW loading per zone w/0.5 mg/l for open space and 10 mg/l for Ag	Calculated GW Loading Zone w/1 mg/l for open space and 13.0 mg/l for ag	Loading coming from sources other than Ag in Zone	Loading from Zone with 25% Ag reduction (13 mg/l to 9.75 mg/l)	Loading from Zone with 50% Ag reduction (13 mg/l to 6.5 mg/l)	Loading from sources other than residential and golf in Zone	Loading from Zone with 25% Non-Ag Reduction (6 mg/l to 4.5, 4 mg/l to 3, gc from 3.58 to 2.69)
Shelter Island (SHE)	7,172.97	3	3.05	3.35	2.78	2.93	2.86	0.82	2.35
South Fork Inland (SF-I)	3,177.06	3	0.93	1.39	3	3	3	2.78	2.88
South Fork Coastal (SF-C)	1,776.95	3	2.24	2.57	3	3	3	1.65	2.52
Peconic River Middle (PR-M)	4,679.02	[illegible]							
Peconic River East (PR-E)	6,884.02	5	3.19	3.63	4.49	4.81	4.61	5.27	4.51
North Fork Inland (NF-I)	1,409.47	8	8.69	10.98	-	7.39	4.93	8.59	7.73
North Fork Coastal (NF-C)	1,797.92	8	6.63	8.08	3.82	6.52	5.04	9.44	7.51
Montauk (MONT)	8,515.18	4	1.62	2.02	3.94	3.98	3.96	3.62	3.71
Little Peconic South (LP-S)	15,090.26	4	3.79	4.09	3.59	3.86	3.72	2.13	3.21
Little Peconic North (LP-N)	9,356.84	9	5.08	5.69	8.22	8.47	7.94	14.26	8.19
Great Peconic South (GP-S)	10,001.38	4	2.95	3.18	3.99	4.00	3.99	2.82	3.32
Great Peconic North (GP-N)	7,010.52	9	6.20	7.30	6.95	7.90	6.80	12.53	8.32
Gardiners Bay South (GB-S)	15,997.73	4	3.39	3.62	3.96	3.98	3.97	2.03	3.22
Gardiners Bay North (GB-N)	3,202.20	9	4.14	5.06	7.89	8.30	7.59	10.12	8.69
Meetinghouse Creek (MC)	1,236.24	9	7.15	8.20	7.14	7.97	6.94	12.59	8.34
TOTAL	97,307.76								

GW Management Zone	Loading from sources other than ag, residential and golf courses in zone	Loading from Zone with 25% Reduction in ag and non-ag sources (excluding open space)	Loading from Zone with 50% Reduction in ag and non-ag sources (excluding open space)	Loading from sources other than ag and additional vacant and subdividable lots (i.e., loading from protected, golf courses, existing resid.)	% golf courses and existing resid from golf courses, existing resid and protected	Full Build Out	Loading from sources other than additional vacant and subdividable lots	Worst Case Full Build Out	GW #'s for Cumulative Improvements - Existing Conditions, inc. 0.2 mg/l reduction from atm dep.(still have to account for STP effluent out of system May-Sept and 31.3% reduction in Atm.	GW #'s for Cumulative Improvements - Full Build Out (still have to acct for STP effluent out of system and 31.3% Atm Dep.
Shelter Island (SHE)	0.27	2.28	1.56	3.06	0.59	3.13	3.31	3.38	2.08	2.38
South Fork Inland (SF-I)	2.78	2.88	2.76	3.18	0.10	3.22	3.18	3.22	2.68	2.83
South Fork Coastal (SF-C)	1.65	2.52	2.05	3.08	0.35	3.08	3.08	3.11	2.32	2.58
Peconic River Middle (PR-M)										
Peconic River East (PR-E)	4.38	4.32	3.64	4.78	0.48	4.88	5.30	5.18	4.12	3.98
North Fork Inland (NF-I)	-	8.20	5.47	-	0.93	6.53	8.24	8.09	8.00	4.50
North Fork Coastal (NF-C)	0.54	6.02	4.05	4.66	0.86	6.18	9.00	8.35	5.82	4.37
Montauk (MONT)	3.55	3.69	3.38	4.09	0.23	4.07	4.15	4.13	3.49	3.59
Little Peconic South (LP-S)	0.75	3.07	2.13	3.98	0.73	4.05	4.43	4.34	2.67	3.03
Little Peconic North (LP-N)	15.12	7.66	6.32	10.00	0.89	8.61	10.59	9.44	7.46	6.34
Great Peconic South (GP-S)	2.79	3.32	2.64	4.47	0.63	4.28	4.49	4.38	3.12	3.33
Great Peconic North (GP-N)	11.55	7.22	5.43	8.32	0.93	7.72	10.13	9.34	7.02	5.55
Gardiners Bay South (GB-S)	1.91	3.20	2.40	4.34	0.65	4.16	4.38	4.32	3.00	3.24
Gardiners Bay North (GB-N)	8.99	7.98	6.97	8.33	0.32	8.11	9.39	9.13	7.78	6.85
Meetinghouse Creek (MC)	11.89	7.31	5.61	9.41	0.99	7.87	10.81	9.52	7.11	5.61
TOTAL										

