FORGE RIVER WATERSHED MANAGEMENT PLAN

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The Town of Brookhaven

Prepared by

Cameron Engineering & Associates, LLP

In Association with

CH2MHILL

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APPENDICES

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1 Executive Summary

1.1 Introduction

The Forge River has been a distressed estuary since the early part of the 20th century. Extensive duck farming in the 20th century along the banks of the Forge River and high-density residential development contributed to the high-nitrogen sediment load that remains. Residential development booms the Mastic Beach area in the early 20th century and on the peninsula in the mid-20th century added thousands of onsite wastewater treatment systems (cesspools and septic systems) inside the Forge River watershed. Residents of the Forge River watershed continue to report malodorous conditions and fish kills while local scientists report hypoxic and anoxic conditions that are inhospitable to aquatic life.

1.2 Watershed Characterization and Subwatershed Prioritization

Several initial studies detailed the background necessary to establish management strategies that would improve water quality in the Forge River estuary. The Forge River groundwater and stormwater contributing areas comprise the 'watershed' for the purpose of the study. Each of the Forge River creeks drains its own subwatershed. The initial *Watershed Characterization* report includes descriptions of the geographic setting (topography, hydrology, infrastructure, etc.), existing and projected land use, land cover, and socioeconomics. The report covered living resources for the estuary and adjacent upland area, described the quality of the sediments and the history of dredging, and summarized the available water quality data (Coliform bacteria, chlorophyll, dissolved oxygen, and nitrogen). The Characterization includes detailed information on nitrogen sources and loading and the impacts on water quality and living aquatic resources derived in large part from research conducted by SUNY Stony Brook's School of Marine and Atmospheric Sciences.

Nitrogen loading, in order of quantity delivered to the estuary, is from residential septic systems, the duck farm, private treatment plants, release from the sediments, residential and agricultural fertilizer use, and to a lesser extent atmospheric deposition and stormwater. The Characterization report concludes that the severe dissolved oxygen depletion in the Forge River is primarily due to algal blooms fed by exceptionally high nitrogen. The majority of the nitrogen entering the estuary is from groundwater that is years or tens of years old and therefore reflects historic inputs. Groundwater continues to receive nitrogen from septic systems and fertilizer use. Dense algal blooms will recur annually, particularly during the summer, as long as new and historic nitrogen loading and circulation remains unchanged.

Stormwater–borne sediments, years of accumulated duck waste and organic matter from decades of decayed algal blooms, and leaf fall have shallowed the estuary and restricted circulation. Poor circulation further degrades water quality. Muddy, anoxic bottom conditions preclude habitation by most estuarine organisms. Only highly mobile benthic organisms and pelagic species can avoid the low oxygen conditions. Tidal wetlands are limited to areas with no shoreline hardening and are more prevalent in the lesser developed southern reaches of the estuary. Large stands of Phragmites have invaded portions of the estuary.

Another report, the Subwatershed Prioritization, examined data for each of the Forge River's 14 subwatersheds to quantify the degree of impairment experienced by each. The report established weighted values for land cover, land use, stormwater, nitrogen loading, habitat, and ecological conditions. Wills Creek, West Mill Pond, and Poospatuck Creek subwatersheds are the most impaired.

The Management Plan identifies solutions that address the highest priority impairments in the highest priority locations. Based on the characterization of the waterbody and its watershed, an evaluation of the regulatory and programmatic environment affecting the management of the Forge River estuary, and a prioritization of the subwatersheds, watershed-based management strategies are identified to protect and restore the resources of the Forge River and its watershed.

1.3 Evaluation and Ranking of Management Strategies

The Town, the County, and other responsible parties can phase in the management strategies over the short-term, mid-term, and long-term. The phases, in general, also reflect lower, moderate, and higher costs, respectively. The broad classification of strategies includes:

- Land use management
- Stormwater management
- Nitrogen reduction
- Water quality improvements and habitat restoration
- Research and data collection
- Training, education and stewardship programs

Each strategy has four associated factors that help measure its potential for achieving water quality improvements for the Forge River. The factors have the following parenthetical weightings based on their significance in improving water quality in the Forge River:

- Water quality benefits (4)
- Cost (3)
- Acceptance by the public (2)
- Technical and legal implementation difficulty (1)

The full Forge River Management Strategies report prioritizes all the strategies according to these and other criteria. The Jurgielewicz Duck Farm ceased operations just prior to the publication of this report. Consequently, nitrogen loading and recommendations concerning nitrogen continue to reference the duck farm. Nitrogen loading will be re-calculated as part of the formulation of the TMDL without the input from the duck farm.

1.4 Short-Term Management Strategies

1.4.1 Land Use Management

- **(S1) - Establish a Forge River Protection Overlay District (FRPOD)** for properties inside the 50-year contributing area. The FRPOD would enable the Town to implement special regulations inside the district to protect and improve water quality in the estuary.
- **(S2) - Explore potential dedicated funding sources such as a FRPOD fee to provide water quality improvement services to property owners** based on water usage and assessed value. Such a fee could be added to property owners' tax bills. Property owners already connected to private STPs would be assessed a lower fee.
- **(S3) - Create a Forge River Protection (FRP) Fund for program expenditures, green infrastructure, and loans** to property owners for eligible improvements.
- **(S4) - Establish a low-interest loan program for property owners** for onsite wastewater treatment system (OWTS) improvements with initial funding potentially from the FRP Fund. Property owners could repay the loans through their tax bill. Loans would survive changes in property ownership and stay with the property.
- **(S5) - Identify properties for acquisition or purchase of development rights** based on location and environmental resources. Reducing future development opportunities can lower future nitrogen generation and release.
- **(S6) - Acquire and remediate the Jurgielewicz Duck Farm and consider acquisition and cleanup of the Barnes Road and Titmus duck farms to protect Forge River water quality**.
- **(S7) - Impose stricter clearing limits** inside the FRPOD to retain existing native, non-fertilizer dependent vegetation.

1.4.2 Stormwater Management

- **(S8) - Replace direct discharge stormwater systems** by incorporating new technology including, where appropriate, catch basin inserts and end-of-pipe equipment that removes pollutants before they are discharged to the estuary. Utilize preferentially and where possible vegetated swales, rain gardens and other 'green' treatments. Green alternatives increase infiltration and degradation by soil bacteria.
- **(S9) - Adopt a 'Green Streets' policy** to improve roadway design to capture, treat, and improve stormwater management.
- **(S10) - Develop a demonstration low-impact stormwater management site** at a Town-owned facility to demonstrate to builders and homeowners methods for improved stormwater management.

1.4.3 Nitrogen Reduction

- **(S11) - Impose strict limits of nitrogen fertilizer use** to the month of April for all land uses except agriculture.
- **(S12) - Develop installation requirements for replacement OWTS** using SCDHS standards as guidelines.
- **(S13) - Require inspections of all OWTS** at no cost to the property owner. Property owners would be required to make improvements to systems that do not meet new Town requirements within three years of the initial inspection. A FRPOD fee would cover the cost of the inspection. Utilize low interest loans from the FRP Fund for replacement systems. Improvements might include replacement of cesspools with modern septic systems, installation of leaching fields for properties with high groundwater and other improvements required through inspections.
- **(S14) - Enact ordinance requiring pump-outs for all OWTS every five years.** A FRPOD fee would cover the cost of the service. Pump-outs would extend the life and improve the efficiency of OWTS.
- **(S15) - Require all OWTS to meet new Town requirements on sale of property.** Require inspections of all OWTS prior to the sale of property with fee paid by seller. Systems that do not meet new Town OWTS requirements would need to be improved prior to sale of the property (similar to existing Wetland and Waterways requirement for building extensions).
- **(S16) - Reduce residential water use** to reduce wastewater volume and increase residency time and treatment efficiency in OWTS. Require dual flush toilets for all new bathroom installations or remodels. Require low flow faucets for all new or remodeled bathrooms and kitchens.
- **(S17) - Provide water conservation kits** to homeowners with funding from the FRPOD fee.

1.4.4 Water Quality Improvements and Habitat Restoration

- **(S18) - Encourage riparian area restoration** by offering tax rebates to property owners for voluntary restoration of the wetland buffer in the absence of a building permit or by offering grants from the FRP Fund to qualified property owners.
- **(S19) - Encourage use of indigenous landscape plants** by offering tax rebates to property owners for installing new landscaping that limits nonindigenous vegetation to no more than 15 percent of the lot area in properties adjacent to wetlands. Alternately, offer grants from the FRPOD Fund to qualified property owners for voluntarily limiting nonindigenous vegetation.
- **(S20) - Install an oyster grow-out system for algal bloom control** in priority subwatershed creeks. Oysters can filter 10 liters an hours and convert algae into oyster tissue. Algal bloom control is important to maintaining dissolved oxygen for aquatic organisms. Transfer of oysters grown in the Forge River to certified waters would be required.
- **(S21) - Install surface and water-column creek aerators** in priority subwatershed creeks to improve dissolved oxygen concentrations and help support aquatic organisms.

1.4.5 Research and Data Collection

- **(S22) - Collect additional groundwater data to determine groundwater nitrogen types, vertical and horizontal concentrations, and travel time**. Additional information is

needed on the fate of the different forms of nitrogen reaching groundwater. Specifically, research is needed to determine how inorganic and organic nitrogen concentrations and forms (nitrate, nitrite, ammonia, etc.) change over time (if at all) in groundwater.

- **(S23) - Continue research on benthic nitrogen flux** to determine the flux of nitrogen from sediments into the water column. A better estimate of the contribution of sediment nitrogen is necessary to determine the value of extensive long-term dredging in the Forge River before such long-term dredging is funded and undertaken.

1.4.6 Training, Education, and Stewardship Programs

- **(S24) - Develop methods to reduce agricultural fertilizer use and stormwater runoff.** Work with farmers on strategies including changing fertilizer types, crops, and practices. Organic fertilizers typically release nitrogen more slowly allowing increased uptake by plants. For example, grapes require very little nitrogen, whereas potatoes require large quantities. Stormwater controls can contain high nitrogen runoff.
- **(S25) - Provide educational programs for property owners on implementation of Forge River management strategies**. Public acceptance and participation improve with increased outreach to the community.

1.5 Mid-Term Management Strategies

1.5.1 Land Use Management

- **(M1) - Acquire selected open space and direct development to developed areas outside the FRPOD or to future sewered areas** in the watershed through the Town Transfer of Development Rights (TDR) program. Utilize the FRPOD as a 'Sending Area,' and designate selected hamlets and commercial areas outside the FRPOD as 'Receiving Areas.' The Town's long-term land use strategy encourages development in hamlet centers and commercial areas to preserve green space and the character of single-family neighborhoods. The TDR program provides a mechanism to incentivize development in designated mixed-use centers.
- **(M2) - Purchase development rights for existing farms in the Forge River watershed**. The Town and County recognize the value of existing farms to Long Island and have purchased the development rights for thousands of acres of existing farms, including the duck farm properties of the Forge River. Encourage organic farming and IPM to reduce fertilizer and pesticide use. Permit well-managed and regulated greenhouse farming that has zero fertilizer and pesticide discharge. Restrict lot coverage and provide a vegetated buffer to maintain the aesthetic appeal of open space acquired through the purchase of development rights program.
- **(M3) - Prepare land use plans for the duck farm properties** that include riparian and upland restoration.

1.5.2 Stormwater Management

- **(M4) - Provide stormwater treatment systems at selected creek heads**. There are opportunities to construct wetlands and other stormwater treatments at the heads of Wills and Poospatuck Creeks and potentially others. Acquisition of undeveloped property may be necessary depending on the preferred treatment.
- **(M5) - Provide stormwater treatment for runoff into the East and West Mill Ponds and the Forge River** from Montauk Highway. Treat stormwater to remove sediments and associated contaminants prior to its release into the waterbodies.

1.5.3 Nitrogen Reduction

- **(M6) - Determine the Total Maximum Daily Load** (TMDL) for nitrogen that allows for a dissolved oxygen concentration in the estuary above 4.8 mg/L (the DEC standard). The Town prepared a Request for Proposals for a consultant to prepare the TMDL. The TMDL is critical, as it will set the maximum number of pounds of nitrogen that can be loaded into the Forge River from all sources. The TMDL consultant will develop allocation scenarios for each of the various loads. The TMDL will help determine the most appropriate mid- and long-term management strategies necessary to achieve the nitrogen reduction. It may be possible to achieve the required nitrogen reductions by applying multiple smaller (and less expensive) strategies than fewer and more expensive techniques.
- **(M7) - Develop a TMDL implementation plan based on the preferred allocation scenario**. The Town should have an implementation plan prepared for the selected allocation scenario that provides preliminary engineering/phasing plans that detail how each of the reductions could be implemented and where. The implementation plan would include cost estimates, locations, and type of sewering, if any, required within the FRPOD.
- **(M8) - Evaluate the need and locations for a regional wastewater treatment plant**. If the Town or County determines that regional sewering is the best option for meeting the nitrogen TMDL, then a suitable location must be identified. The Barnes Road or Titmus duck farms may be good candidates as they are centrally located, sufficiently large, already disturbed, and have few residential neighbors. The properties are sufficiently large to permit a substantial riparian restoration and open space set aside. Other potential sites might include the Brookhaven Airport or one of several undeveloped parcels in the watershed, and an expansion of the Town's Sewer District #2. Regionalization may include the adjacent hamlet of Center Moriches.
- **(M9) - Impose stricter nitrogen limits on STPs within the FRPOD** based on the nitrogen TMDL. The nitrogen discharge limit for new and existing STPs should be lowered from current County requirements if required by the TMDL.

1.5.4 Water Quality Improvements and Habitat Restoration

- **(M10) - Dredge sills at mouths of creeks and accumulation at the mouth of the Forge River**. Removal of the deposits at the mouths of selected creeks will increase circulation in the creeks and improve water quality.
- **(M11) - Remove stormwater-borne sediments** in the waters just south of Montauk Highway including *Phragmites*. Removal of these deposits will increase circulation in this portion of the estuary. Removal of the invasive reed *Phragmites* will increase available open water and tidal wetland habitat.
- **(M12) - Dredge by the LIRR trestle** to improve flushing of the Forge River estuary north of the railroad trestle. Increased flushing north of the trestle will increase salinity and reduce the growth of *Phragmites.*
- **(M13) - Deepen Ely Creek** to improve tidal circulation and reduce *Phragmites* growth. The shallow depth of Ely Creek (much is a mud flat at low tide) severely limits circulation and thus degrades water quality.
- **(M14) - Harvest and dispose of *Ulva*** to remove the assimilated nitrogen and avoid the aesthetic and water quality problems engendered by its decay.
- **(M15) - Restore native riparian vegetation** including tidal wetlands and high marsh on public property. Reduce road width where possible to expand riparian area. Additional vegetated riparian areas will help capture contaminants and will create new wildlife habitat.

1.5.5 Research and Data Collection

- **(M16) - Measure nitrogen removal by *Phragmites*, *Spartina*, and mudflats**. Identify the quantity of nitrogen removed by plant roots and the bacteria associated with them. Bacteria in mudflat soils may remove more nitrogen than vegetated tidal areas. *Phragmites*, if an effective nitrogen remover, might be harvested annually to remove the nitrogen from the estuary.
- **(M17) - Test permeable reactive barriers (PRBs) for their effectiveness in removing nitrogen from groundwater** in a high-nitrogen subwatershed, preferably in a riparian conservation easement. Permeable reactive barriers are groundwater treatment systems installed in a trench upgradient of the shoreline that utilize non-toxic materials like wood chips and vegetable oil as a substrate for bacteria to remove nitrogen from groundwater. If as effective as reported, PRBs could significantly reduce nitrogen loading from groundwater into the estuary.
- **(M18) - Test nitrogen reduction by septic system bio-augmentation** to improve OWTS efficiency. Injection of selected bacteria into septic systems has been shown to improve their effectiveness in degrading nitrogen. Modifications to septic systems may increase bio-augmentation effectiveness.
- **(M19) - Test nitrogen reduction by groundwater bio-augmentation** and carbon source injection for nitrogen removal. Nitrogen removal from groundwater by selected non-toxic bacteria fed a non-toxic carbon source may be possible. Test various bacterial species and carbon sources for their effectiveness in removing groundwater nitrogen.

1.6 Long-Term Management Strategies

1.6.1 Land Use Management

- **(L1) - Implement the land use plan for the Jurgielewicz Duck Farm** for the uses determined by the Town and community to be most appropriate for the restoration of the estuary.

1.6.2 Nitrogen Reduction

- **(L2) - Install permeable reactive barriers** if proven effective, in the riparian area of all high priority creeks to remove historic groundwater nitrogen. This would require securing conservation easements for the installation, monitoring, and maintenance of the systems from property owners.
- **(L3) - Pump groundwater to treatment locations** such as wetlands or denitrification reactors. The cost and feasibility of moving and treating large volumes of water would need to be measured against the costs of other treatment options.
- **(L4) - Improve the operation of private STPs**. The three existing wastewater treatment plants in the Forge River watershed could be upgraded for additional nitrogen removal or could be converted to pump stations connected to a future regional STP.
- **(L5-L8) - Sewer part or all of the FRPOD**. Engineering studies in progress now will help determine the most advisable sewering strategy for the Forge River watershed and or adjacent communities. Since the TMDL implementation plan will identify the need for and extent of sewering needed, design plans for reaching the TMDL will be required and may include the following options: a) construct a conventional collection system and treatment plant, or b) construct advanced onsite systems for individual FRPOD parcels to avoid collection system cost, or c) collect septic system effluent from all FRPOD parcels and

treat it at a centralized community STP, or d) incorporate adjacent areas in the Mastic and Shirley peninsulas and parts of Center Moriches into the sewer district as these all contribute nitrogen to Moriches Bay and their inclusion could reduce per parcel cost and expand environmental benefits.

1.6.3 Water Quality Improvements and Habitat Restoration

- **(L9) - Pump bay water to head of the Forge River and into priority creeks** to increase circulation and increase dissolved oxygen to support marine life. Increased circulation can improve water quality for aquatic organisms, but will require a substantial investment in pumping equipment and operational costs.
- **(L10) - Dredge to remove accumulated organic matter from estuary.** Institute a long-term dredging operation if benthic flux studies determine that the strategy could be effective. Many feet of duck farm waste and decaying algal blooms accumulated in the Forge River and could contribute substantial nitrogen to the water column. Consider use of the Barnes Road or Titmus duck farms for temporary dredged material management if acquired for public use.
- **(L11) - Fill creek depressions** with sand to eliminate stagnant anoxic areas. Eliminating these areas would help improve circulation in the affected creeks. Such filling would require a tidal wetland permit and special approval from the DEC.
- **(L12) - Conduct long-term maintenance dredging of Moriches Inlet** to improve flushing of Moriches Bay and the Forge River. Improved inlet water flow would increase the tidal range in Moriches Bay and the Forge River and therefore increase circulation.

1.7 Phasing of Management Strategies

1.7.1 Introduction

This portion of the plan prioritizes the proposed management strategies and recommends their phasing in order to achieve water quality improvement and habitat restoration goals. The categorization of the management strategies by short-, mid- and long-term implementation periods, as provided in Section 4 through 6 above, establishes an initial phasing of the strategies. The scoring of each of the strategies according to the four evaluation criteria, however, permits a ranking, or prioritization, of the strategies within the short-, mid- and long-term strategy categories. Thus, the strategies that received the highest scores should be considered for earliest implementation. Furthermore, depending upon the availability of funding, it may be possible to implement only a portion of the management strategies. Under such conditions, the highest ranked strategies would offer the greatest benefit for the available funding.