Appendix C: Agricultural Environmental Management/Agricultural Stewardship

Implementation Highlight: Agricultural Environmental Management/ Agricultural Stewardship

Introduction

The Suffolk County Agricultural Stewardship Program was established in response to growing concerns about nitrate levels and pesticide residues in Long Island ground and surface waters. Cornell Cooperative Extension, the coordinating agency of the Stewardship Program, works together with Suffolk County Soil and Water Conservation District and USDA Natural Resource Conservation Service to protect the Long Island's water resources while at the same time preserving the region's viable and sustainable agricultural industry. This program is funded by the Suffolk County Water Quality Protection and Restoration Program.

Background

The Long Island Agricultural Stewardship Committee was formed in 1999 to address environmental concerns with the intent of preserving farmland while protecting groundwater. The goals of the stewardship committee are to promote the use of agricultural inputs in a responsible and environmentally sound manner while maintaining a strong, viable agricultural industry. The committee has begun to develop and implement a voluntary management plan that addresses groundwater and surface water protection by appropriately using nitrogen (fertilizer) and pesticides registered for use on Long Island.

The stewardship committee originally developed thirteen environmental risk assessment worksheets for Long Island growers modeled after the NYS Agricultural Environmental Management (AEM) Program. Worksheet topics include pesticides, nutrients, soil, irrigation, water, and well management. These worksheets are part of the AEM five-step program, which allows growers to address environmental concerns on their farms, while maintaining a healthy agricultural economy. Other important aspects of the stewardship program include providing information on Best Management Practices and conducting various pilot projects to evaluate practices to reduce nitrogen and pesticide loading into the groundwater.

What is AEM?

Agricultural Environmental Management (AEM) is a voluntary, incentive-based program that helps farmers operate environmentally sound and economically viable businesses. The AEM program coordinates agricultural and environmental conservation agencies and programs, as well as private sector consultants, to provide one-stop shopping for services. The AEM program benefits both farmers and the environment by helping to manage fertilizer nutrients, protect drinking water, conserve soil, improve neighbor and community relations, and comply with environmental regulations.

How does AEM work?

Using AEM's 5-tiered approach, farmers work with the Agricultural Stewardship Program, including Suffolk County's Soil and Water Conservation District (SWCD) and National Resource Conservation Service (NRCS) staff, to develop and implement comprehensive, site-specific farm plans.

Tier 1: A short questionnaire identifies current farm activities, future plans and potential environmental concerns.

Tier 2: AEM worksheets document current environmental stewardship while identifying and prioritizing environmental concerns. The Stewardship Program has focused the worksheets on nutrient and pest management, highlighting the agricultural practices that have the greatest impact on Long Island's ground and surface waters.

Tier 3: A plan is developed providing solutions to environmental concerns identified in Tiers 1 and 2. Plans are designed with a farm's mission, goals, and objectives in mind.

Tier 4: SWCD, NRCS, the Stewardship Program staff and consultants provide farms with technical and educational assistance to implement best management practices (BMPs).

Tier 5: Ongoing evaluations ensure that AEM helps protect both the environment and the viability of farm businesses.

What Assistance Does AEM Provide?

Technical Assistance and Information:
- Environmental farm plan development
- Best Management Practice design and installation
- Education programs to help farmers operate viable and environmentally sound farms

Financial Assistance:
Sources of cost-share funds for environmental farm plans and BMP implementation on Long Island include:
- NYS Agricultural Non-point Source Abatement and Control Grant Program
- USDA Farm Bill Programs such as the Environmental Quality Incentive Program (EQIP) and the Wildlife Habitat Incentives Program (WHIP)
- Agrichemical Mixing Facility

Components of the Stewardship Program
There is always room for improvement in every farm operation when it comes to best management practices. Participation in the Stewardship Program is voluntary and confidential.

Confidential Nutrient and Pest Management worksheets (AEM Tier II Worksheets) help growers evaluate farm management practices and address issues such as:
- Fertilizer/pesticide storage, mixing and loading practices, calibration, nitrogen management, pesticide use, and integrated crop management practices.
- Growers receive recommendations, technical assistance and conservation management plans tailored to meet specific stewardship needs.
- Cost-Share opportunities are available to assist growers in implementing changes in management practices to improve stewardship.

- Educational programs, On-farm demonstration projects, and DEC credits are available to growers who chose to participate.

Farm Site Evaluation
The Agricultural Stewardship Program has developed a list to help growers determine if they are using Best Management Practices (BMPs) which help protect ground water and surface water. The grower is first asked to review the conditions within the growing areas on their farm. If they check NO to any of the questions, they are then asked to determine Best Management Practices designed to address the particular point made in the question. Cornell Cooperative Extension of Suffolk County, Suffolk County Soil and Water Conservation District, or Natural Resources Conservation Service may be contacted for information on practices they should be following. If the grower uses a custom applicator or dealer who offers a full service program, he or she can inform the grower of steps they can take to protect the water resources on and near their property. Growers may contact the NYS Department of Environmental Conservation or their local agricultural chemical representative for more information.

Agricultural Demonstration Projects and Research Summary
Suffolk County agricultural growers and farmers participate in voluntary on-farm demonstration projects, and a growing number of others are requesting information on becoming involved. Commodity groups participating in these programs include vegetable crops, nursery, greenhouse, sod farms and vineyard. In addition research experiments continue to be conducted at the Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead.

Several of these project reports are included as an attachment to this document (see Appendix C). Reports included summarize work to evaluate fertilizer and pesticide application rates as related to crop yield and quality, show the effect of slow release nitrogen fertilizers in nursery stock and vegetable crops, evaluate the reduced rates of fertilizer application on growth of ornamental plants, and reducing nitrogen groundwater contamination from sod production.

Agricultural Demonstration Projects and Research Summary
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VEGETABLE / POTATO PRODUCTION

EVALUATION OF CONTROLLED RELEASE NITROGEN FERTILIZER IN SWEET CORN PRODUCTION

Investigators: S. Menasha, D. Moyer, K. Sanwald
Location: Long Island Horticultural Research and Extension Center

‘Providence’ sweet corn was grown to evaluate the performance of three controlled release nitrogen fertilizers in sweet corn production compared to a standard water-soluble nitrogen fertilizer by assessing yields and plant nitrogen content at two nitrogen (N) rates, 100 and 150 lbs per acre. The controlled release fertilizer treatments included granular products from Georgia Pacific, GP-43G (43-0-0) a methylene urea polymer; ESN® (44-0-0), a polymer, coated urea from Agrium; and Agrocote® (38-0-0), a polymer, sulfur-coated urea from Scotts. All of the controlled release nitrogen fertilizer treatments were compared to ammonium nitrate (34-0-0), a standard water-soluble nitrogen fertilizer. The experiment was grouped as a 4x2 factorial arranged in a randomized complete block design with 4 replications. Plots were 20’ long by 4 rows wide spaced on 34” centers. Seeds were planted 8.8” apart on July 3rd with a Mater Macc precision vacuum planter. At planting, all treatments received 300 lbs per acre 13-13-13, equivalent to 39 lbs N per acre, banded slightly below and to the side of the seed. Nitrogen was in the form of monoammonium phosphate (11-52-0) and ammonium sulphate (20-0-0). On July 12th, when plants were 2-4” tall, all treatments were sidedressed with either 60 lbs or 110 lbs N per acre with N source and rate determined by the treatment. Corn was irrigated throughout the season as needed, worm pests were managed with Warrior, and weeds were controlled with Prowl H_2O and Aatrex 4L. The center 2 rows from each plot were harvested on September 22nd and data on number of dozen ears per acre and weight were recorded. To further evaluate the performance of the N fertilizer programs examined, leaf and stalk samples were taken as a means of monitoring nitrogen sufficiency levels in the plant. Ear leaf samples were taken on Sept 8th, about 2 weeks before harvest. Stalk samples were taken 3 days after harvest on Sept 25th.