In addition to phasing, certain strategies require sequencing within or across the short-, mid- and long-term management periods. For example, the efficacy of certain long-term strategies for nitrogen removal must be proven through either short- or mid-term strategies that involve research and testing. There is also a group of short-term strategies that share a degree of interdependence, *i.e.*, the implementation of one short-term strategy requires the

completion of a related strategy. The selection of appropriate long-term management strategies is also highly dependent upon the preferred allocation scenario to be defined by the TMDL development, a mid-term management strategy. The phasing of the management strategies – which includes their proper sequencing where applicable is summarized in Sections 7.2 through 7.4 below for the short-, mid-, and long –term strategies.

1.8 Phasing of Short-Term Management Strategies

The short-term strategies are ranked in descending order in Table 7.1 according to their scores which range from 33 to 62.

Recommendation. Implement the first-tier strategies, *i.e.*, S21, S11, S20, S13, S14, and S23 immediately; these have the greatest potential for short-term water quality improvement benefits at reasonable cost to implement, *i.e.*, are the most cost-effective strategies. The first-tier short-term strategies also require the long lead times for implementation, providing an additional justification for their early project initiation. Strategies S24, S1, S4, S3, S12, S2, S15, S5 S22 and S6 offer significant water quality benefits – though less than the first tier – and at reasonable cost. However, moderate to minimal public support combined with technical and administrative challenges to implementation relegate these strategies to secondary importance; their implementation should follow the first-tier strategies. Third-tier strategies, *i.e.*, S25, S18, S9, S16, S7, S19, S17, S8 and S10, are easy to implement but offer less significant benefits; their implementation should follow the second-tier strategies.

Table 1-1. Ranking of short-term management strategies by weighted total

Management Strategy		Water Quality Benefit	Cost	Technical & Legal Difficulty	Public Acceptance	Weighted Total
S21	Install surface and water column creek aerators in priority subwatershed creeks	7	4	8	7	62
S11	Impose strict limits on nitrogen fertilizer use, allowing fertilizer application only in the month of April	4	8	9	5	59
S20	Install oyster grow-out system for algal bloom control in priority subwatershed creeks	5	6	8	6	58
S13	Require inspections of all OWTS	4	9	10	2	57
S14	Require pump-outs for all OWTS within the FRPOD every five years through Town ordinance	4	8	8	3	54
S23	Continue research on benthic flux to determine nitrogen contribution from sediments to water column	4	6	6	7	54
S24	Develop methods to reduce agricultural fertilizer use and runoff and work with farmers to implement them	3	8	5	6	53
S1	Establish FR Protection Overlay District (FRPOD) for properties inside 50-yr contributing area	3	7	8	6	53
S4	Establish a low-interest loan program for property owners for OWTS improvementswith FRP Fund. Loans repaid via tax bill and stay with property.	4	8	5	4	53
S3	Create a Forge River Protection (FRP) Fund for program	4	5	9	6	52
S12	Develop OWTS installation requirements for replacement systems using Suffolk County Department of Health Services standards as guidelines	4	7	8	3	51
S2	Explore potential dedicated funding sources such as a FRPOD fee to provide water quality improvement services to property owners	3	8	5	5	51
S15	Require all OWTS to Meet new Town Requirements	4	8	7	1	49
S5	Identify properties for acquisition or purchase of development rights based on location and environmental resources	1	8	5	8	49
S22	Collect additional groundwater data for determining nitrogen types, concentrations and travel time	3	6	6	6	48
S6	Acquire duck farm properties, conduct environmental assessment and prepare remediation plan*	4	5	6	5	47
S25	Provide educations programs for property owners on	1	7	7	7	46
S18	Encourage riparian area restoration by offering tax rebates to property owners for voluntary restoration of the wetland buffer.	2	8	6	3	44
S9	Adopt a Green Streets policy	1	8	5	5	43
S16	Reduce residential water use by requiring dual flush toilets and low-flow faucets for all new bathroom installations or remodels.	1	9	7	2	42
S7	Impose stricter clearing limits inside the FRPOD to retain existing native, non-fertilizer dependent plants	1	9	5	3	42
S19	Encourage use of indigenous landscape plants by offering tax rebates for their installation	1	8	7	3	41
S17	Provide home owners with free water conservation kits	1	6	8	5	40
S8	Replace direct discharge stormwater systems with vegetated swales, and other 'green' treatments	1	4	8	7	38
S10	Develop one or more demonstration low-impact stormwater management site	1	5	4	5	33

1.9 Phasing of Mid-Term Management Strategies

The mid-term strategies are ranked in descending order in Table 7-2 according to their scores which range from 28 to 71. Three strategies, (M14, M10 and M12) received very high scores and stand out demonstrably among the 19 mid-term strategies, particularly for their water quality benefits and expected ease of implementation. Strategies M6 and M7 – which comprise the TMDL development process –are absolutely essential to the proper selection of appropriate long-term management strategies as well as some of the mid-term strategies. These five highest-ranked strategies comprise the top quarter of the mid-term strategies and are grouped into the first tier of recommended mid-term strategies.

Recommendation. Implement the first-tier mid-term strategies, (M6, M7, M10, M12 and M14) immediately. These have the greatest potential for mid-term water quality improvements. The first-tier mid-term TMDL strategies, (M6 and M7), are key to the implementation of long-term strategies and should be expedited. The second-tier, mid-term strategies (M9, M13, M11, M17, M16, M5, M4, M8, M18, M3, and M19) that provide data on potential long-term strategies should also be initiated, as soon as is feasible in order to support the development of the TMDL preferred allocation scenario. The implementation of third-tier mid-term strategies (M15, M2 and M1) should follow that of the second-tier strategies.

Table 1-2. Ranking of mid-term management strategies by weighted total

Management Strategy		Water Quality Benefit	Cost	Technical & Legal Difficulty	Public Acceptance	Weighted Total
M14	Harvest and dispose of Ulva to remove assimilated nitrogen and its associated water quality problems	8	5	6	9	71
M10	Dredge sills at mouths of creeks and accumulation at mouth of Forge River	8	3	8	10	69
M12	Dredge in vicinity of LIRR trestle to improve flushing of waterbody north of trestle.	6	5	8	10	67
M7	Develop a TMDL implementation plan based on the preferred allocation scenario	8	5	2	5	59
M6	Determine TMDL for nitrogen	6	5	5	5	54
M9	Impose stricter nitrogen effluent limits on STPs within FRPOD based on nitrogen TMDL	4	8	3	5	53
M13	Deepen Ely Creek to improve tidal circulation and reduce Phragmites growth.	5	3	5	9	52
M11	Remove deposits downstream of East and West Mill Pond discharges including Phragmites.	5	3	6	8	51
M17	Test permeable reactive barrier pilot system in high nitrogen subwatershed, preferably in riparian conservation easement	6	5	3	4	50
M16	Measure groundwater nitrogen removal by Phragmites, Spartina, and a mud flat.	3	7	7	5	50
M5	Provide stormwater treatment for runoff into the Mill Ponds and FR from Montauk Highway.	4	5	5	7	50
M4	Provide stormwater treatment systems at creek heads - may require property acquisitions	4	4	5	7	47
M8	Evaluate need and locations for a regional wastewater treatment plant	4	7	3	2	44
M18	Test bioaugmentation in septic systems to improve OWTS efficiency	3	6	4	5	44
M3	Prepare engineering plans for restoration of duck farm properties. Consider property for regional STP.	3	4	4	6	40
M19	Test groundwater bioaugmentation and carbon source injection for nitrogen removal effectiveness	3	5	3	5	40
M15	Restore riparian vegetation including tidal wetlands and high marsh on public property and reduce road width where possible to expand riparian area.	2	5	5	5	38
M2	Purchase development rights for farms in watershed. Allow greenhouse farming with lot coverage limits.	2	3	5	7	36
M1	Acquire selected open space and direct development to developed areas outside FRPOD or to future sewered areas in watershed through TDR program. FRPOD as 'Sending Area,' downtowns & commercial areas outside FRPOD as 'Receiving Areas.'	2	4	2	3	28

1.10 Phasing of Long-Term Management Strategies

The long-term management strategies are ranked in descending order in Table 7.3 according to their scores which range from 38 to 62. There are twelve management strategies – considered here – whose implementation would occur in the long-term. Upon evaluation per Table 7-3, two strategies, (L10 and L3), stand out among the set of long-terms strategies with the highest values of 62 and 56, respectively. Strategy L10 provides for the long-term dredging of the estuary to remove accumulated organic matter while L3 offers a solution that would remove past, present and future nitrogen loads from groundwater, a major contributor to poor water quality in the estuary.

Recommendation. Although strategies L10, L3 and L2 have the highest scores, all of the long-term strategies presented and evaluated here should be included for evaluation in the development of the TMDL preferred allocation scenario.

Table 1-3. Ranking of long-term management strategies by weighted total

Management Strategy		Water Quality Benefit	Cost	Technical & Legal Difficulty	Public Acceptance	Weighted Total
L10	Institute long-term dredging operation to remove accumulated organic matter from estuary if determined effective by benthic flux studies.	7	5	3	8	62
L3	Pump groundwater to treatment location which may be a wetland or denitrification reactor (large volumes of water are involved)	10	1	3	5	56
L2	Install permeable reactive barriers (if proven effective) in riparian area of all high priority creeks to remove historic groundwater nitrogen.	10	1	2	2	49
L6	Construct advanced onsite systems for individual FRPOD parcels; avoids collection system cost, but requires regular maintenance **OR**	8	2	4	2	46
L11	Fill creek depressions with sand to eliminate stagnant anoxic areas (presumptively incompatible with wetland permit - requires DEC approval)	4	5	3	5	44
L4	Improve operation of private STPs by upgrading for additional nitrogen removal or connect private STPs to future regional STP	4	3	8	5	43
L5	Sewer entire FRPOD. Construct conventional collection system and treatment plant **OR**	8	1	4	2	43
L7	Collect septic system effluent from all FRPOD parcels, treat at centralized community STP **OR**	8	1	4	2	43
L8	Incorporate adjacent areas (Mastic Shirley and Center Moriches) to reduce per parcel cost and expand environmental benefits.	8	1	3	2	42
L12	Conduct long-term maintenance dredging of Moriches Inlet to improve flushing of Moriches Bay and FR.	5	3	1	5	40
L1	Implement the land use plan for the duck farm properties to support restoration of the Forge River	2	3	4	9	39
L9	Pump bay water to head of Forge River and priority creeks to increase circulation, reduce algal blooms, and increase dissolved oxygen.	4	3	5	4	38

2 Community Involvement

2.1 Community and Advocacy Organization Participation

Mastic and Shirley residents in cooperation with their community organizations played a prominent role in the efforts to restore the Forge River and its tributaries. *Save the Forge River*, a non-profit environmental advocacy organization, was established specifically to address the condition of the River, its tributaries and the greater watershed. They have been instrumental in bringing attention to the plight of the Forge River.

Environmental organizations such as *Ducks Unlimited*, *Peconic Baykeeper*, and others have also contributed to the dialog. The *Poospatuck Indian Nation* borders the estuary. They too have a strong interest in the health of the waters. The Affiliated Brookhaven Civic Organization, Waterways Homeowners Association, Mastic-Shirley Chamber of Commerce, Manor Park Civic Association, and the William Floyd Community Summit have all been involved in the efforts to address Forge River problems and find solutions.

2.2 Watershed Advisory Committee

The Forge River Task Force, formed in 2005 by the Town of Brookhaven included local lawmakers, state and local officials, environmentalists and advocacy group representatives. The Task Force was instrumental in developing a strategy to restore Forge River health. It worked with the NYS DEC to place the estuary on the State's Impaired Waters List and, along with *Save the Forge River*, played an advocacy role in securing federal funding for the river.

The Forge River Task Force is chaired by the NYS DEC Regional Director, Peter Scully, and provided oversight for watershed research activities including the SUNY Stony Brook sediment and characterization study and a stormwater remediation project along Montauk

Highway. In its 2007-2008 year, the Forge River Task Force provided oversight for a hydrographic study and the continuation of various studies including river sediments and a nitrogen budget study. It produced a non-point source guide brochure that was mailed to residents in the summer of 2008. As a result of its continued advocacy efforts and success, the Forge River Task Force was designated as the Watershed Advisory Committee (WAC) for the development of the Forge River Watershed Management Plan.

FORGE RIVER TASK FORCE MEMBERS

- NYS DEC – Chair
- Brookhaven 6th Council District
- Brookhaven Division of Environmental Protection
- South Shore Estuary Reserve
- SC Department of Health Services
- SC Department of Planning
- SC Department of Public Works
- SC Soil & Water Conservation Service
- Suffolk County 3rd Legislative District
- Save the Forge River
- Peconic Baykeeper
- Ducks Unlimited
- Poospatuck Indian Nation
- Waterways Homeowners Association
- Mastic Fire Department
- Representative from the marine trades
- Citizens Campaign for the Environment
- National Parks Service

2.3 Outreach

Regular meetings were held with the Forge River Task Force to review project documents and progress, and to advise the Town and consultant team. Presentations were made to stakeholders and the public at the completion of key project documents (Watershed Characterization, Subwatershed Prioritization, and Draft Management Strategies). A project website was established where all background information, documents, maps, and other relevant information are posted. The draft Forge River Watershed Management Plan was reviewed by the public through the public comment process. Numerous comments were received and changes to this document were made as a result of those comments.

2.4 Support

Funding for the development of the Forge River Watershed Management Plan was provided by the New York State Department of State Division of Coastal Resources under Title 11 of the Environmental Protection Fund, and the Town of Brookhaven. Technical assistance was provided by the US Army Corps of Engineers, New York State Department of Environmental Conservation, Suffolk County Department of Health Services, and SoMAS SUNY Stony Brook.

3 Watershed Characterization Introduction

The Forge River has been a distressed estuary since the early part of the 20th century. The Woods Hole Oceanographic Institution referred to the tributaries of Moriches Bay (Forge and Terrell Rivers) as "objectionable" and "highly contaminated" (Redfield, 1952). Extensive duck farming over many decades along the banks of the Forge River contributed to the high-nitrogen sediment load that remains. Residential development booms in the mid-twentieth century added thousands of onsite wastewater treatment systems (cesspools and septic systems) that have contributed substantial nitrogen to the water body via groundwater.

Although referred to as the Forge 'River,' the water body more closely meets the definition of an 'estuary.' An estuary is usually defined as "*a semi-enclosed coastal body of water, which has a free connection with the open sea, and within which sea water is measurably diluted with freshwater derived from land drainage* (Pritchard, 1967)." No portions of the Forge River are strictly fresh water, like the Peconic River and the Carmans River. The Forge River estuary is a shallow tributary of the Moriches Bay estuary, which is itself part of the larger South Shore Estuary. A number of small tributary tidal creeks feed the central portion of the Forge River estuary. Accumulated sediments at the mouths of some of the creeks have limited tidal flushing. There is a relatively shallow area across the mouth of the Forge River that along with a poor connection to the intracoastal waterway channel limits flushing from the Bay. Changes in inlets from the ocean have also influenced Forge River flushing. Most of the surface water input to the Forge River comes from the East and West Mill Ponds, both of which are highly eutrophic. The West Mill Pond continues to collect runoff and effluent from the remaining duck farm. Nitrogen from sediment, groundwater, and surface water inputs leads to regular and dense phytoplankton and macroalgae blooms. Those blooms die, and the oxygen utilized during microbial decay leads to prolonged anoxic conditions in the water column.

Years of accumulated duck waste and organic matter from decades of decayed algal blooms have shallowed the estuary and created muddy anoxic bottom conditions that preclude habitation by most estuarine organisms. Only highly mobile benthic organisms and pelagic species can avoid the low oxygen conditions.

The estuary shoreline retains some tidal marsh vegetation, but is also bulkheaded along much of its coastline. Turfgrass and ornamental vegetation has replaced marsh vegetation along many shoreline areas and still others are covered by the invasive common reed *Phragmites.*

The Forge River watershed comprises both the groundwater and surface water (stormwater runoff) contributing areas. When compared with stormwater runoff, the groundwater input is more significant as it contributes a large portion of the external loading of the nitrogen to the estuary. Nitrogen enters groundwater primarily from the thousands of residential onsite

wastewater treatment systems located adjacent to and up gradient of the Forge River. Ornamental and agricultural fertilizer use is responsible for another fraction of groundwater nitrogen. As groundwater travel-time to the estuary is measured in years or tens of years, nitrogen contributions to the estuary reflect past nitrogen contributions to groundwater that may be years or even decades old. The Forge River contributing area is subdivided into subwatersheds, based on groundwater contributing areas. The subwatersheds are distinctive in terms of their land uses, topography, and contribution to Forge River water quality. Those with high residential housing densities and low elevations are most problematic in terms of nitrogen contributions to the estuary. The East and West Mill Pond subwatersheds contribute large nitrogen loadings via surface water runoff as they collect significant duck farm and other agricultural runoff. Some subwatersheds contribute higher sediment loads via stormwater runoff than others. The types and densities of land uses differ among the subwatersheds, with more commercial, industrial, and agricultural land uses further north and large lot residential in the southernmost subwatersheds. A prioritization of the subwatersheds follows this characterization as the next step in identifying actions to reduce impacts on Forge River water quality.

4 Watershed and Subwatershed Delineations

The watershed and subwatershed boundaries, as delineated in Figure 4-1, provide an essential framework for characterizing the upland areas that contribute flow and contaminants to the Forge River. First, the watershed boundary – in addition to the surface waters of the Forge River estuary – effectively establishes the study area for this watershed plan. Secondly, a host of data for the watershed, such as land use, impervious surface area, density of on-site wastewater systems and population characteristics, are summarized and evaluated according to subwatershed boundaries. These subwatershed summaries will ultimately be employed to prioritize the subwatersheds according to the selection and timing of appropriate watershed management strategies. Section 4.1 below describes the methodology and data sets that were used to delineate the watershed and subwatershed boundaries.