Results from the study indicate that although numerically the number of marketable ears per acre was greatest in the ammonium nitrate treatment of 150 lbs N per acre, there were no significant differences between this treatment and three of the controlled release nitrogen treatments; ESN® at 150 lbs and both Agrocote® treatments at 100 and 150 lbs. Furthermore, all the controlled release nitrogen fertilizer treatments produced marketable ear counts statistically similar to the ammonium nitrate treatment at 100 lbs N per acre except the GP-43G at 150 lbs N per acre treatment. The low yields in the GP-43G at 150 lbs N per acre treatment is believed to be a result of possible ammonia toxicity to plant roots. Multiple plants had lodged in these plots shortly after sidedressing due to a minimal to non-existent root system. Looking at the effect N source alone had on marketable dozen ears/A and ignoring all other effects, we see that N source did not significantly impact ear counts per acre. So, in this study, controlled release nitrogen fertilizers were able to perform as well as ammonium nitrate and although there were numeric differences, the number of marketable ears per acre was not statistically influenced by N source.

Percent foliar N levels tested within the adequate range for all treatments and did not statistically differ. Stalk N tests indicate nitrogen levels at harvest to be either deficient or marginal possibly due to the release rate of the products. Looking solely at the effect N source had on stalk N levels, we see that stalk N levels from Agrocote® treatments were significantly lower than all other N fertilizer treatments. This suggests that N release may have been too slow or too fast to match crop demands. When looking at the effects N rate had on stalk N levels and ignoring all other effects, the lower N rate of 100 lbs N produced stalk N levels significantly lower than the high N rate of 150 lbs N. Moreover, high rainfall amounts that occurred during the trial could have contributed to deficient or marginal stalk N levels regardless of N source or N rate.

In conclusion, marketable yields of controlled release nitrogen fertilizer treatments, except GP-43G at 150 lbs N per acre, were comparable to marketable yields obtained when using ammonium nitrate at 100 lbs or 150 lbs N per acre. Therefore, controlled release fertilizers have shown the promising ability to supply sufficient nitrogen for growth in order to obtain statistically similar marketable dozen ears/A as with ammonium nitrate in sweet corn production.

ON-FARM EVALUATION OF CONTROLLED RELEASE NITROGEN FERTILIZER IN SWEET CORN PRODUCTION; ANDERSON'S FARM, RIVERHEAD

Investigators: S. Menasha, D. Moyer, K. Sanwald
Cooperators: Anderson's Farm, Agricultural Stewardship Program
Location: Riverhead, NY

An experiment was conducted to evaluate the use of controlled release nitrogen fertilizer in sweet corn production by assessing impacts on yield and plant nitrogen (N) content. The study took place at Anderson's Farm in Riverhead, NY. The controlled release nitrogen fertilizer treatments included GP-43G (43-0-0), composed of methylene urea polymers by Georgia Pacific and ESN® (44-0-0), a polymer, coated urea by Agrium. These treatments were compared to ammonium nitrate (34-0-0) a standard, soluble nitrogen fertilizer source. The experiment was arranged in a randomized complete block design with four replications. Plots were 40' long by four rows wide, and rows were spaced on 34" centers. At planting, 500 lbs per acre 10-10-10 fertilizer was applied. On July 20th, when plants were 6-8" tall, treatments were sidedressed with 70 lbs N per acre with N source at sidedress determined by treatment. Fertilizer was applied 2-4” to one side of the plant and then cultivated in. Corn was irrigated throughout the season as needed. Ears were harvested on September 18th from two, 20 foot sections from the center two rows of each plot. Ear numbers and weights were recorded. In order to further evaluate the different N fertility programs, leaf samples were taken at mid-silk on September 5th to determine plant tissue nitrogen content. Stalk samples were collected on September 18th to identify the nitrogen status of the corn crop at harvest. Non replicated data was collected from the grower’s standard fertility program for comparison.

Results indicate that there were no significant differences in the number of marketable ears produced per acre among the nitrogen fertility programs analyzed. When compared to the grower standard, the controlled release fertilizer treatments produced similar or a greater number of marketable ears per acre. Marketable ear weights also did not statistically differ among the treatments analyzed and were comparable to the grower’s standard treatment. Numerically, the GP-43G treatment yielded the lowest for both ear weight and the number of ears per acre. Tip fill was statistically similar among the treatments analyzed and was comparable to the grower standard treatment. Percent foliar N content did not statistically differ among the analyzed treatments or to the grower’s standard treatment and all N levels were within the adequate range. Percent stalk N levels fell in the marginal range for the GP-43G treatment and the grower standard treatment while the ammonium nitrate and ESN® treatment values were within the optimal range. Although these differences were not significant, N release in controlled release fertilizers can be sufficient for crop production and indicates the potential use for controlled release nitrogen fertilizers in sweet corn production as a means of increasing fertilizer use efficiency by the crop and reducing nitrate contamination in groundwater.

ON-FARM NITROGEN DEMONSTRATIONS: USING THE “END-OF-SEASON CORNSTALK TEST” TO EVALUATE SWEET CORN NITROGEN FERTILITY PROGRAMS

Investigators: S. Menasha, D. Moyer, K. Sanwald
Cooperators: Cornell Cooperative Extension Agricultural Stewardship Program
Location: Long Island Horticultural Research and Extension Center and the North and South Forks, Long Island, NY

The end-of-season cornstalk test is a diagnostic tool useful for determining the nitrogen (N) status of a corn crop at the end of the growing season. The test is based on studies that determined corn plants will accumulate excess N in the basal stalk tissue when abundant amounts of N are available in the soil. This information in turn can be used to evaluate grower sweet corn fertility programs and to adjust N rates accordingly for economic and environmental benefits. Although, the test does not directly indicate how much nitrogen rates should be increased or decreased, it does allow growers to make adjustments toward optimal N rates when conducted over several years. In 2006, the same eight growers from 2005 participated in this experiment and 5 of the 8 in 2004.

At harvest, approximately twenty, 8” stalk samples were cut beginning at the 6” mark above the ground. Any leaves and leaf sheaths were removed from the stalks before drying. Samples were dried at 70º C for twenty-four hours prior to analysis. Samples were sent to Brookside Laboratories Inc., Ohio and were analyzed using the Total Nitrogen by Combustion Test. Sampling procedures were the same for all years.

When interpreting test results, it is important to consider weather conditions that occurred during the growing season as dry years may minimize N leaching potential and wet years may increase it. For that reason, N rates most profitable over many years can be expected to test deficient in some years and excessive in other years. So, after multiple years of testing, trends become apparent and N rates can be increased or decreased depending on whether those N rates usually test deficient or excessive.

During the 2006 growing season, precipitation was above the 20 year average and resulted in 6 of the 9 sample sites testing in the marginal range possibly due to increased nitrogen leaching. So, in drier years, the latter 6 sample sites may test in the optimal or excessive range. For example, Grower 8 applied 120 lbs N per acre and tested in the marginal range this season and tested optimal in 2005, which was a very dry year (driest in 25 years). Therefore, although data isn’t sufficient to make recommendations yet, an N rate of 120 lbs/A may be optimal over time for this particular site.

EVALUATION OF CONTROLLED RELEASE NITROGEN FERTILIZERS IN POTATO PRODUCTION
Investigators: S. Menasha, D. Moyer, K. Sanwald
Location: Long Island Horticultural Research and Extension Center

Three granular and one liquid controlled release nitrogen fertilizer were evaluated against two soluble nitrogen fertilizers to determine effects on yield, tuber quality, and plant tissue nitrogen content of ‘Reba’ potatoes. Two rates of nitrogen (N), 150 and 200 lbs per acre, were applied either as a split application or all at planting. Fertilizer treatments included: Agrocote®, a polymer, sulfur-coated urea produced by Scott's (38-0-0); Scott's Potato Blen (13-15-15-2(Mg)) containing 80% controlled release N in the form of Agrocote® and the other 20% as soluble N in the form of diammonium phosphate; a granular product by Georgia Pacific, GP-43G (43-0-0); a liquid product, Nitamin® 30L, (30-0-0) also from Georgia Pacific; and two water soluble nitrogen fertilizers: urea (46-0-0) and ammonium nitrate (34-0-0) as the standard nitrogen fertilizer. The experiment was grouped as a 2x7 factorial arranged in a randomized complete block design with 4 replications. Plots were 20 feet long by 4 rows wide spaced on 34" centers. Potatoes were planted 9.3" apart within the rows on April 17th and 18th. At planting, fertilizer was applied using a two-row planter designed for fertilizer experiments, in furrows 2" to the side and slightly below the seed piece. Liquid fertilizer treatments received 30 lbs N per acre soluble fertilizer at planting in the form of ammonium nitrate (34-0-0). Also at planting, 200 lbs/A of both Triple Super Phosphate (0-46-0) and Muriate of Potash (0-0-60) were applied to all treatments except the Potato Blen treatments which received 173 lbs/A, both phosphorus (P) and potassium (K), in the low N rate treatment and 230 lbs/A, both P and K, in the high N rate treatment. On May 23rd, when plants were 1-2" tall, liquid fertilizer treatments were sidedressed with Nitamin® 30L. Liquid fertilizer was knifed in about 6" to each side of the plant. On May 31st granular sidedress treatments were fertilized by hand 2" to the side of the plant and then cultivated in. Plants were 4" to 8" tall. Sidedress N for the granular treatments was from the same N source as was applied at planting.