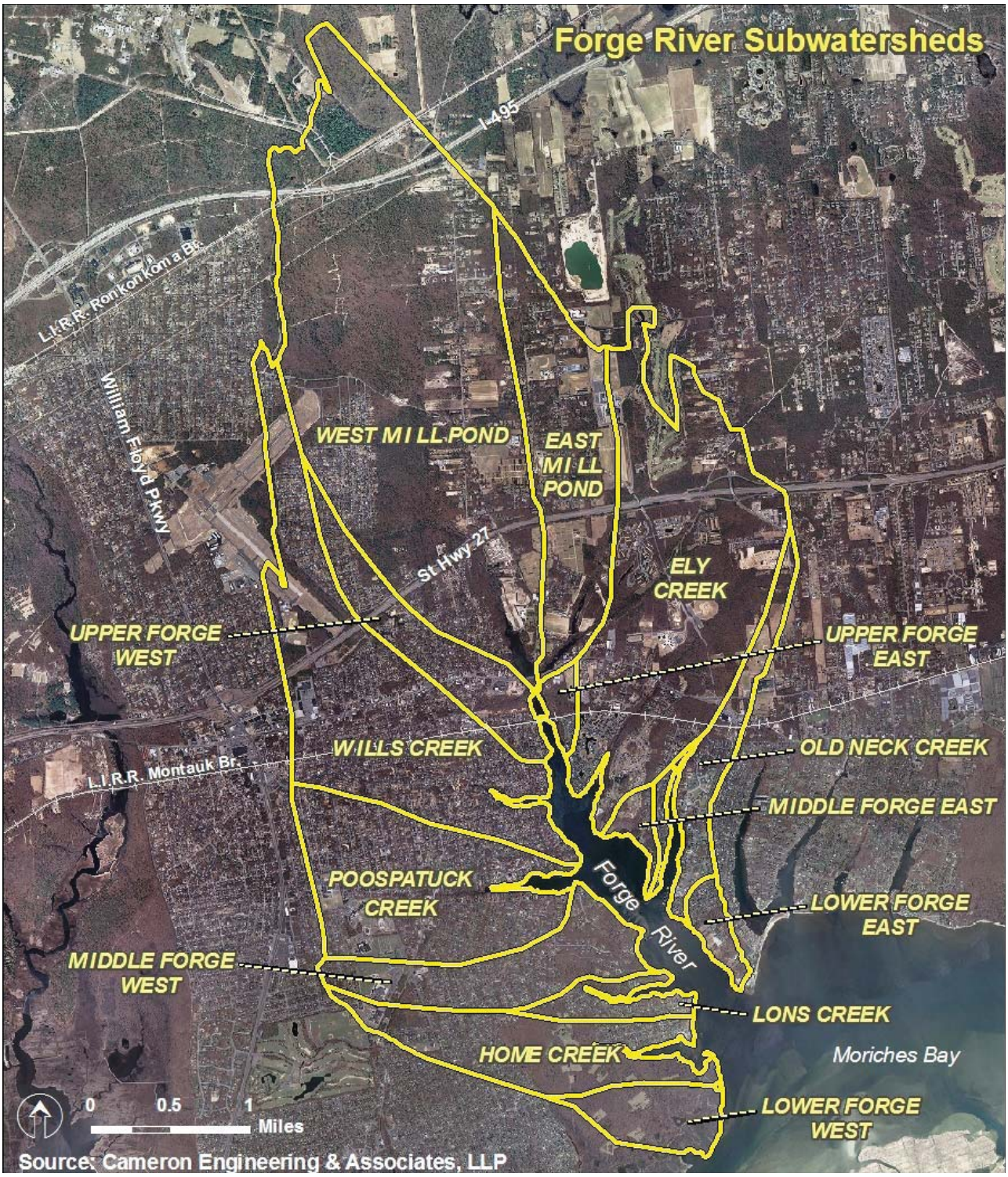
4.1 Delineation Methodology

For the purposes of this study, the overall watershed boundary is equivalent to the groundwater contributing area for the Forge River. The groundwater contributing area for the Forge River was delineated based upon a groundwater model that was developed for Suffolk County (Camp Dresser & McKee, 2009). The Forge River groundwater contributing area, as depicted in Figure 2-2 below, is the extent of the upland area from which groundwater contributes to the base flow of the streams and creeks that are tributary to the Forge River.

The methodology for delineating the subwatershed boundaries entails the integration of the stormwater collection system areas for the lower reaches of the watershed and the groundwater contributing areas for the upper or outermost reaches of the watershed. In the upper and outermost reaches of the watershed – which comprise mostly undeveloped and low-density areas where drainage infrastructure is limited or absent – the groundwater contributing areas are appropriately segmented to establish subwatershed boundaries. It is noted that, with the exception of farmland, runoff from the vacant and lesser developed portions of a watershed typically contribute far less stormwater volume and contaminants than the more developed areas. The delineation of the subwatershed boundaries in the more developed areas of the watershed, however, depends on the configuration of the stormwater infrastructure (*e.g.*, catch basins and pipes); this is discussed in detail in Section 4.3.2 below.

The subwatershed boundaries are modeled in the project Geographic Information System (GIS) and appropriately labeled according to local geography (*e.g.*, Upper Mastic, Poospatuck Creek North, West Mill Pond, etc.). The subwatershed boundaries can be used as the sub-basin framework for the development of a formal Request for Proposal for a Total Maximum Daily Load model for nitrogen.

Figure 4-1. The Forge River Watershed and Subwatersheds



4.2 Groundwater Contributing Areas

As discussed in Section 2.1 above, the watershed boundary is equivalent to the groundwater contributing area for the Forge River. The groundwater contributing area was further divided – via output from the Suffolk County model – into areas that correspond with timeframes for groundwater to reach the Forge River. The groundwater travel timeframes are as follows:

- 0 to 2 years
- 2 to 5 years
- 5 to 10 years
- 10 to 25 years
- 25 to 50 years

The groundwater travel times were extracted from a Suffolk County Department of Health Services (SCDHS) Geographic Information Systems (GIS) database (Figure 4-2). It is important to recognize that the groundwater travel time frames expand outward – in a generally concentric manner – around the creeks and ponds that provide base flow to the Forge River. The areas between these concentric rings are bisected to establish the boundaries between the subwatersheds. This delineation approach is relevant primarily in the uppermost, and lesser-developed, portions of the watershed where stormwater collection infrastructure is limited or absent.

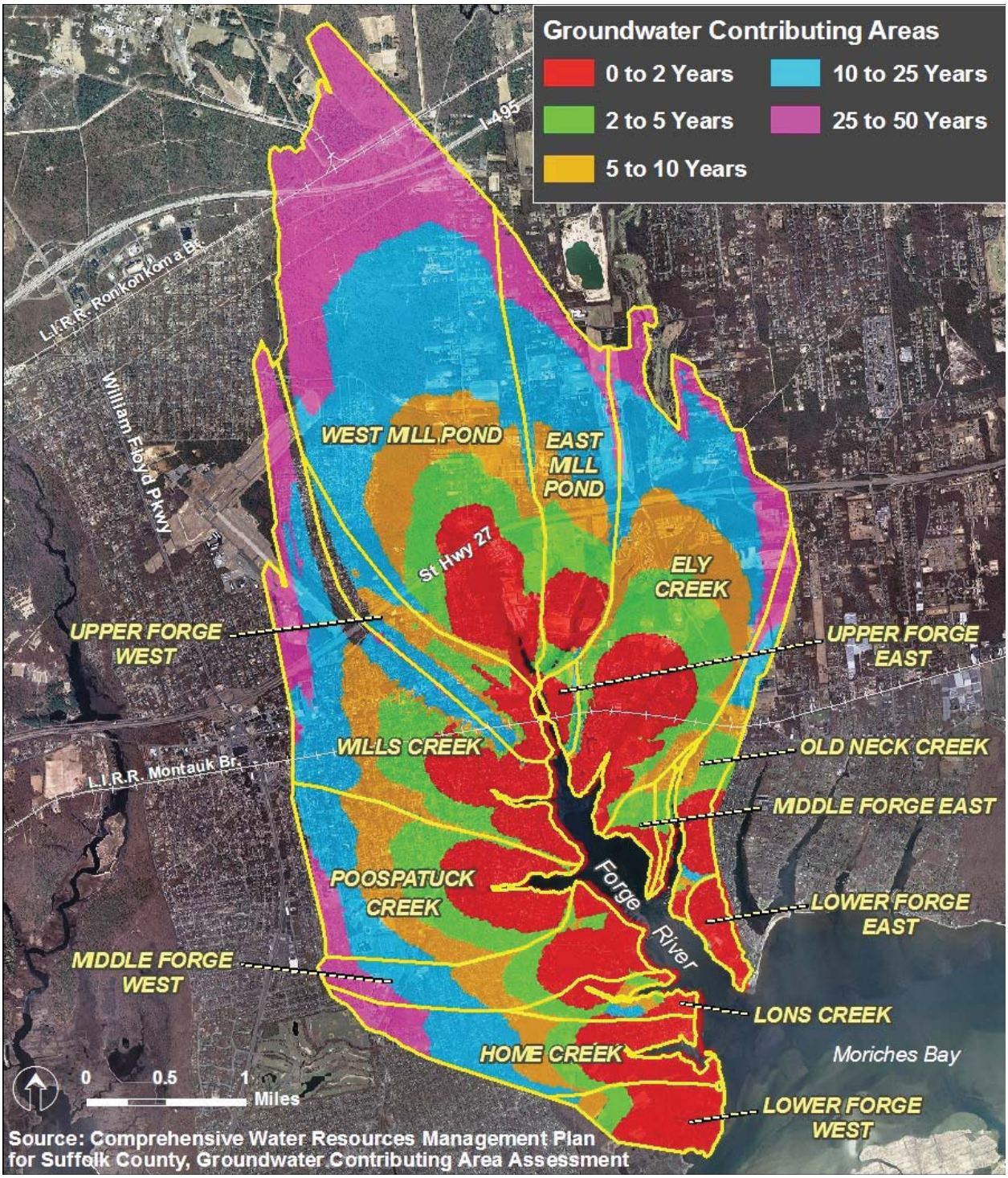
4.3 Stormwater Contributing Areas

4.3.1 Stormwater Collection and Infiltration Systems

An understanding of stormwater drainage infrastructure within the watershed was essential to the subwatershed delineation. (Stormwater infrastructure is discussed in detail in 5.6.1 below). The stormwater collection system within the Forge River's watershed area (as represented by GIS data provided by the Town of Brookhaven) consists of approximately 115 recharge basins, 1,526 drainage leaching structures and a number of other conveyance features (non-leaching catch basins, pipes, etc.). Combined, these stormwater infrastructure components total to more than 3,500 total structures.

Stormwater catch basins collect runoff and direct it to recharge basins that return stormwater to the water table through soil infiltration. Drainage leaching structures – which are not piped to recharge basins – are also utilized. These collect runoff locally and also directly recharge it to the soils beneath and then to groundwater.

Figure 4-2. Groundwater Contributing Areas by Travel Time to the Forge River



In the neighborhoods where stormwater is directed to recharge basins, the subwatershed boundaries follow the stormwater collection areas. It is recognized that a portion of the rain that falls within stormwater collection areas is directly recharged to groundwater via infiltration through pervious surfaces and thus is not captured by the stormwater collection system. The groundwater contributing area for a given subwatershed is typically coincident with the stormwater collection system area. However, where the stormwater collection system does not match the groundwater contributing area, the stormwater collection system area governs the subwatershed delineation. Other considerations and assumptions employed during the delineation of the subwatershed boundaries are discussed below in Sections 4.3.2 through 4.4 below.

4.3.2 Stormwater Collection and Direct Outfall Systems

In areas directly adjacent to the Forge River and its tributary creeks, runoff is typically collected via a network of catch basins and pipes and then discharged directly to the river via stormwater outfalls. Each storm-sewer-shed represents the drainage area associated with a major outfall or a collection of smaller outfalls to the Forge River. This network of drainage infrastructure – comprising pipes, catch basins, manholes and outfalls – establishes storm-sewer-sheds. These storm-sewer-sheds define the lower reaches of the Forge River subwatersheds. Because this approach does not utilize recharge basins, the storm-sewer-sheds are also termed “no-recharge” areas for the purposes of this study. Stormwater handled in this manner does not receive the additional treatment afforded by percolation through the soil beneath recharge basins. Fortunately, “no-recharge” areas do constitute only a small portion of the Forge River watershed. Figure 4-3 depicts the stormwater outfall collection, or “no-recharge,” areas.

4.3.3 Direct Runoff Contributing Areas

In areas that have ineffective or limited existing drainage structures, *i.e.*, direct-runoff-contributing areas, runoff follows the topography and creates overland flow to the Forge River. These areas typically have high impervious cover and are located directly adjacent to the Forge River and its tributary creeks. They are included within the “no-recharge” areas depicted in Figure 4-3. Like areas drained by catch basins and outfalls, the precipitation in these direct-runoff-contributing areas the precipitation in these areas receives little to no treatment before entering the river.

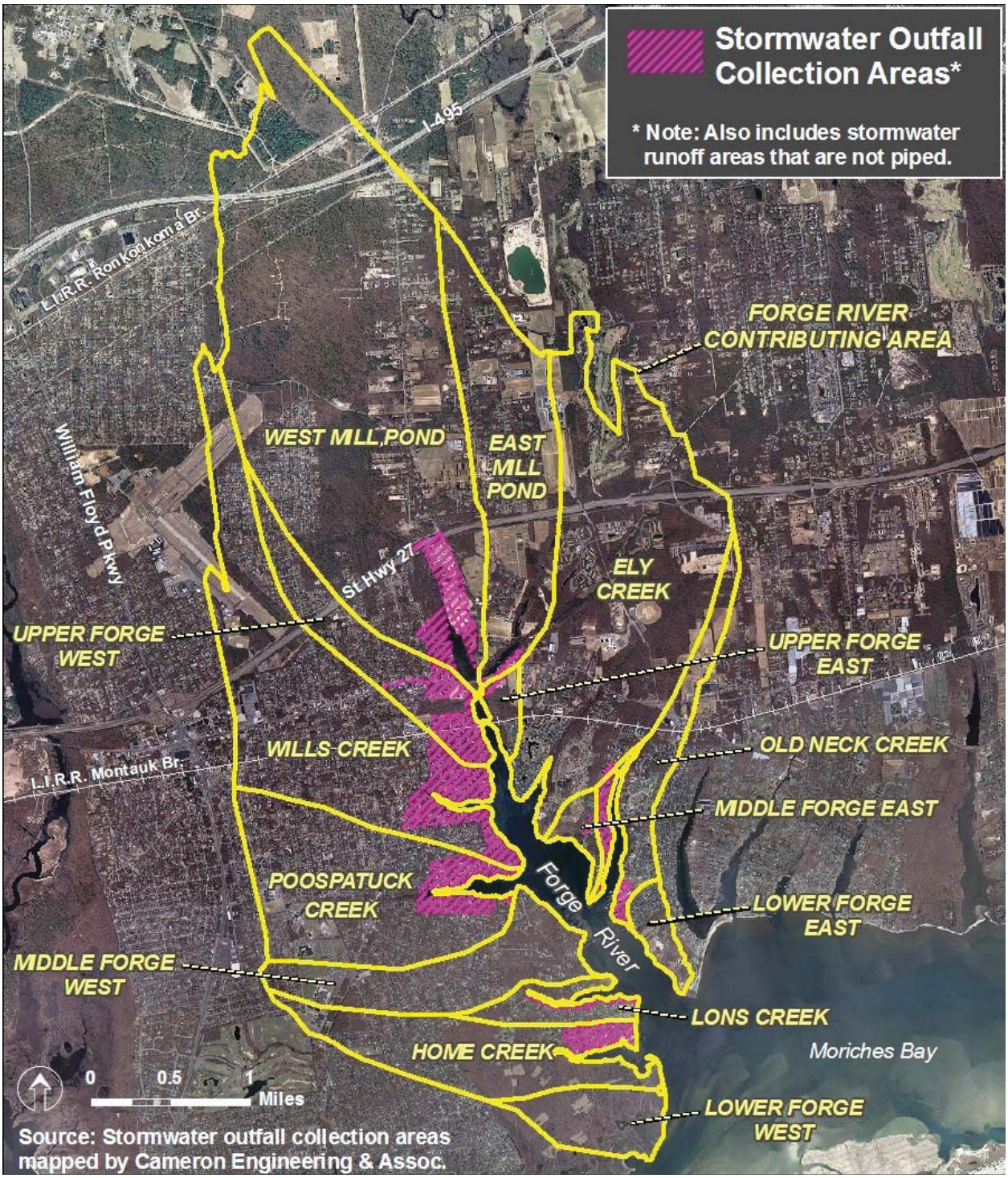
4.4 Subwatershed Areas

The total area of the watershed is approximately 9,450 acres. Of the entire 9,450 acres that comprise the watershed, 8,860 acres are classified as "recharge" areas. The remaining 590 acres are "no-recharge" areas. Table 4-1 below summarizes the area of the subwatersheds.

Table 4-1. Subwatershed Areas.

Subwatershed Name	Area (acres)
Lower Forge West	213.0
Home Creek	523.2
Lons Creek	135.8
Mid Forge West	443.2
Poospatuck Creek	851.6
Wills Creek	1,242.9
Upper Forge West	380.8
West Mill Pond	2,814.9
East Mill Pond	779.0
Upper Forge East	59.0
Ely Creek	1,549.4
Middle Forge East	63.6
Old Neck Creek	310.2
Lower Forge East	84.4
Total	**9,451.0**

Figure 4-3. Stormwater Outfall Collection Areas (No-Recharge Areas)



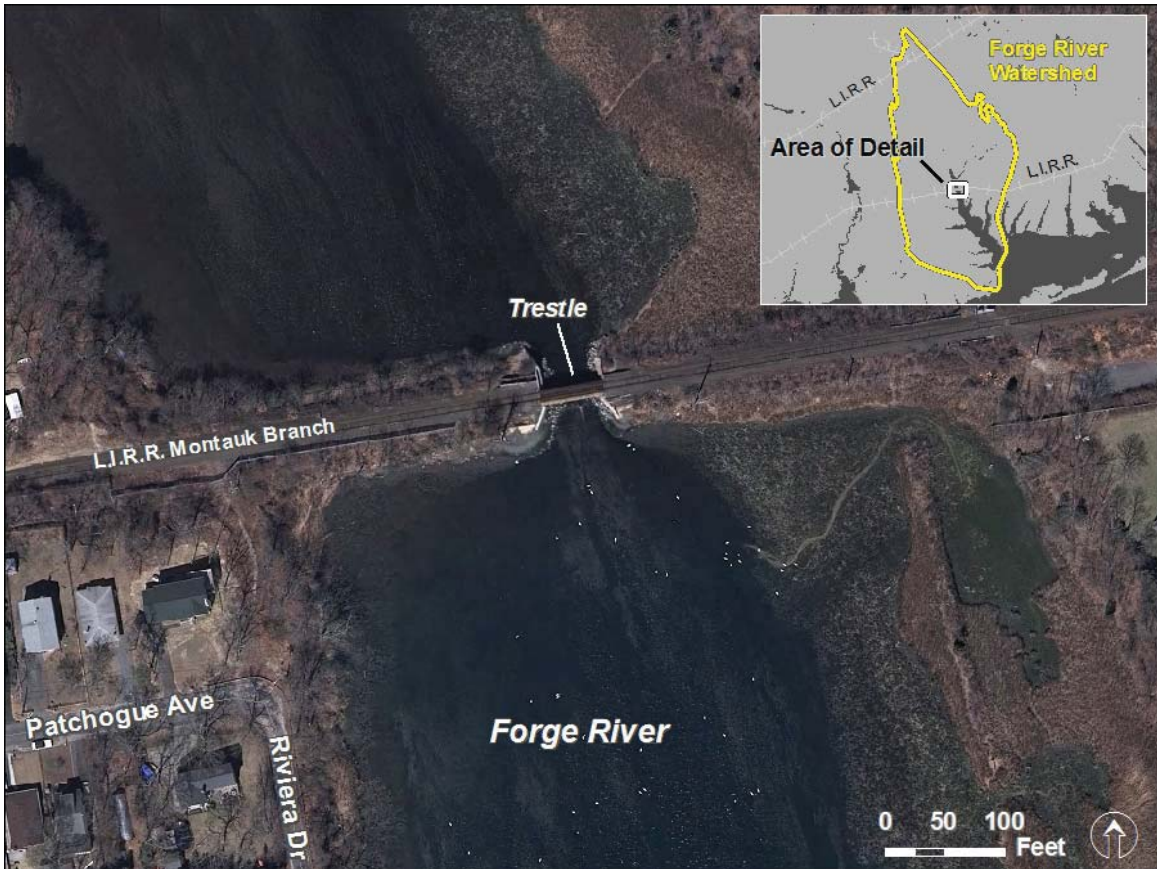
5 Geographic Setting

The Forge River is a partially mixed estuary that discharges to Moriches Bay. The upland area of the Forge River, *i.e.*, the watershed area, is situated in the southeastern portion of the Town of Brookhaven and encompasses the hamlets of Mastic and Moriches and the Poospatuck Reservation. Portions of the hamlets of Manorville, Shirley and Center Moriches and the Village of Mastic Beach also comprise the watershed. Figure 5-1 provides a location map for the Forge River watershed communities and adjacent areas.