Leaf samples were collected on June 6th, June 30th, and July 27th to determine plant tissue nitrogen content throughout the growing season as a means of evaluating nitrogen release and plant uptake. Plant vigor and maturity ratings were recorded. The experiment was irrigated 7 times with approximately 1" of water per week to supplement rainfall. Pests were managed according to Cornell Guidelines. Plants were vine-killed on September 5th with Gramoxone Max (paraquat) at a rate of 1 pt/A. Potatoes were harvested on September 19th from the center two rows of each plot and then graded. Data collected included yield, specific gravity, and tuber quality.

Results show that Agrocote® at 150 and 200 lbs, Potato Blen at 200 lbs, and Nitamin® 30L at 200 lbs produced significantly greater marketable yields than the standard (ammonium nitrate at 200 lbs N per acre). All controlled release fertilizer treatments produced statistically similar or greater marketable yields than both ammonium nitrate treatments, except for the high rate of GP-

43G applied all at planting which produced significantly lower yields than the standard. However, the lower yields associated with the at-planting, GP-43G treatments is believed to be a result of possible ammonia toxicity to plant roots. Plants from these treatments were stunted and light green during most of the growing season. Furthermore, when looking at the effect N source had on marketable yields, ignoring all other effects, it is again confirmed that controlled release N fertilizers Potato Blen®, Agrocote®, and Nitamin® 30L produced significantly greater yields than the standard ammonium nitrate. Total and marketable yields between the high and low rates of water soluble fertilizer treatments were not significant. Additionally, within each controlled release nitrogen fertilizer treatment, marketable yields were not significantly increased when a higher rate of nitrogen was applied except in the Nitamin® 30L treatment where a higher rate of N per acre (200 lbs) produced significantly greater marketable yields than Nitamin® 30L at a lower rate of 150 lbs N per acre. This is further backed by the fact that when looking at the effect N rate had on marketable yields, ignoring all other effects, the results show there was no significant difference between the high, 200 lbs/A, or the low rate, 150 lbs/A of nitrogen among the N sources evaluated.

Tuber size distribution was similar in most treatments except the percentage of small tubers was greatest in the at-planting, GP-43G treatments which most likely is a result of the assumed ammonia toxicity to plant roots to plants in this treatment. A greater percentage of misshapen tubers occurred in the Agrocote® treatments and the high rate, at-planting, GP-43G treatment. Internal defects were greatest in GP-43G at 200 lbs, split application; Nitamin® 30L at 200 lbs; and ammonium nitrate at 150 lbs. Foliar nitrogen content on all three dates showed N levels to be within the adequate range or above for all treatments illustrating that nitrogen release of the controlled release nitrogen fertilizers met the demands of the crop.

In summary, controlled release fertilizers were capable of maintaining or significantly increasing marketable yields over the standard, 200 lbs N per acre of ammonium nitrate. Further, nitrogen rates reduced to 150 lbs N per acre using controlled release fertilizers maintained or increased marketable yields over the standard. Therefore, it may be possible to even further reduce N rates with controlled release fertilizers in potato production without decreasing yields over the standard with the use of controlled release nitrogen fertilizers. Reduced N rates and greater yields with controlled release fertilizers suggest improved nitrogen use efficiency by the crop and thus reduce nitrate leaching potential into groundwater.