Figure 5-1. Location Map of the Forge River Watershed

The Forge River watershed contains two major highways, an important arterial, a network of local roads, and other noteworthy transportation infrastructure. Interstate Highway 495 traverses the northern tip of the watershed while State Highway 27 (Sunrise Highway) runs east to west through the center of the watershed. Montauk Highway, located south of State Highway 27, is an important east-west corridor for local commerce; it passes through the population center of the Village of Mastic. Other transportation features in the watershed include the Long Island Rail Road Montauk and Ronkonkoma Branches and the Brookhaven Airport. The Montauk Branch runs east to west across Shirley, Mastic, and Moriches and crosses the upper reaches of the Forge River via a trestle. The trestle, shown in Figure 5-2, is an important landmark of the Forge River. A portion of the Brookhaven Airport falls within the western boundary of the watershed.

Figure 3.2 Long Island Rail Road Trestle Across the Upper Forge River



Most of population within the watershed is located south of State Highway 27 and to the west side of the Forge River within Mastic, Mastic Beach, Shirley, and the Poospatuck Reservation. Residential neighborhoods are located on the east side of the Forge River, though they are significantly less extensive than those on the west side. Except for a medium-density residential area adjacent to the Brookhaven Airport, population density within the upper reaches of the watershed is relatively low and vacant land area is significant.

5.1 Data Sources and Maps

To characterize the watershed, *i.e.*, the upland areas of Forge River, this plan utilizes a variety of geographic, environmental, and socioeconomic data. Sources of the data are primarily government and academic institutions. Table 5-1 summarizes the data types and providers of the data utilized for this study. Where data was developed and updated or enhanced as part of this study, the source is listed as 'Consultant.' References to published reports are contained in the body of the report and listed in 'Works Cited,' Section 14. The Works Cited section includes numerous reports by the School of Marine and Atmospheric Sciences (SoMAS) of Stony Brook University which, in most cases, were prepared for the Town of Brookhaven.

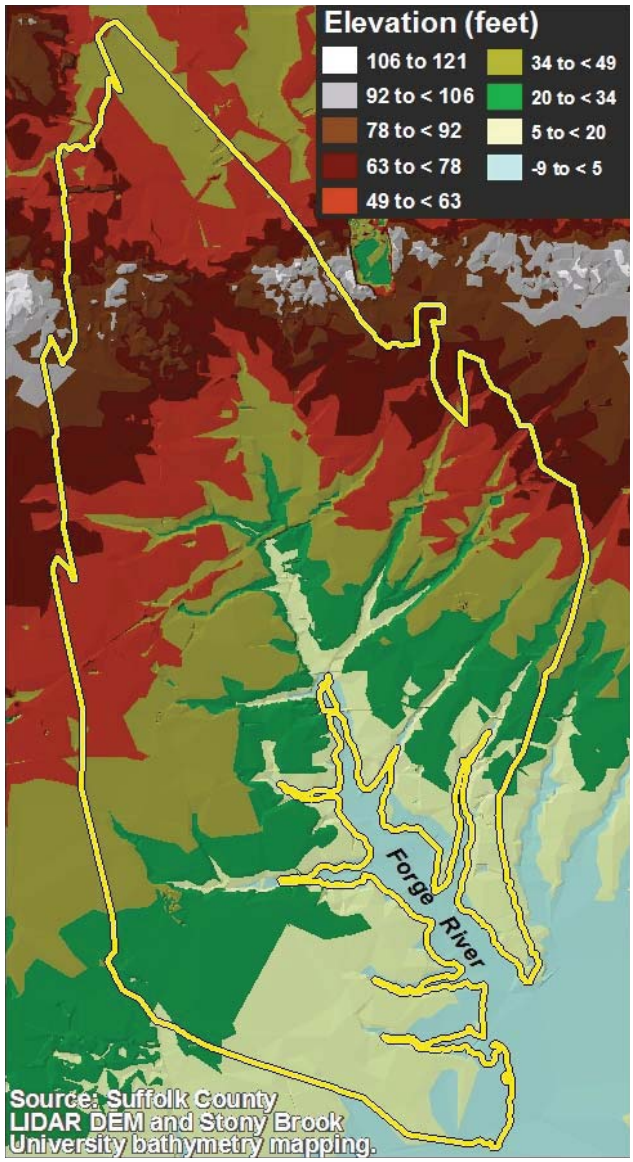
Table 5-1. Data Category and Class

Data Type	Source
Stormwater Infrastructure	Town of Brookhaven
Topography	Town of Brookhaven and Suffolk County
Hydrology	NYS DEC and consultant
Flood Zones	FEMA
Precipitation	NOAA
Land Use	Town of Brookhaven and Consultant
Land Cover	Consultant
Population	LIPA
Housing	US Bureau of the Census
Economics	US Bureau of the Census
Zoning	Town of Brookhaven
SPDES Permits	NYS DEC
Nitrogen Load/Balance	SoMAS and consultant
Benthic Habitat	NYS DOS
Bathymetry	Town of Brookhaven

5.2 Topography

Figure 5-2 depicts a relief model of the watershed topography and river bathymetry. This relief model is an integration of a recent (2006) LIDAR-based (LIght Detection And Ranging) digital elevation model of topography that was provided by the Suffolk County GIS Department and a bathymetry model produced by Stony Brook University (Flood, 2007). The LIDAR-based topography model is a high-resolution grid of 5-foot-by-5-foot ground elevation cells while the bathymetry model comprises 10-cm (0.1m) contours.

Figure 5-2. Terrain Relief Model of the Watershed



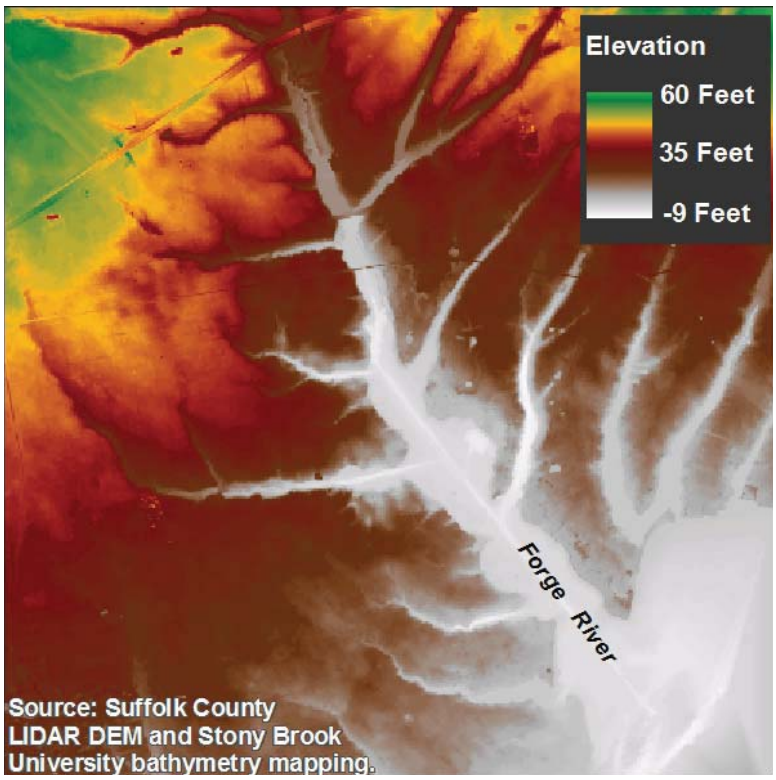
(Source: Town of Brookhaven and Suffolk County).

The integrated topography and bathymetry model provides excellent detail, and it was utilized for the delineation of the storm-sewer-shed boundaries described in Section 4. The combination model provides sufficient detail such that sills, dredged channels and the banks of the estuary are clearly revealed. Because of its accuracy and high-resolution, the relief model can be utilized for the development of the TMDL model. A section of the combined elevation-bathymetry model for the Forge River area is provided in Figure 5-3.

A review of the digital elevation model (Figure 5-2) reveals that most of the lower half of the watershed comprises gentle to moderately sloping terrain except near the creeks. Along the

edges of the creeks and the streams, the terrain changes abruptly and forms elongated cuts in the landscape. In the upland areas of the middle reaches of the watershed, elevations reach approximately 100 feet and then fall to 45 feet at the northernmost tip of the watershed. The observation that the terrain rises and falls is counterintuitive to the generally accepted concept of watershed delineation, *i.e.*, where boundaries are typically drawn along break, or ridge, lines where rainfall is shed in opposing directions on either side of the break lines. However, these areas are encompassed by the Forge River groundwater contributing area. The bathymetry of the Forge River, along with a discussion of dredging operations over time, is discussed in Section 10.1.

Figure 5-3. Detailed View of the Integrated Digital Elevation and Bathymetry Models



(Source: Suffolk County LIDAR DEM and Stony Brook University bathymetry mapping.)

5.3 Hydrology

There a number of watershed functions which govern the hydrologic environment. Initially, the watershed collects water from precipitation, a portion of which becomes runoff. In areas directly adjacent to the Forge River, runoff is directed to the river via the outfalls of the stormwater collection systems or via direct runoff (*i.e.*, overland flow) from impervious surfaces. The other areas of the watershed temporarily store the remainder of the

precipitation in various amounts and durations in storage basins and the soil. In the latter instance, precipitation is transmitted to the water table via infiltration through soil and other pervious surfaces. In the developed portions of the watershed, stormwater recharge basins release rainfall accumulated from their collection areas into groundwater via recharge. Stormwater that is recharged to the water table is eventually released to the Forge River as groundwater discharge from its banks and from the ponds, streams and creeks that are tributary to the Forge River.

According to report prepared for the Town of Brookhaven by the School of Marine and Atmospheric Sciences entitled *Some Aspects of the Forge River Ecology* (Brownawell, Gobler, & Swanson, May 2009), the East and West Mill Ponds are the major sources of surface discharge to the Forge River, contributing 80 percent of surface water runoff. In 2007, the School of Marine and Atmospheric Sciences measured the flow from the East and West Mill Ponds at approximately 0.96 million cubic feet per day. In addition, they also found that groundwater flow was 1.6 times that of stream flow. This finding is less than half that reported in Redfield's 1952 study (Redfield, 1952), where groundwater flow was estimated at 3.6 times stream flow. Although the ratio of groundwater to stream flow varies with time of year and climatic conditions, it is clear that groundwater flow is the major source of flow from the upland areas to the Forge River.

Figure 5-4 depicts the surface water features of the watershed that comprise the Forge River, its tributary creeks and streams, ponds, ditches and the shorelines. The shoreline of the Forge River and its creeks is extensive, tracing a perimeter of approximately 15 miles. The perimeter of the ponds within the watershed is also considerable and encompasses a linear periphery of about 4.6 miles, though mostly comprising the banks of the East and West Mill Ponds. The streams of the watershed account for less than two miles of total linear distance and thus do not extend far beyond their interface with the various creeks and ponds of the watershed. This is due mostly to the well-drained soils that are found throughout the watershed and, in part, to the configuration of the stormwater system. In the developed areas of the outer (*i.e.*, eastern and western) and upper reaches of the watershed, stormwater systems typically recharge runoff to groundwater through basins and leaching pools, thereby reducing runoff and overland flow.

Table 5-2 summarizes the areas of the Forge River, its tributary creeks and the freshwater ponds. The surface waters of the watershed encompass approximately 574.3 acres. The Forge River proper (*i.e.*, less its tributary creeks) accounts for the majority (69.0 percent) of the surface waters, or 396.1 acres. Old Neck, Home, Poospatuck, Lons, and Wills Creeks are 40.9, 29.4, 25.5, 15.2, and 7.7 acres in area, respectively. West Mill Pond (25.9 acres) and

East Mill Pond (10.2 acres) account for 36.2 acres of surface fresh water. The various natural and man-made ponds – located mostly within the eastern half of the watershed – total 23.4 acres in area.

Table 5-2. Areas of Water Bodies in the Watershed

Water Body	Area (Acres)	Percent of Total Area
Forge River	396.1	69.0 percent
Old Neck Creek	40.9	7.1 percent
Home Creek	29.4	5.1 percent
West Mill Pond	25.9	4.5 percent
Poospatuck Creek	25.5	4.4 percent
Small Ponds & Basins	23.4	4.1 percent
Lons Creek	15.2	2.6 percent
East Mill Pond	10.2	1.8 percent
Wills Creek	7.7	1.3 percent
Total	**574.3**	**100.0 percent**

Figure 5-4. Water Features of the Watershed

5.4 Flood Zones

Figure 5-5 on the following page depicts the flood zones within the Forge River watershed. Approximately 600 acres of the lower-lying areas of the watershed lie within the 100-year flood hazard area. This places approximately 750 properties – the overwhelming majority of which are residential uses – within the 100-year flood hazard zones, including the VE zones that are susceptible to wave action or storm surges. These include the following zones as designated by the Federal Emergency Management Administration (FEMA):

- High-Risk Areas
  - Zone A: Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
  - Zone AE: The base floodplain where base flood elevations are provided. AE Zones are now used on new format Flood Insurance Rate Maps (FIRMs) instead of A1-A30 Zones.
- High-Risk Coastal Areas
  - Zone VE: Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves.

5.5 Precipitation

Annual average precipitation in the area is 45.07 inches/year (Source: National Oceanic and Atmospheric Administration data at Central Park in New York City, 65 miles west of the Forge River, 1869-2009). As discussed in Section 11.9.8, data from the National Atmospheric Deposition Program (NADP) was used to determine the total nitrogen contribution from precipitation. This data was taken from 2004-2008 at Site NY-96 located in Cedar Beach, Southold, New York, which is approximately 30 miles northeast of the Forge River. The average annual precipitation at this site is 47.3 inches for Years 2004 through 2008.

5.6 Infrastructure

5.6.1 Drainage

The drainage infrastructure in the Forge River watershed consists of typical stormwater collection and conveyance structures such as catch basins, leaching basins, manholes, pipes, outfalls and recharge basins. According to GIS data obtained from the Town, there are approximately 24 outfalls that discharge to the Forge River and the creeks upstream (Figure 5-6). These collect stormwater from the neighborhoods and roads immediately adjacent to the Forge River and discharge directly to the estuary with no treatment. The

majority of storm drainage in the watershed discharges to the ground via leaching basins and recharge basins. Most of the subwatersheds contain storm-sewer-sheds, or areas that are piped to and/or have overland flow to a small recharge basin. The stormwater collected in the recharge basins receives some treatment through deposition of suspended particles and microbial activity during detention and infiltration prior to reaching groundwater.

5.6.2 Sanitary

Suffolk County is only approximately 30 percent sewered. These areas consist of a mix of municipally- or privately-owned sewage treatment plants. The remainder of the County is dependent on on-site systems for wastewater treatment. Prior to the mid-1970s, – when much of the development in the Forge River watershed occurred – cesspools were installed for on-site wastewater treatment. These structures comprise simple leaching basins into which untreated wastewater flows. Beginning in the mid-1970's, on-site wastewater treatment system design was improved with the installation of septic systems. Septic systems have a holding tank for solids and an associated leaching system. Septic systems are designed to have a two-day detention time, thus providing greater treatment (when properly maintained) than cesspools. Effluent from on-site wastewater treatment systems infiltrates into the ground and ultimately reaches groundwater, which, in turn, flows, to the Forge River.

5.7 Geographic Setting Summary

The Forge River is a partially-mixed estuary that discharges to Moriches Bay. The Forge River contributing area has moderately sloping terrain with greater relief in the upland part of the basin. Hydrology is dominated by groundwater due to highly permeable soils and shallow depth to groundwater in the lower portions of the watershed. Surface water enters the Forge River from the East and West Mill Ponds and through creeks that have small drainage areas, some of which include stormwater collection systems. On-site wastewater treatment systems are common in the watershed due to its early development for seasonal beach communities and the lack of a large centralized wastewater treatment facility. Many of the on-site wastewater treatment systems in the watershed are still cesspools. Most of the on-site wastewater treatment systems are likely to be quite old and/or infrequently serviced.

Figure 5-5. Flood Zones of the Forge River Watershed

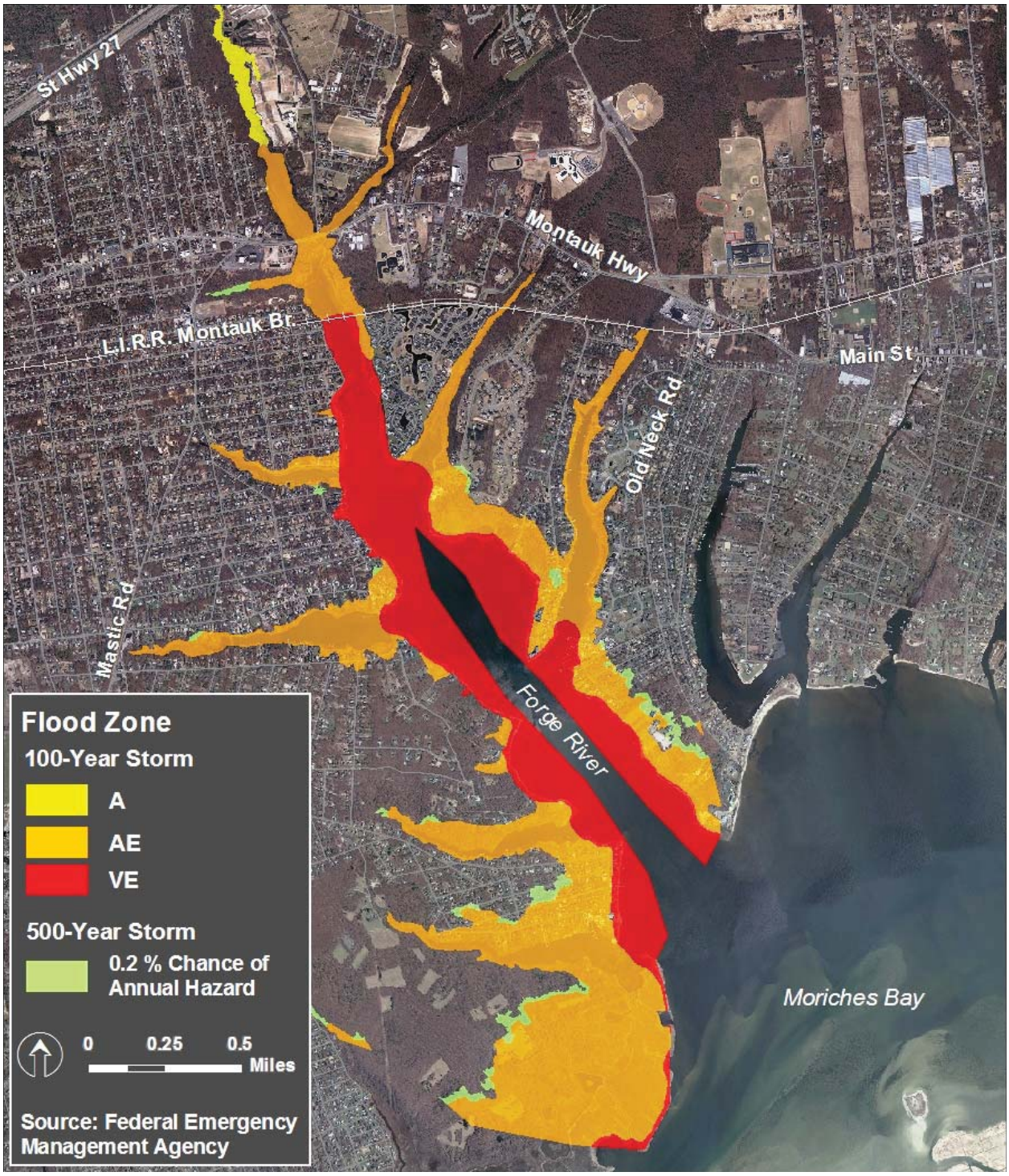
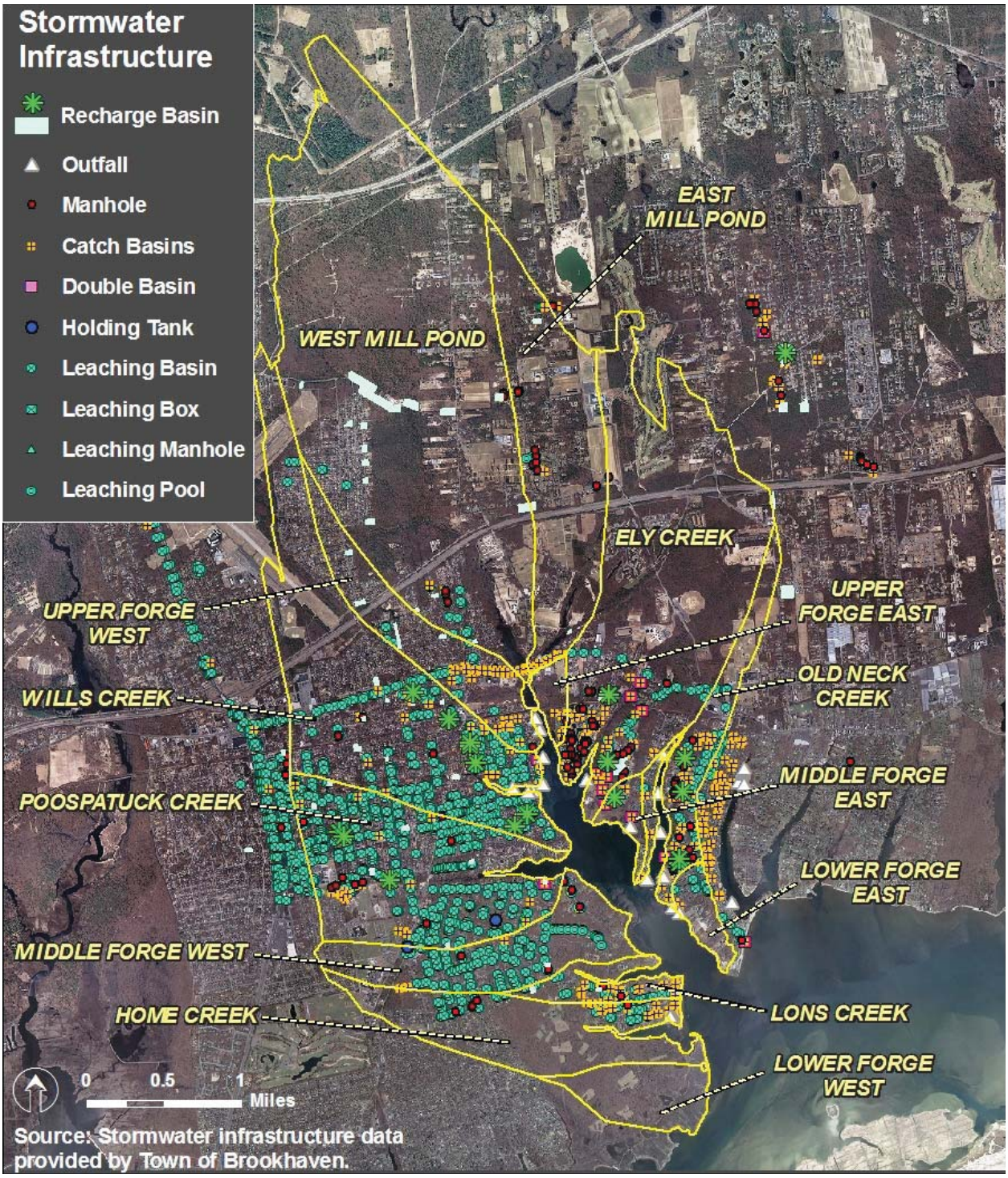


Figure 5-6. Stormwater Infrastructure in the Forge River Watershed



There are an estimated 8,100 existing onsite systems within the watershed with estimated flows ranging from 20 gallons per day (a small fruit stand) to over 42,000 gallons per day (public school). Historically, the urbanization of the watershed began in a manner similar

to other coastal areas on Long Island, *i.e.*, as a seasonal beach community. As population spread eastward, many of these beach communities began supporting year-round residents. While other infrastructure was upgraded to accommodate the growing population (*i.e.*, water, electricity, etc.), wastewater continued to be treated by existing on-site systems. Those systems required only limited repair and maintenance to maintain working order. Many of the on-site systems in the watershed are still cesspools and most of the on-site systems are quite old. As there are no requirements for maintenance or upgrades to on-site systems, most homeowners service them only when a problem arises. Pump-outs will alleviate most on-site system problems until the surrounding soils can no longer infiltrate the effluent. Typically, only then are these systems replaced.

Following Suffolk County's adoption sanitary requirements (*i.e.*, 300 or 600 gallons per day (gpd) per acre, depending on the hydrogeologic zone), private developments that exceeded the flow limits were required to construct new sewage treatment plants (STPs) or connect to existing ones. These STPs require approval from Suffolk County and the New York State Department of Environmental Conservation (NYSDEC). They are regulated by their State Pollution Discharge Elimination System (SPDES) permit and at the national level, the NPDES permit. Discharge Monitoring Reports (DMR's) are required on a monthly basis and fines are distributed to those sanitary STPs that do not comply with their permit conditions. The Forge River watershed has three housing developments and one business that operate with these SPDES discharge permits.

- Waterways at Bay Point
- The Villas at Pine Hills
- Pine Hills South
- Jurgielewicz Duck Farm

The STPs that serve the housing developments have either sub-surface or recharge basins where effluent leaches to groundwater and thus ultimately reaches the Forge River. The Jurgielewicz Duck Farm discharged directly to West Mill Pond, which empties into the Forge River.

An examination of the County's groundwater model reveals that the three housing development STPs are within the Ely Creek contributing area (Figure 5-7 and Table 5-3). The Villas at Pine Hills, Pine Hills South, and Waterways at Bay Pointe are within the 10-25-year zone, 2-5-year zone, and 0-2-year zone, respectively. The DMR's of the plants include quarterly sampling results from the groundwater monitoring wells located upstream and downstream of the STP's discharge.

Table 5-3. Ely Creek Area Groundwater Nitrogen Concentrations

Wastewater Treatment Plant Name	Monitoring Dates	Average Upstream Monitoring Well Nitrogen Concentration (mg/L)	Average Downstream Monitoring Well No. 1 Nitrogen Concentration (mg/L)	Average Downstream Monitoring Well No. 2 Nitrogen Concentration (mg/L)	Linear Distance to Ely Creek (miles)
Villas at Pine Hills	10/1/09-3/31/10	5.8 (Peak: 5.9)	13.7 (Peak: 20.8)	19.05 (Peak: 32)	1.8
Pine Hills South	10/1/07-12/31/07 7/1/09-9/30/09 1/1/10-6/30/10	3.0 (Peak: 3.5)	5.9 (Peak: 8.9)	18.325 (Peak: 58.9)	1.2
Waterways at Bay Pointe	2/1/09 – 4/30/10	4.04 (Peak: 7.1)	12.74 (Peak: 22.6)	17.46 (Peak: 36.3)	0.4

Since these readings are taken from groundwater, they include nitrogen inputs from every source (*i.e.*, not just wastewater treatment plants) including stormwater recharge. The Duck Farm's SPDES permit has different nitrogen limits that range from 5 mg/L in the summer to 10 mg/L in the winter. Data from July 2009- June 2010 were obtained through a FOIL request to the NYSDEC. Averages from this data are represented in Table 5-4. Average flow for this data range is 0.578 million gallons per day (MGD).

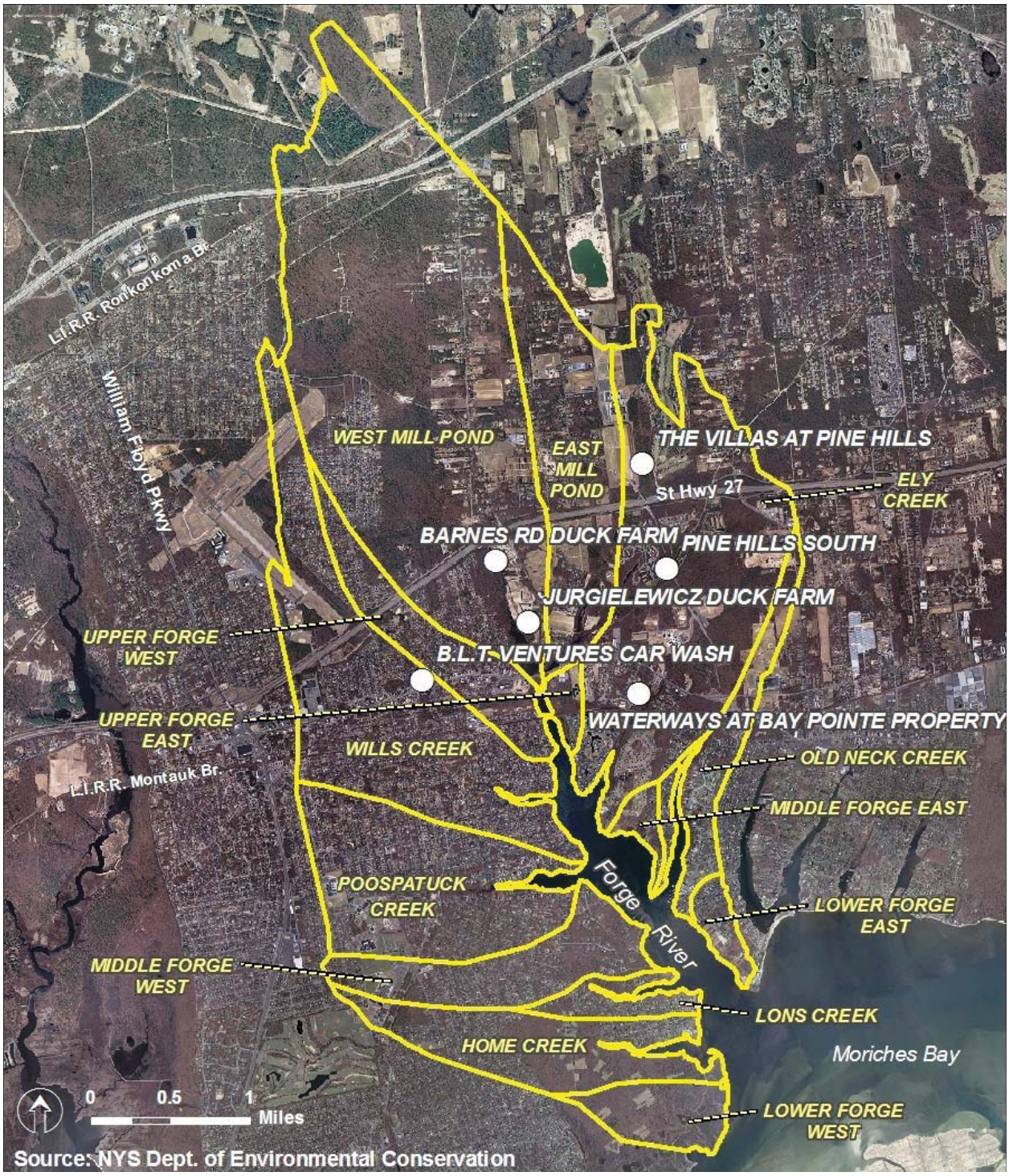
Table 5-4. Duck Farm Average Effluent Data*

Average Effluent Concentrations	lbs/day	mg/l	no./100 ml
Total N (as N)	195.0	42.8	
Phosphorous		9.7	
Total Ammonia as (NH_3)		28.9	
Total Fecal – 30 day Geometric Average			116.1
Total Fecal – 7 day Geometric Average			423.3
Total Fecal – Monthly Medium			183.6

* Note: the Jurgielewicz Duck Farm has ceased operations

As shown in Figure 5-7, there are two additional wastewater treatment dischargers. They are the Barnes Road Duck Farm and B.L.T Ventures Car Wash. The Barnes Road Duck Farm is comprised of four lined lagoons and has a "zero-discharge" SPDES permit. Because the SPDES permit requires no discharge, there is no effluent data collected or available. The presumption is that waste from the duck farm's lined effluent lagoons is removed and taken off-site for disposal. The discharge from B.L.T. Ventures Car Wash is not considered a 'sanitary' discharge. The constituents of its discharge presumably contribute little to no nitrogen to the Forge River. Therefore, neither of these facilities is considered a nitrogen contributor to the Forge River.

Figure 5-7. Wastewater Treatment Locations



6 Land Use

6.1 Current Land Use

Figure 6-1 provides a current land use map for the Forge River watershed. The land use data upon which the map is based was stored within a GIS tax-parcel database provided by the Town of Brookhaven. The GIS tax parcel database was subsequently updated through a review of aerial photography and field work.

Land use, as depicted in Figure 6-1, varies significantly across the Forge River watershed. A substantial portion of the southern half of the watershed (*i.e.*, south of State Highway 27) has been developed. This is especially evident in the southwest portion of the watershed, which is almost entirely built-out with residential, commercial and community services uses. A majority of the southeastern portion of the watershed has been developed, primarily with residences that tend to be concentrated along the shorelines of the Forge River, Ely Creek, and Old Neck Creek. Community services and agricultural uses are also located within the southern half of the watershed, though they are significantly less in area than the residential uses. Most of the remaining vacant land in the southern portion of the watershed lies within the Ely Creek subwatershed.

Commercial uses are notably concentrated along the Montauk Highway corridor, which runs east to west through the central portion of the watershed. Transportation comprises an important share of the watershed's land use, especially in the central part of the watershed where a significant amount of land is dedicated to the Brookhaven Airport and the right-of-way for State Highway 27. The right-of-way for Interstate 495 also occupies a large swath of land in the northernmost tip of the watershed. The numerous residential streets of the watershed constitute a significant share of the land devoted to transportation.

The northern half of the watershed differs greatly in character from its southern half because of its generally lower development density. In fact, whereas moderate-density residential uses tend to dominate land use in the southern half of the watershed, vacant land and low-density residential uses are prevalent throughout the northern half. The exception to this pattern is the moderate-density residential area that is adjacent to the Brookhaven airport. The community services use in the northernmost tip of the watershed is a portion of Brookhaven National Laboratory. As this portion is mostly undeveloped, it may alternatively be deemed vacant.

Figure 6-1. Land Use in the Fourteen Forge River Subwatersheds

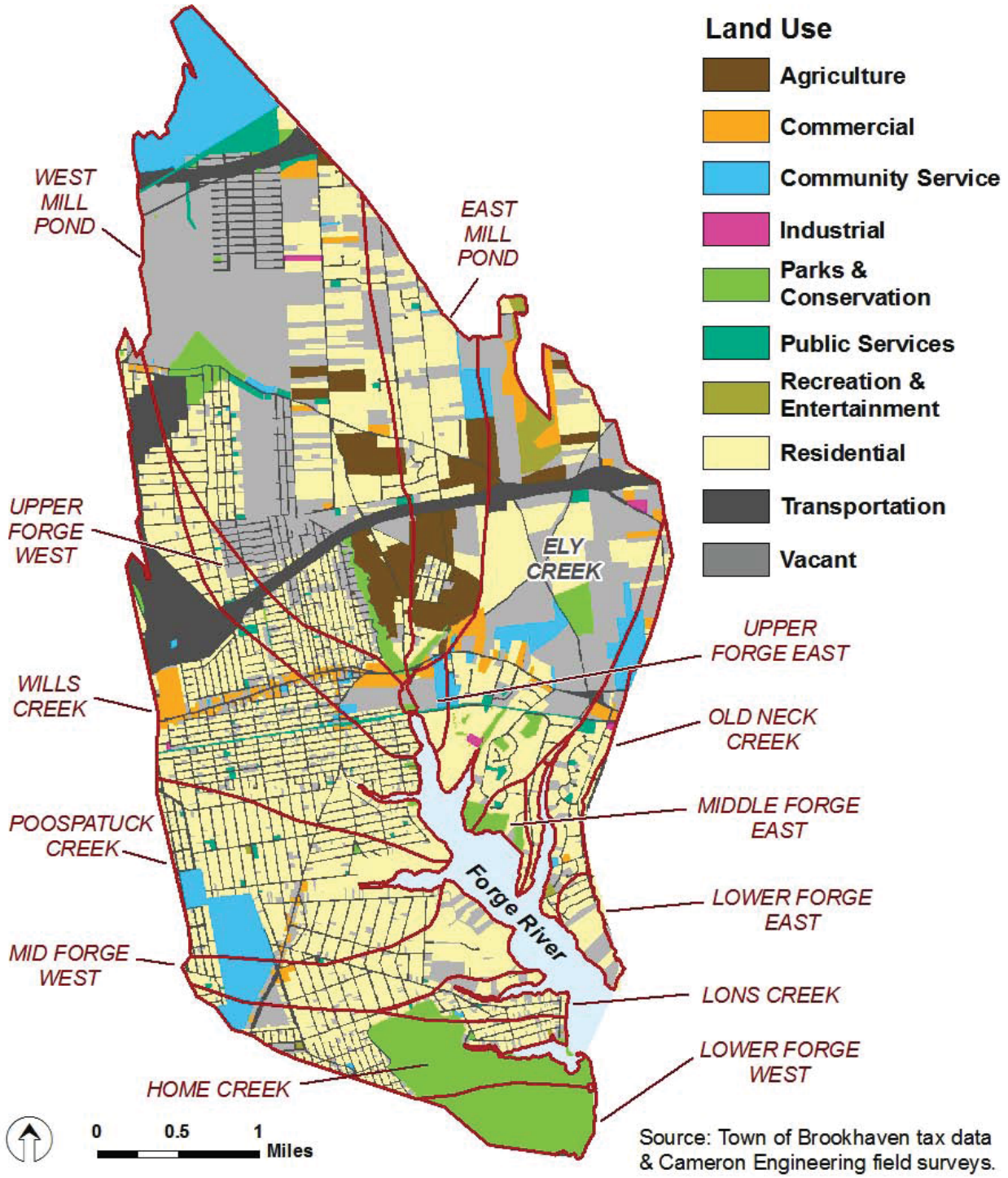


Table 6-1 provides a summary of land use for the watershed and its fourteen subwatersheds. Residential land accounts for the largest single use of land within the watershed; approximately 3,620 acres within the watershed, or 38.5 percent of the total, are dedicated to residential use. Transportation, industrial, commercial, and public service uses – which are relatively intense land uses – encompass 1,419, 14.2, 243.3 and 150.5 acres, respectively, for a total of 1,827 acres, or 19.4 percent of the total watershed area. Collectively, residential, transportation, industrial commercial, and public service uses comprise approximately 5,450 acres, or 58 percent, of all the land in the watershed. Recreation & Entertainment and Community Services – which are generally lower intensity uses – comprise 664 acres, or only 7.1 percent of the total. There are approximately 648.7 acres of permanently preserved Parks and Conservation land. Vacant land (2,252 acres) and Agriculture land use (397 acres) account for 2,649 acres, or 28.1 percent of the total; some of the land in this land use group – excluding parcels that have been deed-restricted for agricultural and conservation uses in perpetuity – could be developed in the future. The future build-out of vacant land in the watershed is addressed in Section 6.2 below.