ON-FARM EVALUATION OF CONTROLLED NITROGEN RELEASE-FERTILIZER IN POTATO PRODUCTION; FOSTER FARMS, SAGAPONACK

Investigators: S. Menasha, D. Moyer, K. Sanwald
Location: Foster Farms, Sagaponack, NY

An on-farm demonstration was conducted to compare a controlled release nitrogen fertilizer source to a soluble nitrogen fertilizer source, each at two nitrogen (N) rates. Effects on yield, specific gravity, and plant tissue nitrogen content of ‘Reba’ potatoes were evaluated. Four fertilizer programs were assessed. All plots received 3.5 lbs N/acre liquid fertilizer (9-18-9) at planting which is represented in the total N rates for each treatment. The fertilizer programs included the grower’s standard fertilization program at a total of 198.5 lbs N per acre where 165 lbs N/acre (11-14-16-4(Mg)) was applied at planting and 30 lbs N/acre liquid (30-0-0) was sidesressed; the grower program at a reduced rate of 168.5 lbs total N per acre (11-14-16-4(Mg)); Scotts controlled release fertilizer Potato Blen (13-15-15-2(Mg)) at a high rate of 198.5 lbs total N per acre; and Scotts controlled release fertilizer Potato Blen (13-15-15-2(Mg)) at a low rate of 159.5 lbs total N per acre. Scotts Potato Blen contains 80% controlled release N in the form of Agrocote® (38-0-0) and 20% N in the form of diammonium phosphate (18-46-0). Potatoes were planted at the end of April.

Leaf samples were collected on June 8th, June 27th, and July 27th to determine plant tissue nitrogen content through the growing season as a means of evaluating nitrogen release and plant uptake. All foliar N levels fell above the adequate range for growth and production. Within each treatment, foliar N levels decreased gradually throughout the growing season. While, on June 27th, foliar N levels in the controlled release nitrogen treatments were clearly greater than the foliar N levels in the grower’s programs and maintained above adequate foliar N levels on the last sampling date signifying the likelihood of greater nitrogen use efficiency by the crop with controlled release nitrogen fertilizers.

Potatoes were hand-dug and graded on September 27th and 28th, respectively. Yield results from hand-dug sampling indicate that the controlled release nitrogen fertilizer produced higher yields than the grower’s fertilizer programs. The high rate of the controlled release nitrogen fertilizer produced the greatest yield, followed by the reduced rate of the controlled release fertilizer. The low N rate of 159.5 lbs N/A with controlled release nitrogen fertilizer increased marketable yields by 65 cwt per acre over the grower’s standard program of 198.5 lbs N/A. Therefore, controlled release nitrogen fertilizers increased marketable yields over soluble N fertilizers and were able to outperform with a reduced rate of nitrogen over the grower's standard program. This suggests greater nitrogen use efficiency and uptake by the crop with controlled release nitrogen fertilizers and the ability to reduce N leaching potential.

SOD PRODUCTION

REDUCING NITROGEN GROUNDWATER CONTAMINATION FROM SOD PRODUCTION ON LONG ISLAND, NY

Sponsor: Cooperative Extension of Suffolk County, Agricultural Stewardship Program
Duration: March 15, 2005 – December 31, 2007
Investigators: A. Martin Petrovic, Dept. of Horticulture, Cornell University, D. Moyer,
K. Sanwald, L. Loizos, L. Mickaliger
Participating Grower: DeLea Sod Farms, Millerplace NY

Introduction

Many of the surface waters in the US, including New York State and the New York City watershed, as well as most of the northeastern US are at risk from the negative impacts of nitrogen and phosphorus runoff and leaching into groundwater. As example, fertilization during sod production on Long Island resulted in groundwater consistently above drinking water standard (nitrate concentration averaged 18.6 mg/L in 2001 and 24.8 mg/L in 2002). The Peconic Estuary Program recommends a 25% reduction in nitrogen loading from sod production with the implementation of best management practices (PEP CCMP, Appendix H, August 2000). Sod production, accounting for about 3,000 acres on Long Island, is constantly in the establishment phase where the potential for nitrogen leaching is the greatest. During spring and fall, leaching losses of nitrogen and phosphorus can be significant. Furthermore, the application of soluble nutrients needed to establish a dense stand of turf has the potential to contaminate ground and surface water. The need to develop sound best management practices for nitrogen management for sod production is imperative.