Table 6-1 also provides a breakdown of land use by subwatershed. In general, the table reveals that residential and transportation uses account for a majority of the land use in several subwatersheds. For example, on the west side of the estuary, residential and transportation uses account for 65.9, 75.1, 82.2 and 85.8 percent of the land in the Lons Creek, Mid Forge West, Poospatuck Creek and Wills Creek subwatersheds, respectively, or 3,238 acres. Meanwhile, on the eastern side of the estuary, transportation and residential comprise 52.3, 42.9, 63.4 and 61.1 percent of East Mill Pond, Ely Creek, Middle Forge East and Old Neck Creek subwatersheds respectively, or 1,300 acres. Collectively, transportation and residential uses in these eight subwatersheds account for almost half of the land in the watershed.

6.2 Projected Land Use / Build-out Analysis

The future land use in the watershed was modeled for two build-out scenarios. The first considers the maximum development possible if sewering were not provided for the remaining vacant and developable areas of the watershed. Under these conditions, development is constrained by Suffolk County Department of Health Services (SCDHS) regulations that limit development density when on-site wastewater treatment systems are utilized for wastewater disposal. The second scenario assumes public sewering of the remaining vacant and developable areas of the watershed.

Table 6-1. Summary of Land Uses by Subwatershed

(Note: land use is tax-parcel based and thus total parcel acres does not match total watershed area)

Subwatershed	Agriculture		Commercial		Community Services		Industrial		Parks / Conservation		Public Services		Recreation / Entertainment		Residential		Transportation		Vacant		Total	
	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area	Acres	% of area
Lower Forge West									210.6	99.9%					0.0	0.0%	0.2	0.1%			210.8	2.24%
Home Creek			0.7	0.1%	19.3	3.6%			238.1	45.0%			2.6	0.50%	164.3	31.0%	56.3	10.6%	48.2	9.1%	529.5	5.63%
Lons Creek					0.9	0.6%			15.6	11.2%	0.7	0.5%			75.1	54.1%	16.4	11.8%	30.1	21.7%	138.8	1.47%
Mid Forge West			5.0	1.1%	45.5	10.3%					1.4	0.3%			288.3	65.2%	43.8	9.9%	58.0	13.1%	442.0	4.70%
Poospatuck Creek			6.0	0.7%	97.3	11.4%			1.0	0.1%	6.4	0.8%	1.0	0.10%	572.9	67.3%	127.2	14.9%	39.7	4.7%	851.5	9.05%
Wills Creek			56.5	4.6%	3.5	0.3%	0.7	0.1%	4.8	0.4%	18.6	1.5%	0.5	0.00%	610.7	49.3%	451.4	36.5%	91.6	7.4%	1,238.3	13.16%
Upper Forge West			23.4	6.2%	5.7	1.5%			0.9	0.2%	10.4	2.7%			179.0	47.2%	88.8	23.4%	71.2	18.8%	379.4	4.03%
West Mill Pond	182.4	6.5%	31.0	1.1%	258.2	9.2%	5.0	0.2%	92.3	3.3%	79.8	2.8%			642.7	22.9%	386.7	13.8%	1129.6	40.2%	2,807.7	29.83%
East Mill Pond	171.5	22.0%	9.2	1.2%	27.6	3.5%			7.5	1.0%	2.0	0.3%			334.8	43.0%	72.2	9.3%	153.9	19.8%	778.7	8.27%
Upper Forge East			4.4	7.7%	13.3	23.2%			0.6	1.0%	1.6	2.8%			17.2	30.0%	1.7	3.0%	18.6	32.4%	57.4	0.61%
Ely Creek	42.5	2.7%	90.4	5.8%	81.0	5.2%	7.5	0.5%	59.6	3.9%	19.1	1.2%	54.7	3.50%	531.6	34.3%	133.4	8.6%	528.0	34.1%	1,547.8	16.45%
Middle Forge East									17.1	27.4%	1.2	1.9%			35.6	57.1%	3.9	6.3%	4.6	7.4%	62.4	0.66%
Old Neck Creek	0.1	0.0%	12.3	4.0%	36.8	11.9%	1.0	0.3%			7.3	2.4%	3.0	1.00%	153.9	49.8%	34.8	11.3%	59.9	19.4%	309.1	3.28%
Lower Forge East			4.4	7.6%	13.3	23.0%			0.6	1.0%	2.0	3.5%			17.2	29.8%	1.7	2.9%	18.6	32.2%	57.8	0.61%
Totals	396.5	4.2%	243.3	2.6%	602.4	6.4%	14.2	0.2%	648.7	6.9%	150.5	1.6%	61.8	0.7%	3,623.3	38.5%	1,418.5	15.1%	2,252.0	23.9%	9,411.2	100.00%

Not every parcel within the watershed was incorporated into the build-out analysis. Approximately 2,250 of the more than 11,000 total parcels were excluded from the buildout. Of the 2,250 excluded parcels, over 400 are part of housing developments that have their own treatment plant. The duck farms were excluded as the development rights have been purchased. The remaining excluded parcels would not be built-out due to land use constraints including:

- Cemetery
- Utilities (*i.e.* electrical, water supply and flood control)
- Transportation (*i.e.* airport, road, railroad and other right-of-way)
- Municipal (*i.e.* police/fire protection, public golf course and school/school yards)
- Undevelopable (*i.e.* land under water and wetlands)

The SCDHS requires 1.0 acre for the sewage flow from each single-family home (300 gpd) and 0.5 acres for the flow from each Planned Retirement Community (PRC) residential unit (150 gpd). Consequently, for the non-sewered scenario, residential parcels less than 1.0 acre and PRC parcels less than 0.5 acre were not included. Vacant and agricultural parcels within the watershed are zoned residential and were built out based on their zoning and the above SCDHS regulations. The parcels that are part of the Montauk Highway Corridor Study and Land Use Plan for Mastic and Shirley (Figure 6-2) were incorporated into the build-out analysis according to the proposed zoning. Some of the notable changes from the existing conditions are the preservation of vacant parcels for parks, new multi-family zoning, and additional B, C and J6 zoning. The assumptions made in the build-out analysis are shown in Table 6-2 and the results displayed in Table 6-3.

6.3 Land Use Summary

Land use varies significantly across the Forge River watershed. A substantial portion of the southern half of the watershed, particularly in the southwest, is almost entirely built-out. Commercial uses are notably concentrated along the Montauk Highway corridor which runs east to west through the central portion of the watershed. Transportation comprises an important share of the watershed's land use, especially in the central part of the watershed where a significant amount of land is dedicated to the Brookhaven Airport and the right-of-way for State Highway 27. The northern half of the watershed has a generally lower development density. Vacant land and low-density residential uses are prevalent throughout the northern half. Collectively, transportation and residential uses in the eight subwatersheds account for almost half of the land in the watershed.

Figure 6-2. Land Use Plan for Mastic-Shirley

Table 6-2. Build-out Analysis Methodology and Results

Zone	Without Sewers	With Sewers
Residential Vacant Parcels	Add 1 residence per 1 acre (as per SCDHS density requirements). Parcels less than 1 acre remained vacant	Add residences based on the average size of lots that were not vacant. Apply SCDHS sewage generation rate: 300 gpd/home <u>Average Size Lots for each Zone</u> • A 0.68 acres • A1 0.34 acres • A2 2.00 acres • A5 2.50 acres • B 0.34 acres • MF 0.17 acres • PRC 0.17 acres
Commercial Vacant Parcels	Maximum flow based on 300 gpd/acre Land Use was not a factor (Only Density Loads were included)	Determine Maximum Floor Area Ratio as per Zoning, proposed use was based on using average commercial land use from other sewered communities in Suffolk County (average of Lindenhurst and Bay Shore land uses) and apply SCDHS sewage generation rates. Assume 1 use per parcel. • Auto Service/Towing: 2.0 percent 0.04 gpd/sf • Dining: 15.0 percent - 39.5 sf/seat 30.0 gpd/seat • Retail: 14.0 percent 0.03 gpd/sf • Grocery: 5.5 percent 0.05 gpd/sf • Health and Beauty: 16.0 percent 0.10 gpd/sf • Community Services: 5.0 percent 0.03 gpd/sf • Recreation: 1.5 percent 0.1 gpd/sf • Offices: 27.5 percent 0.06 gpd/sf • Medical Offices: 13.5 percent 0.10 gpd/sf
Industrial Vacant Parcels	300 gpd/acre Land Use was not a factor No process water	Determine Maximum Building Area (sf) and apply SCDHS sewage generation rates. • L1: 30 percent 0.04 gpd/sf • L2: 50 percent 0.04 gpd/sf

Table 6-3. Build-out Analysis Results

	Without Sewers	**With Sewers**
Total Flow (gallons per day, gpd)	3,071,913 gpd (3.07 MGD)	3,851,694 gpd (3.85 MGD)
Additional Residential Build-out	968 homes 75 apartments/PRCs	1,737 homes 748 apartments/PRCs
Additional Commercial Build-out	Per Density	• Auto Service/Towing 0 parcels • Dining 6 parcels • Retail 20 parcels • Grocery 7 parcels • Health and Beauty 22 parcels • Community Services 12 parcels • Recreation 0 parcels • Offices 66 parcels • Medical Offices 19 parcels
Additional Industrial Build-out	Per Density	• L1 10,982,959 sf • L2 673,478 sf Total Industrial: 11,656,437sf

7 Land Cover

7.1 Classification Methodology

Land cover has been mapped via spectral analysis and classification of Year 2007 color-infrared imagery for all of the fourteen subwatersheds of the watershed. The source of the color-infrared imagery – for which the spectral classification was conducted – is the New York State Office of Cybersecurity and Critical Infrastructure Coordination. Collected during the winter season (*i.e.*, under leaf-off conditions), the color-infrared imagery is ideal for watershed characterization as impervious surfaces are easily identified and mapped. Broad vegetation classes can also be classified and mapped through the spectral analysis. The land cover classification comprises nine categories as follows:

- *Agriculture/Bare Ground* - This category includes land in agricultural production; this land is regularly cleared and/or left fallow for one growing season and is experiencing or is susceptible to erosion. Also included in this category are areas that are typically non-vegetated due to soil conditions or moderate wear.
- *Coniferous Forest* - This category includes small patches to larger, contiguous areas of needle-leaved, evergreen, and/or cone-bearing trees (*e.g.*, pines, spruces, and firs).
- *Deciduous* Forest - This category includes small patches to larger contiguous areas of trees that shed foliage at end of growing season (*e.g.*, oaks and maples)
- *Developed* - This category includes all manmade, impervious surfaces that shed precipitation (*e.g.*, buildings and paved surfaces) and disturbed areas within urbanized areas that have been heavily compacted.
- Turf - This category includes lawns that are fertilized and mowed by homeowners, businesses, and institutions.
- *Grasslands* - This category includes fields or patches of native grasses and forbs, and lawns that are mowed regularly, but not fertilized.
- *Shrub/Transitional* - This category includes areas that consist primarily of short pine trees and short, woody vegetation that may be intermixed with grass and forbs.
- Wetlands - This category encompasses freshwater and tidal wetlands.
- *Water* - This category includes freshwater bodies.

These classifications were established to support the objectives of this watershed characterization. Impervious areas were mapped in order to estimate stormwater runoff volumes from areas that are piped directly to estuary outfalls. To support the development of potential landscape management strategies (*e.g.*, policies to reduce nitrogen loads), it was useful to quantify and locate lawns that are well-fertilized. Such lawns are readily evident in color-infrared imagery. Locations subject to erosion, which may contribute sediment to the estuary, were also identified by mapping bare ground and areas that are regularly cleared (*e.g.*, agricultural land). The detailed, high-resolution (*i.e.*, utilizing 4-foot pixels) land cover

classification that was conducted for this project contributes essential data for the development of a hydrologic model of the Forge River watershed.

7.2 Land Cover Characteristics and Distribution

The land cover classification is summarized in Table 7-1 at the subwatershed and watershed levels. At the broad watershed level, deciduous forest and clusters of such trees constitute the single largest amount of land cover for a total of approximately 3,985 acres, or 42.2 percent of the total land cover. Conifers are found in patches within the much larger tracts of deciduous trees or as clusters of evergreen landscaping in urbanized areas; conifers account for approximately 903 acres, or 9.6 percent, of the total land cover. In effect, trees (*i.e.*, deciduous and evergreen trees) cover a majority, or 51.8 percent, of the watershed. Impervious surfaces comprise the next largest land cover class, occupying 17.6 percent of the watershed for a total of 1,659 acres. Grassy areas – which are not fertilized or minimally fertilized - account for about 1,374 acres; these comprise primarily swaths along highways and airport medians, low-maintenance lawns in suburban neighborhoods, and natural grasses (though limited as a portion of this land cover class). Only 474 acres, or approximately five percent, of the total land cover are well-fertilized lawns. Bare ground, comprised mostly of agricultural areas, constitutes approximately 627 acres or 6.6 percent of the total land cover. Freshwater and tidal wetlands and freshwater bodies comprise only 173 acres (2.1 percent) and 46 acres (0.5 percent) of the land cover, respectively.

In terms of it relative distribution, land cover varies widely from north to south and east to west across the watershed. The wide variation in land cover within the watershed is evident in Figure 7-1. From a review of Figure 7-1 it is apparent that forested areas, comprising deciduous and evergreen trees and shrub land dominate the northernmost areas of the watershed. The north central portion of the watershed comprises a significant amount of agricultural land, which is essentially bare for a significant portion of the year. The bare ground also includes the duck farms that are just above the northern tip of the Forge River estuary. Large swaths of grassy areas, the largest swaths within the watershed, are located in the central western portion of the watershed along the airport runways. A dense concentration of impervious surfaces is located just east of the airport and is intermixed evenly with lawns and landscaping, including deciduous and evergreen trees. Impervious surfaces are less densely concentrated within the northeast quadrant of the watershed. The well-fertilized greens of the golf course are evident at the central eastern edge of the watershed just north of State Highway 27.

Table 7-1. Land Cover for the Subwatersheds of the Watershed

Subwatershed	Agriculture / Bare Ground		Conifers (Evergreen Forest)		Deciduous Forest		Developed / Impervious		Turf - Fertilized		Shrub / Transitional		Wetlands		Grassland		Water		Totals	
	Acres	% of Area	Acres	% of Area	Acres	% of Area	Acres	% of Area	Acres	% of Area	Acres	% of Area	Acres	% of Area	Acres	% of Area	Acres	% of Area	Acres	% of Area
Lower Forge West	0.5	0.2%	2.9	1.4%	92.2	43.7%	0.2	0.1%	0.1	0.0%	9.6	4.6%	89.0	42.2%	15.8	7.5%	0.6	0.3%	210.9	2.2%
Home Creek	3.9	0.7%	22.5	4.3%	290.4	55.6%	75.8	14.5%	35.7	6.8%	3.4	0.7%	22.1	4.2%	68.3	13.1%			522.1	5.5%
Lons Creek	1.4	1.0%	5.4	4.0%	66.2	48.7%	22.2	16.3%	14.2	10.4%			8.1	6.0%	18.4	13.5%	0.0	0.0%	135.9	1.4%
Mid Forge West	4.1	0.9%	20.3	4.6%	212.4	48.0%	86.0	19.4%	53.6	12.1%			4.5	1.0%	61.7	13.9%	0.0	0.0%	442.6	4.7%
Poospatuck Creek	17.9	2.1%	43.7	5.1%	282.0	33.1%	253.5	29.8%	76.0	8.9%	0.1	0.0%	2.9	0.3%	173.7	20.4%	1.1	0.1%	850.9	9.0%
Wills Creek	25.4	2.0%	75.3	6.1%	408.4	32.9%	410.3	33.0%	50.8	4.1%	3.8	0.3%			268.4	21.6%	0.7	0.1%	1243.1	13.2%
Upper Forge West	13.2	3.5%	22.1	5.8%	142.7	37.5%	120.0	31.5%	12.3	3.2%	0.3	0.1%			69.6	18.3%	0.2	0.1%	380.4	4.0%
West Mill Pond	247.6	8.8%	442.8	15.8%	1303.8	46.4%	254.8	9.1%	56.6	2.0%	161.4	5.8%	2.3	0.1%	317.0	11.3%	20.6	0.7%	2806.9	29.7%
East Mill Pond	154.8	19.9%	66.4	8.5%	301.7	38.7%	101.9	13.1%	23.3	3.0%	1.3	0.2%	1.0	0.1%	117.6	15.1%	11.0	1.4%	779.0	8.3%
Upper Forge East	1.5	2.7%	2.0	3.5%	26.2	46.5%	11.4	20.2%	5.4	9.6%			3.8	6.7%	6.0	10.6%	0.1	0.2%	56.4	0.6%
Ely Creek	129.2	8.3%	169.1	10.9%	717.4	46.1%	231.1	14.9%	85.2	5.5%	7.9	0.5%	16.2	1.0%	188.0	12.1%	11.2	0.7%	1555.3	16.5%
Middle Forge East	1.5	2.4%	2.6	4.1%	18.7	29.6%	9.5	15.0%	5.3	8.4%	1.1	1.7%	16.8	26.6%	7.7	12.2%			63.2	0.7%
Old Neck Creek	22.9	7.4%	21.9	7.1%	86.2	27.8%	69.8	22.5%	47.0	15.1%	5.7	1.8%	6.0	1.9%	50.2	16.2%	0.6	0.2%	310.3	3.3%
Lower Forge East	3.2	3.9%	5.5	6.6%	36.6	44.0%	12.3	14.8%	8.8	10.6%	4.0	4.8%	0.6	0.7%	12.1	14.6%			83.1	0.9%
Totals	627.1	6.6%	902.5	9.6%	3984.9	42.2%	1658.8	17.6%	474.3	5.0%	198.6	2.1%	173.3	1.8%	1374.5	14.6%	46.1	0.5%	9440.1	100.0%

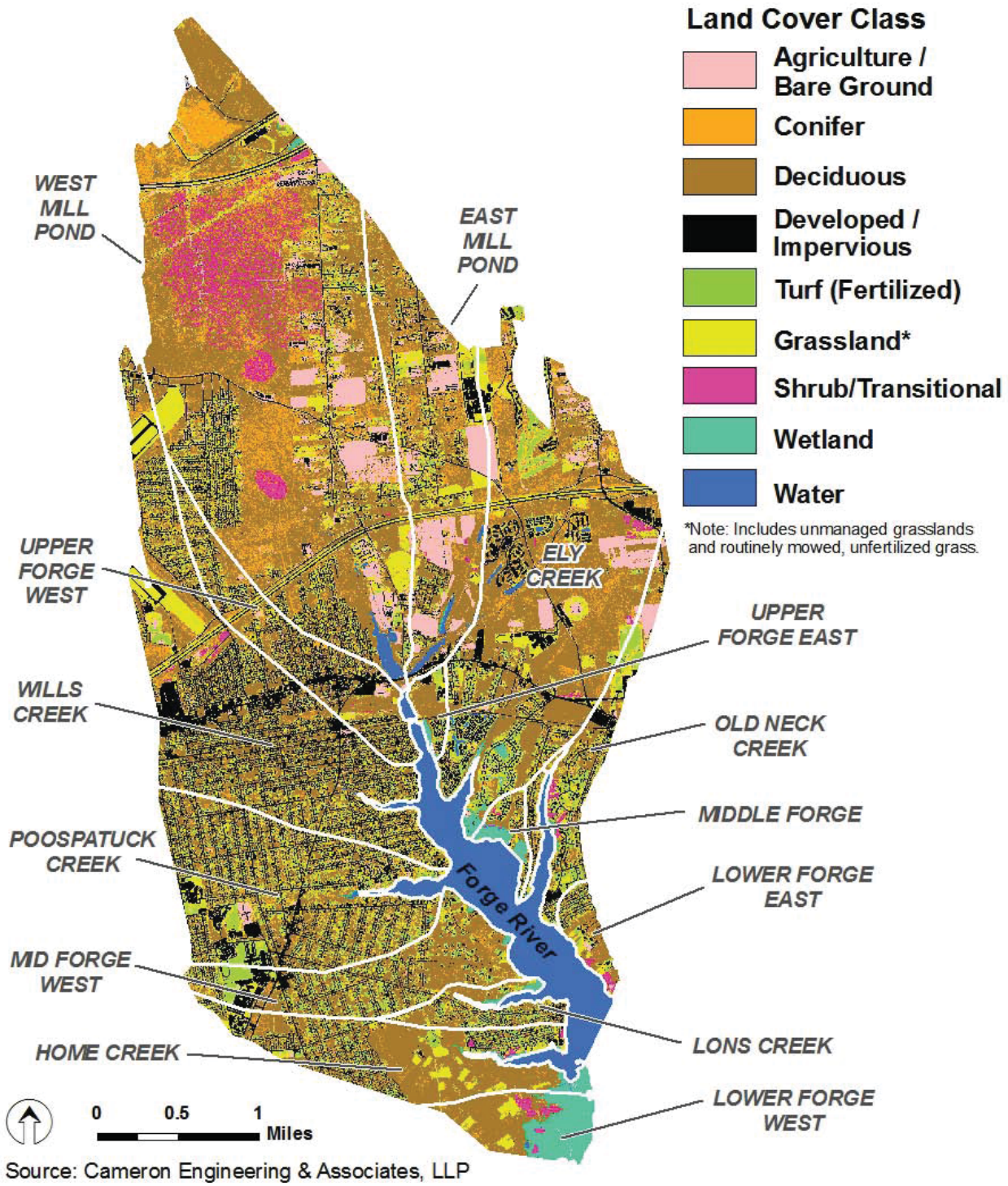
The land cover in the southern half of the watershed is markedly different from that of its northern counterpart. For example, impervious surfaces, including structures, roadways and parking areas, comprise a significant share of the southern half of the watershed, especially on the west side of the estuary. Within the Upper Forge West, Wills Creek, and Poospatuck Creek subwatersheds, impervious surfaces account for approximately 31.5, 33.0, and 29.8 percent of the land cover, respectively. Well-fertilized swaths of lawns and large impervious surfaces are found at the eastern edges of Wills Creek subwatershed (along Montauk Highway), Middle Forge West, and Poospatuck subwatersheds. Impervious surfaces are present within the subwatersheds on the eastern side of the estuary, though in lesser amounts than in the subwatersheds on the opposite side of the estuary. Impervious surfaces comprise 20.2, 14.9, 15.0, and 14.8 percent of the Upper Forge East, Ely Creek, Middle Forge East, and Lower Forge East subwatersheds. With approximately 887 acres of deciduous and evergreen trees, Ely Creek subwatershed is more than half, or 57 percent, forested; Upper Forge East and Lower Forge East subwatershed are approximately half forested. Within the southern half of the watershed, it is interesting to note that unfertilized (or minimally fertilized) lawns are approximately 1.5 times more prevalent than well-fertilized lawns. The southern half of the watershed includes almost all (98 percent) of the 173 acres of wetlands within the watershed.

7.3 Land Cover Summary

Forest covers more than half of the watershed (51.8 percent). Impervious surfaces comprise the next largest land cover class, occupying 17.6 percent of the watershed (1,659 acres). Grassy areas – which are not fertilized or minimally fertilized - account for about 1,374 acres. Bare ground, comprised mostly of agricultural areas, constitutes approximately 627 acres or 6.6 percent of the total land cover. Freshwater and tidal wetlands and freshwater bodies comprise only 173 acres (2.1 percent) and 46 acres (0.5 percent) of the land cover, respectively.

Forested areas, comprising deciduous and evergreen trees and shrub land, dominate the northernmost areas of the watershed. There is a large amount of agricultural land in the north central portion of the watershed, which is essentially bare for a significant portion of the year. Large swaths of grassy areas are located in the central western portion of the watershed along the airport runways. A dense concentration of impervious surfaces is located just east of the airport and is intermixed evenly with lawns and landscaping. Impervious surfaces are less densely concentrated within the northeast quadrant of the watershed.

Figure 7-1. Land Cover of the Fourteen Forge River Subwatersheds



Source: Cameron Engineering & Associates, LLP

8 Socioeconomics

8.1 Population

The Year 2010 population of the Forge River watershed, as provided in Table 8-1 below, is estimated at 31,130 persons. This estimate is based upon an annualized growth factor that was applied to the Year 2000 Census Block-level population counts (Census, 2000). The annualized growth factor was derived from a population survey prepared by the Long Island Power Authority (LIPA, 2006). According to this methodology, the population of the watershed is estimated to have grown by 4,782 persons, or approximately 18 percent, from Year 2000 to 2010. Figure 8-1 provides a population density map of the watershed for Year 2010.

Table 8-1. Population for Years 2000 and 2010 and Build-out Scenarios

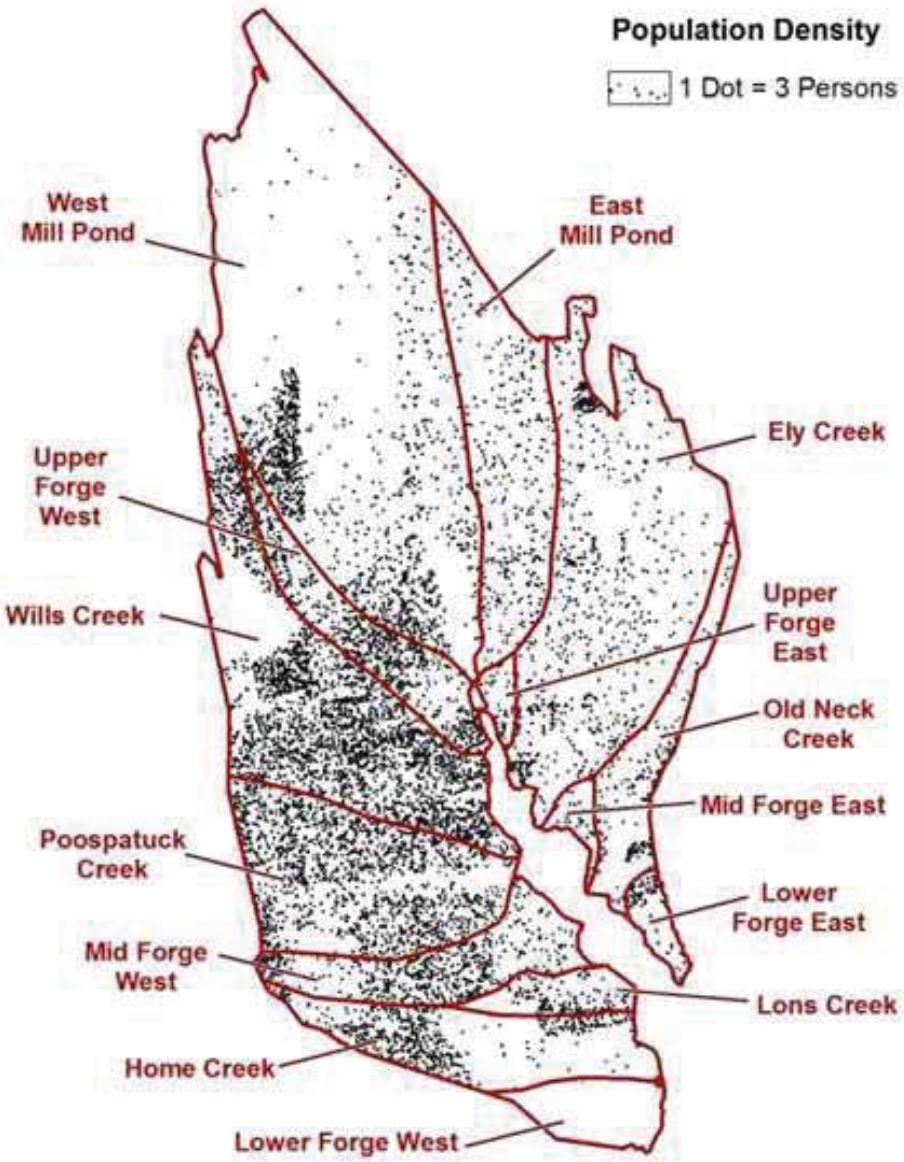
Name	2000 Population[1]	2010 Population[2]	Build-Out Population without Sewers[3]	Percent Change (2010 to Build-out)	Build-Out Population without Sewer[4]	Percent Change (2010 to Build-Out)
East Mill Pond	1,017	1,383	2,000	44.6%	2,058	48.8%
Ely Creek	2,252	3,020	3,966	31.3%	5,344	77.0%
Home Creek	1,681	1,909	1,939	1.6%	2,035	6.6%
Lons Creek	449	515	544	5.6%	573	11.3%
Lower Forge East	223	253	323	27.7%	495	95.7%
Lower Forge West	0	0	0	0.0%	0	0.0%
Mid Forge East	79	109	115	5.5%	138	26.6%
Mid Forge West	1,837	2,101	2,155	2.6%	2,189	4.2%
Old Neck Creek	650	764	901	17.9%	1,259	64.8%
Poospatuck Creek	4,621	5,329	5,338	0.2%	5,445	2.2%
Upper Forge East	155	215	227	5.6%	215	0.0%
Upper Forge West	2,225	2,561	2,591	1.2%	2,847	11.2%
West Mill Pond	3,463	4,135	5,123	23.9%	5,839	41.2%
Wills Creek	7,696	8,836	8,842	0.1%	9,102	3.0%
Total	**26,348**	**31,130**	**34,064**	**9.4%**	**37,539**	**20.6%**

Note 1: US Census
Note 2: Based upon growth rates derived from LIPA population survey.
Note 3: Build-out according to density limits per Suffolk County Health Department regulations.
Note 4: Build-out according to density permitted by Town of Brookhaven zoning.

The future population of the watershed was modeled for two build-out scenarios. The first build-out scenario considers the maximum amount of development that may be accommodated if sewering is not provided for the remaining vacant, developable areas of the watershed. Under these conditions, development is constrained by Suffolk County Department of Health regulations that limit development density when on-site systems are utilized for wastewater disposal. The second scenario assumes sewering of the remaining vacant, developable areas of the watershed. This buildout for sewering assumes that a

treatment plant would be in place to receive and treat the wastewater to specified SPDES permit levels. The development of build-out scenarios is discussed in detail in Section 6.2.

Figure 8-1. Population Density Map for Year 2010



Source: LIPA 2000-2006 growth rate applied to Block-level US 2000 Census.

Table 8-1 provides a summary of population projections for the two build-out scenarios by subwatershed. The potential future population for a build-out without sewering is estimated at 34,064 persons; this is a potential growth rate of 9.4 percent above the Year 2010 population. If future developments within the watershed were provided with sewering, the watershed population would grow by an estimated 20.6 percent from Year 2010 levels for a total population of 37,539 persons.

The growth, under either build-out scenario, would be greatest in the northern and eastern portions of the watershed. The East Mill Pond, Ely Creek, Lower Forge East, Old Neck Creek, and West Mill Pond subwatersheds could ultimately grow by approximately 44.6, 31.3, 27.7, 17.9, and 23.9 percent, respectively, for the unsewered build-out condition and by 48.8, 77.0, 95.7, 64.8, and 41.2 percent, respectively for the sewered build-out condition. The remaining subwatersheds, including Home Creek, Mid Forge East and West, Poospatuck Creek, and Wills Creek, are mostly built-out. They would sustain significantly less new development under both build-out scenarios.

8.2 Income

Median household income, which is a key indicator of socioeconomic conditions, is provided in Table 8-2 from values extracted from the Year 2000 Census data files. Although surveyed a decade ago, it is likely that the relative income variations surveyed in Year 2000 among the watershed communities are likely extant currently. The median household income is listed for places that are wholly (*e.g.*, Mastic and Moriches) and partially (*i.e.*, Shirley, Mastic Beach, Manorville and Center Moriches) within the watershed. In addition, Table 8-2 shows the median income values for the Town of Brookhaven and Suffolk County for the purposes of comparison.

Table 8-2. Median Household Income (Source: Year 2000 US Census).

Municipality/Area	Median Household Income
Suffolk County	$84,767
Town of Brookhaven	$73,556
Manorville	$84,319
Moriches	$63,672
Center Moriches	$61,957
Shirley	$57,294
Mastic Beach	$44,937
Mastic	$43,657

Table 8-2 reveals a wide variation in incomes across the communities of the watershed. In 2000, median household income varied from $43,657 in Mastic to $84,319 in Manorville. Except for Manorville, median household incomes for all other communities of the watershed were below that of the Town of Brookhaven ($73,556) and Suffolk County ($84,767). Most of the population of the watershed resides within Mastic, Mastic Beach and, to a lesser degree, Moriches. Thus, the median household income for the watershed is approximately within a range of $45,000 to $60,000, or significantly below the Town and County values.

8.3 Economic Impacts

Healthy productive estuaries provide a number of goods and services that are valuable to society. Finfish and shellfish may be harvested from estuaries for both recreational and commercial purposes. Boating and hiking are also popular recreational pursuits, especially in healthy estuaries that support diverse flora and fauna. Property values have also been shown to be dependent upon environmental quality (Kildow, 2008).

Because the Forge River is an unhealthy estuary, this section considers the loss of economic value, or potential value, from poor water quality. Alternatively, lost economic value may be considered as benefits that may be reclaimed through investments in ecological restoration. Two significant and readily quantifiable economic impacts are considered: loss of housing value and loss of recreational fishing potential. It is noted that the economic potential of commercial fishing was considered but discounted as unrealistic given the current characteristics and realities of the commercial fishing industry on Long Island.

8.3.1 Housing Values

This analysis considers the loss of value to homes located along the shorelines of the estuary as a result of poor water quality in the Forge River and its tributary creeks.

It is readily acknowledged that waterfront property commands a higher price than properties that are internal to a watershed. An analysis of the assessed value of properties within and adjacent to the study area confirms this widely held expectation. For example, the value of waterfront properties in or within the vicinity of the Forge River watershed are, on average, 30 percent higher in assessed value than comparable non-waterfront properties. For this analysis, the waterfront and non-waterfront properties were equivalent in acreage; non-waterfront properties in this analysis did not include any waterfront improvements (*e.g.*, docks). The 30 percent difference was determined through an analysis of assessed values – stored with a GIS database – that were provided by the Tax Assessor's Office, Town of Brookhaven.

Recalling Kildow's (2008) demonstration of the environmental quality factor in property values, it is likely that waterfront values within the Forge River watershed are negatively affected by the poor water quality in the Forge River, in particular, during hypoxic conditions that occur from late Spring through early Fall. However, there were no peer-reviewed economics studies to be found that could be employed as an analog for housing value impacts vis-à-vis poor water quality. Moreover, an investigation of the key factors that drive housing values within the watershed is beyond the scope of this study. Thus, a simple model of waterfront housing value impacts is presented for consideration.

An estimation of the impacts to waterfront housing value considers the loss of utility of a property during the time periods when hypoxic conditions occur. Hypoxic conditions generate foul and unpleasant odors that impair or preclude the use of the outdoor setting (*e.g.*, backyard) around a waterfront property. Home sales are also likely to be negatively affected during hypoxic conditions. Given that hypoxic conditions persist during the late Spring to early Fall, there is an approximate four-month time period during which the enjoyment and utility of a waterfront property would be impaired. For this analysis, it is conservatively assumed that hypoxic conditions occur for about one week during each of the four months in this time period, inducing approximately 30 days of air quality impacts. (Note: Hypoxic conditions can be much more extensive, occurring frequently throughout the summer months.)

Next, for the purposes of this property impacts estimate, property value is equated with the number of days in a year (*i.e.*, 365 days) for which a household extracts value from owning a waterfront residence. Thus, each day in a year represents 1/365 of the value of the home. If it is assumed that hypoxic conditions detract half of the daily value of the home, then the loss of property value from all hypoxic conditions is equal to 15/365 (0.041 or 4.1 percent) of the total home value. This is expressed mathematically as follows: 30 days x 1/365 x Market Value x 50 percent. Since the total market value of all waterfront properties within the watershed is $140 million, the loss property value from hypoxic conditions is approximately $5,750,000 (*i.e.*, 15/365 x $140,000,000). (Note: Assessed value is converted to market value via a conversion factor employed by the Brookhaven tax assessor's office.)

Although the analysis above is simple, there is some support – albeit circumstantial – for the estimate of losses in waterfront property value along the Forge River when considering home values in nearby estuaries that are not impaired by hypoxic conditions. In effect, the average assessed values for comparable waterfront properties along other estuaries in the vicinity of the Forge River are approximately six percent higher than waterfront properties along the Forge River. Although there is no evidence to substantiate a causal link between the observed difference in waterfront values between the Forge River and other estuaries, it is interesting to note that the observed six percent difference is similar to the 4.1 percent loss of waterfront property values as a result of recurrent hypoxic conditions. A much more sophisticated model of waterfront housing value, incorporating a variety of factors (*e.g.*, quality of schools, crime incidence, proximity to employment centers, etc.) in addition to environmental quality, would be required to better model waterfront housing values in the Forge River and vicinity.

8.3.2 Recreational Fishing

Local economies benefit from spending by recreational fishing. In fact, environmental economists have estimated the value of fishing trips to local economies for many parts of the United States. These estimates vary widely depending upon the location. For example, for California (Huppert & Thompson, 1984), researchers estimated per-person daily fishing trip expenditures at $33.54 while Wegge *et. al.* (Wegge, Carson, & Hanemann, 1988) calculated a comparable rate of $44.33. Downing and Ozuna (Downing & Ozuna, 1996) estimated average daily per-person fishing trip expenditures as high as $171.11 for Texas. A daily rate of $46.54 was inferred for Wisconsin (Bishop, Milliman, Boyle, & Johnson, 1990).

Fishing opportunities are extremely limited within the Forge River estuary. However, if conditions were improved, fishing trips to the estuary could increase. Such trips would comprise non-chartered fishing outings by local residents (*i.e.*, those within a short driving distance - less than five miles on average) to the Forge River. Assuming an increase of 25 person-trips per day for six months of the year and utilizing Bishop's daily expenditure adjusted by three percent per year for inflation to approximately $80 per trip, unrealized fishing trip expenditures to the Forge River could potentially account for approximately $360,000 annually to the local economy. It is important to note that this estimate is an order-of-magnitude approximation based upon reasonable expectations. A formal survey could more accurately gauge potential trips to a restored Forge River estuary and the average expenditures per person-trip.