Objectives

The goal of the research and outreach project is to develop a sod production fertilization program that will minimize the contribution of nitrogen fertilization to groundwater quality degradation. A great deal of work has been done on nutrient losses from agricultural crops, however, due to the nature of turfgrass systems (i.e. perennial ground cover, no tillage) application of crop research to turfgrass can lead to erroneous conclusions. Our hypothesis is that BMPs (nitrogen rate and sources) can be developed to minimize the contamination of groundwater from managed turfgrass areas like sod production while maintaining a rapid sod production rate.

Materials and Methods

The study was initiated in the early fall 2005 and will continue thru 2007 on an actual sod production field in eastern Long Island (Delea Sod Farms). Following the normal establishment practices and seeding, two 30 cm dia. by 30 cm long polyvinalchloride (PVC) lysimeters were installed in each plot. An ion exchange resign bag will be placed at the bottom of each lysimeters to capture nitrate and ammonium leaching passed the root zone. Plots will be 3 m X 3 m, with 4 replication of each fertilizer treatment and plots arrange in a completely random design. Plots were seeded on Sept 15, 2005 with 75%-25% Midnight Moon Kentucky bluegras-Fescue mix at a rate of 100-120 lbs/acre.

Nine treatments included: the conventional establishment fertilization practice at full rate and half nitrogen rate that the sod farm uses, three nitrogen sources (quick, moderate and slow release sources) applied at 3 and 6 lbs N/1000 sq.ft. /yr (6 lbs. N/1000 sq. ft./yr is standard rate for sod production on Long Island, PEP CCMP, Appendix H, August 2000), and an unfertilized control plot to determine the amount of residue N in the soil and the amount of N that was mineralized during the study. Plots were fertilized on Oct. 20, 2005, May 2, 2006 and July 25, 2006. Sod strength measurements Sod strength testing was done on July 25, 2006, Aug 24, 2006, Sept. 18, 2006, Oct. 25, 2006. Sod was cut with a 18" wide sod cutter at a length of 4' by ¾-1" thick. Each plot had two tensile measurements per date taken. Once the sod strength reaches the value for commercially harvestable sod (as determined from sod samples sod by this sod grower), the resign bags were removed on Oct. 25, 2006 from all plots. The bags were frozen and are being analyzed for the amount of nitrate and ammonium that was leached.

Results to Date

Sod is determined to be harvestable if it is dense, dark green foliage and will not fall apart when handled. In the first year of this study we record sod strength measurements over time as seen in Table 1. (In the second year of this study we will record sod strength measurements, as well as visual ratings based on color using the National Turfgrass Evaluation Guidelines (NETP). Generally, the source or rate of fertilizers applied had little affect on sod strength during the first year of the study. Commercially available sod (Briarcliff Sod Farm) was determined to have an average sod strength measurement of 99 lbs by the way we tested it. Based on the sod strength measurements from the first year of the study, almost all fertilizer sources and rates had acceptable sod strength by Oct 25, 2006, 13 months after seeding. Only on the August 24, 2006 sampling date were there any treatment differences, the slow release sources of Nitroform (1X rate), half the amount of the growers program was statistically higher than the regular growers program.

Table 1. Impact of fertilizer sources and rates on sod strength for 2006.

Treatment	7/25/2006	8/24/2006	9/18/2006	10/25/2006
	------------------------------ lbs ------------------------------			
IBDU at 1X	60a*	65ab	90a	108a
IBDU at 0.5X	58a	67ab	85a	109a
Nitroform at 0.5X	52a	72ab	87a	110a
Nitroform at 1X	52a	80a	90a	112a
IBDU at 1.5X	52a	72ab	87a	101a
Nitroform at 1.5X	51a	76ab	86a	114a
Control (unfertilized)	49a	70ab	87a	105a
IBDU at 2X	49a	65ab	82a	100a
Urea at 1.5X	49a	68ab	78a	96a
Urea at 1X	48a	73ab	87a	96a
BMP	48a	65ab	77a	95a
Grower Program at 0.5X	48a	82a	83a	99a
Grower Program at 1X	46a	53b	74a	93a
Nitroform at 2X	46a	70ab	85a	101a
Urea at 0.5X	45a	70ab	93a	110a
Urea at 2X	42a	57ab	73a	95a

*Lbs of sod tensile strength, average of 2 samples per plot and 4 replicates. Values in the same column not connected by same letter are significantly different.

Plans for 2007

The study was repeated in the fall of 2006, two new sites were established and treated as down in 2005-2006. The sod strength will be determined as done previously. In addition, turfgrass quality measurement will be made to help determine when the sod is harvestable, must have good quality and high tensile strength.