8.3.3 Economic Impact Summary

Based on the analysis presented in Section 6.3.1 and 6.3.2 above, the economic losses to waterfront housing value and recreational fishing from the poor water quality of the Forge River are significant.

Table 8-3. Summary of Economic Impacts/Unrealized Potential

Economic Impact Type	Estimated Cost
Loss in Waterfront Property Value	$5,750,000
Annual Loss in Recreational Fishing Expenditures	$360,000

It is important to note that this analysis is limited to only two economic impacts. Other economic impacts, such as those associated with living within the vicinity of a degraded waterbody, may also be significant. For example, poor air quality during the summer months – caused by anoxic conditions in the Forge River – impairs not only the housing value, but also the quality of life of residents, particularly those near the shoreline. Air quality impacts are likely to lower home values, which, in turn, will reduce assessed value

and property taxes collected by the Town of Brookhaven. There are also "intangible" costs that can include the perceived loss of civic pride or community character and a heightened sense of environmental concern. Such intangibles are often difficult to quantify, but are arguably real. The estimation of economic losses from intangibles (*i.e.*, quality of life, mental health, community character, etc.) are beyond the scope of this project, but may well exceed the economic losses to waterfront homes and recreational fishing as discussed above.

9 Living Aquatic Resources

9.1 Key Aquatic Habitats

9.1.1 Reconnaissance

A land reconnaissance of Forge River riparian areas was conducted in mid-August of 2010. Access by boat to the creeks and open water of the Forge River was generously provided by Mr. Ron Lupski in mid-August. The land based reconnaissance included areas primarily in the western portion of the estuary where there was greater access to the water's edge. East and West Mill Ponds were accessed on foot from Barnes Road and Montauk Highway. The wetland area north and west of the West Mill Pond was accessed on foot via Lafayette Avenue through a publically owned parcel. The intertidal area north of the railroad trestle was accessed from the north (off Montauk Highway) and the south from the trestle itself via the northern end of Riviera Drive.

The northwestern portion of the Forge River shoreline was observed from Riviera Drive as was the northern shore of Mill Creek. The heads of Mill Creek and Poospatuck Creek were visited on foot via Mastic Road. All creeks were visited by boat with geographic and historic guidance from Mr. Lupski. The head of the Forge River by the trestle was visited by boat as was the mouth and central spine of the estuary.

Aerials (shot in both summer and winter) of the areas that were inaccessible by land were examined to determine the dominant vegetation types. Topographic maps were examined for additional information about these areas such as the presence of berms, the extent of tidal inundation and the presence of small tributary creeks. Aerial maps were also used to identify potential impairments based on obvious land uses and disturbances. A series of aquatic habitat maps prepared based on field observations and mapping work is found in Appendix A.

9.1.2 East and West Mill Ponds

A reconnaissance of West and East Mill Ponds was conducted in mid-August of 2010 from several accessible vantage points (Figure 9-1). The southern (discharge) ends of both ponds are visible from Montauk Highway (County Road 80). Both ponds are surrounded by dense vegetation. Most of the surrounding areas are forested, particularly the West Mill Pond. Rooted aquatic vegetation was not visible. Approximately half of the water surface of East Mill Pond was covered with floating algal mats and duckweed (Figure 9-1). The water in the West Mill Pond was greenish brown, suggesting a phytoplankton bloom in progress.

Each pond discharges through a culvert under Montauk Highway and into the head of the Forge River north of the railroad trestle.

Figure 9-1. Algae on East Mill Pond and Greenish-brown West Mill Pond Discharge

According to SoMAS researchers (Swanson, Brownawell, Wilson, & O'Connell, 2010), the major sources of surface discharge to the Forge River are the East and West Mill Ponds. They estimated that the ponds contribute approximately 80 percent of the total surface water runoff to the Forge River and 83 percent of the total surface flow north of Poospatuck Creek. The School of Marine and Atmospheric Sciences (SoMAS) recorded the flow from East and West Mill Ponds in January 2007 at 0.96 million cubic feet/day (cubic feet per day) (Wilson, Swanson, Brownawell, Flood, & Gobler, 2009). Additional measurements using a flow meter at the discharge of East and West Mill Ponds in January 2007 by SoMAS found the flow to be 1.31×10^6 cubic feet /day.

The SoMAS researchers found that the flow from the West Mill Pond is 72 percent of the total flow from the ponds. They also reported that flows from the other streams of the Forge River represent only about 20 percent of the flow from the ponds. SoMAS also calculated groundwater flow and estimated that it represented 62 percent of the total freshwater input to the Forge River.

The ponds flow was measured by Redfield in 1947-1948 (Redfield, 1952). He reported a flow from the ponds of 763,000 cubic feet/day, just over half of the flow measured by SoMAS. It is possible that the difference is new residential and commercial public water use since 1948, which is drawn from deep aquifers.

<u>East Mill Pond Impairments</u> - The most obvious impairment to the East Mill Pond is nutrient input, given the extensive coverage by algal mats and duckweed. Nutrients flow to the East Mill Pond from up gradient agricultural fields to the north and area septic systems (some of which are immediately adjacent to the pond).

<u>West Mill Pond Impairments</u> - The drainage and treatment lagoon discharge from the duck farms is the primary impairment of the West Mill Pond. According to research by SoMAS

and confirmation by the Cameron Engineering Team, nutrient input from the duck farms far exceeds that of stormwater. Although there is residential development to the west of West Mill Pond, its nutrient contribution may be mitigated by several factors: lots are relatively large, depth to groundwater is several tens of feet, and an undeveloped buffer surrounds the western side of the pond. High nutrient input can lead to algal blooms (Figure 9-2).

Figure 9-2. Water Clarity and Color in West and East Mill Ponds Suggests Algal Bloom in West Mill Pond

9.1.3 Wetland North of West Mill Pond

There is an extensive freshwater wetland north of the West Mill Pond (Figure 9-3). Relatively dense understory vegetation is present under a forested canopy. Considerable flow was observed from the wetland south to the West Mill Pond. Rooted aquatic vegetation was observed in the open water of the wetland over a sandy bottom and clear water. *Phragmites* was present along the eastern edge of the wetland adjoining the stream channel and opposite the duck farms.

The wetland is directly west of the duck farms. However, the discharge from the duck farms flows directly into the West Mill Pond. Stormwater runoff from the farms could flow toward the wetland, but likely flows in a southerly direction toward West Mill Pond.

Figure 9-3. Wetland North of West Mill Pond

Freshwater Wetland Impairments - Potential impairments to this freshwater wetland include the presence and potential spread of the invasive reed, *Phragmites*, and the impact of untreated and nutrient-rich stormwater runoff from the duck farms to the east.

9.1.4 Head of Forge River - Montauk Highway to the Railroad Trestle

The Forge River north of the railroad trestle and south of Montauk Highway is surrounded by large tracts of *Phragmites* (Figure 9-4). The discharges from the Mill Ponds enter the Forge River through two large culverts under Montauk Highway (see Figure 9-5). There is a large swath of *Phragmites* spanning most of the width of the river less than 100 feet south of the discharges (Figure 9-6). This peninsula and the mudflats south of it represent years of sediment accumulation deposited primarily from the West Mill Pond discharge. The presence of this deposit has also allowed the adjacent upland to grow into the river. This large deposit is likely due to the deposition of organic material (*e.g.*, algal mats, leaf fall, and wetland detritus) from the East and West Mill Ponds and inorganic materials (*e.g.*, sand and grit) from Montauk Highway stormwater runoff. SoMAS researchers (Brownawell, Wang, Ruggieri, Sanudo-Wilhelmy, & Swanson, 2009) found significant quantities of organic detritus (*e.g.*, leaf fall, aquatic plant material) in East Mill Pond sediments, but not in West Mill Pond sediments. In contrast, West Mill Pond sediments were highly enriched with organics in the form of decaying algal mats and single-celled algal blooms. Note the color difference between the East and West Mill Ponds in the aerial photograph (Figure 9-2). It suggests that even when this photo was taken (*i.e.*, in the fall or winter) an algal bloom may have been in progress. Both East Mill Pond detritus and West Mill Pond algal material is discharged to the tidal portion of the Forge River where it accumulates just south of Montauk Highway.

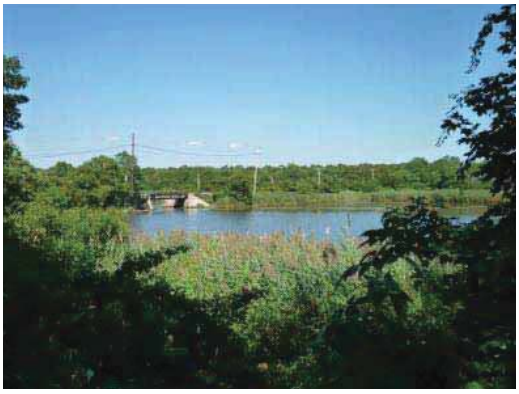
According to SoMAS researchers (Wilson, Swanson, Brownawell, Flood, & Gobler, 2009), tidal exchange in this portion of the Forge River is restricted by the railroad trestle. They suggest that freshwater is temporarily impounded during low tides by sediments accumulated under and just downstream of the railroad trestle.

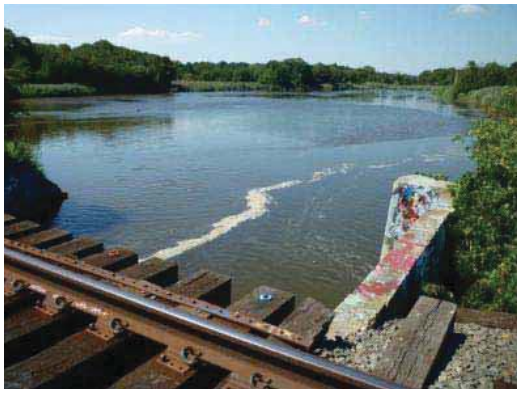
Suffolk County measurements reported by Wilson indicate that the area is brackish with highly variable salinities. Four measurements in this area between 2005 and 2006 showed salinity varying between 7.8 and 19.8 practical salinity units (psu). The lower measurement was during low water and the higher reading near a spring high tide.

Stormwater runoff to this portion of the Forge River from the eastern and western land uses flow overland and via Swift Creek, respectively. A large greenhouse production facility is located to the east of the Forge River; its stormwater, nutrient, or other contaminant contribution, if any, to the Forge River is unknown. Substantial forested areas along Swift Creek and on the east side of the Forge River in this area buffer the estuary somewhat from the effects of stormwater runoff, though some sediment deposits are evident downstream of the mouth of Swift Creek (See Section 7.1.6 below).

Circulation in this portion of the tidal Forge River is restricted by the deposits accumulated just downstream of the East and West Mill Pond discharges. Circulation is also restricted by the sediment accumulated near the railroad trestle. Poor circulation has created a waterbody with wide swings in salinity. The brackish conditions and disturbances have made conditions suitable for the growth of *Phragmites*.

Figure 9-4. Tidal Portion of the Forge River South of the Railroad Trestle





<u>Head of Forge River Impairments</u> – This area is not technically the 'head' of the river, but it is the furthest north that tides exert an influence. The area experiences a wide salinity range and receives the largest input of freshwater to the Forge River. The freshwater input, however, carries with it the largest single input of nitrogen to the system from the duck farm. Organic-rich particulate material (*e.g.*, leaf fall and other detritus, algal mats, and decaying algal blooms) flows from the East and West Mill Ponds into the Forge River. A major suspended solids load also enters the Forge River here as evidenced by the substantial deposits accumulated over the years. *Phragmites* growth dominates a large portion of the shoreline.

Figure 9-5. Discharges from the West and East Mill Ponds into the Forge River South of Montauk Highway

Figure 9-6. View South from West Mill Pond Discharge

9.1.5 Swift Creek

Swift Creek discharges into the western side of the upper portion of the Forge River just south of Montauk Highway (Figure 9-7). A plume is visible in the aerial that reveals silt and sediment-laden stormwater discharges from the mouth of Swift Creek to the middle of the Forge River. A reconnaissance of the area reveals a nursery between the creek and Montauk Highway along with a large shopping center parking lot (see aerial below). Both could be contributing to stormwater flow from Swift Creek. In fact, the presence of *Phragmites* at the creek mouth is typical of stormwater influenced creek systems (Figure 9-6). Swift Creek is not designated as a separate subwatershed or creek system as its contributing area is small and it has a minimal and intermittent surface water flow and virtually no tidal exchange. It is part of the Upper Forge West subwatershed.

Swift Creek Impairments – Stormwater runoff and associated erosion and sedimentation from Swift Creek contribute to Forge River impairment. The sediment plume that extends into this portion of the Forge River reduces circulation and provides substrate for the growth of *Phragmites.*

Figure 9-7. Swift Creek Discharges into the Forge Depositing Sediments and Associated Contaminants

9.1.6 Forge River - Railroad Trestle to Moriches Bay

The main body of the Forge River from the railroad trestle south to its mouth at Moriches Bay is relatively shallow with a dredged channel straight down the center of the water body. The adjacent upland along the upper reaches of the Forge River is developed. There are marinas on both the east and west sides of the estuary. The vegetated buffer along the eastern shore is wider than that along the western shore of the Forge River. There is a relatively large wetland on the eastern shore between Ely Creek and Old Neck Creek in the Middle Forge East subwatershed.

The eastern half of the Middle Forge West subwatershed is sparsely developed and heavily wooded near the shoreline. Relatively large tidal wetlands border the western shore of the Forge River between Poospatuck and Lons Creeks (Figure 9-8). There is little natural area remaining along the shoreline between Lons and Home Creeks, a reflection of relatively dense upland development.

The largest tidal wetland of the Forge River estuary is found on the western shore; it is situated south of Home Creek to the mouth of the estuary at Moriches Bay. The upper half of the eastern shore, south of Old Neck Creek, is bulkheaded. The southern half of the eastern shoreline, from the bulkheads to the mouth of the estuary, is sandy beach.

Figure 9-8. Tidal wetlands between Poospatuck and Lons Creeks

Forge River - Railroad Trestle to Moriches Bay Impairments – The main body of the Forge River has experienced shoreline hardening, loss of tidal wetlands, organic deposition, and anoxic sediment accumulation.

9.1.7 Forge River Creeks – Wills Creek

Wills Creek is a relatively narrow and short tributary of the Forge River (Figure 9-9). Most of its southern shore is heavily hardened with bulkheads and its northern shore, though 'natural,' is a very narrow strip of land between Riviera Drive and the water (Figure 9-10). There are homes at all but one of the properties on the southern shore, and in many cases, these homes have lawns that end at the water's edge.

There is a small vegetated wetland at the head of Wills Creek with small forested areas on both sides. A creek flows through a wetland from a pond on the west side of Poospatuck Lane. The pond is just downstream of an unimproved parking area that appears to be built on fill.

Large volumes of stormwater reportedly flow down both Mastic Road and Poospatuck Lane into the area upstream of the Wills Creek headwaters. As the creek and its headwaters lie in a slight valley, it is expected that stormwater would flow down here toward the creek.

There are numerous narrow patches of *Phragmites* that line the northern shore of Wills Creek and very few areas of vegetated tidal wetland (Figure 9-10).

Figure 9-9. Wills Creek Headwaters – Note the pond on the West Side of Poospatuck Lane

Figure 9-10. Sandy Shore and Phragmites at Wills Creek with Spartina at Mouth

<u>Impairments to Wills Creek</u> – Wills Creek has very little if any tidal vegetation along its southern and northern banks. Erosion of its northern banks is a problem; runoff across the turfgrass lawns of its southern shores may contribute nutrients and pesticides to the waterbody. There is little natural shoreline along its southern shore to intercept runoff or provide aquatic habitat. Stormwater runoff from the roadways to the west finds its way into headwaters of the creek with only minimal treatment by the pond and a small wetland at the creek's western end. A shallow sediment sill extends across much of the creek mouth that restricts tidal flushing.

9.1.8 Forge River Creeks – Poospatuck Creek

Poospatuck Creek is wider toward its mouth than Wills Creek, though, it too has a sill at its mouth that partially restricts tidal flow into the creek (Figure 9-11). Its southern shore is primarily a natural shoreline, with few bulkheads. The condition of the northern shoreline is varied, most of which forms the southern boundary of the 55-acre Poospatuck

Reservation of the Unkechaug Indian Nation. Although only small parts of it are bulkheaded, some properties are cleared to the waterline. A large construction and demolition disposal area occupies most of one of the properties (Figure 9-11).

Figure 9-11. View East from Poospatuck Creek and C&D Deposits and Phragmites on North Side

There is a substantial creek blockage at its head where a deposit, covered with *Phragmites*, stretches almost fully across the creek (Figure 9-12). The headwaters of the creek begin near Mastic Road and travel through a rather long and heavily wooded area approximately 1/3 as long as the creek itself. The wooded area provides a buffer along this portion of the creek (Figure 9-12). Stormwater enters the creek untreated from Mastic Road.

Figure 9-12. Head of Poospatuck Creek – Note Obstruction to the East and Sediment Plume.

<u>Impairments to Poospatuck Creek</u> – Though less bulkheaded than Wills Creek, tidal wetlands are in short supply along the banks of Poospatuck Creek. There is evidence of sediment laden stormwater flow into the creek from the west.

9.1.9 Forge River Creeks – Lons Creek

The Lons Creek shoreline remains primarily natural; there is little hardened shoreline and most of the shores have well-vegetated banks (Figure 9-13). Substantial tidal wetland vegetation is present along its northern shoreline, which benefits from a large, relatively undeveloped, and heavily wooded area to the north (Figure 9-14). The central part of the creek is lined along the northern shore by *Phragmites*. The headwaters of the creek originate in a wooded area that is contiguous with the undeveloped area along the creek's northern shore. The creek's southern shore is developed, but much of the shoreline remains relatively natural. Only a few of the properties along the southern shoreline area bulkheaded, while the majority retain a vegetated buffer.

Impairments to Lons Creek –Lons Creek has a substantial tract of tidal wetland along its northern shore. The northern shore – which supports several large-lot (*i.e.*, 2-acre and greater) residences – is less densely populated than the medium-density residential areas along the southern shore. There are no significant impairments to the Creek.

Figure 9-13. Phragmites and Tidal Wetland Vegetation on North Side of Lons Creek

Figure 9-14. Tidal Wetlands along the Northern Shore of Lons Creek Bordered by Woodlands

9.1.10 Forge River Creeks – Ely Creek

Ely Creek lies along the southern shores of the Waterways Condominiums development. It is a very shallow creek, having experienced no real dredging in its recent history. Mudflats are found less than 1,000 feet inside the creek. Its shorelines are heavily vegetated, providing a natural buffer along its entire length; no bulkheading is present. Most of its northern shore, from just below the headwaters to the extent of the tidal reach, is lined with a wide swath of *Phragmites* (Figure 9-15). The southern shore is wooded along most of its length. The headwaters originate from a wooded area to the north.

Impairments to Ely Creek – Ely Creek's primary impairments are its shallow water depth and associated poor circulation. Its muddy substrate is not likely support intertidal vegetation or benthic organisms. A substantial swath of *Phragmites* along the northern shore of Ely Creek precludes the growth of other tidal wetland vegetation.

Figure 9-15. Extensive Stands of Phragmites along the Northern Shore of Ely Creek

9.1.11 Forge River Creeks – Old Neck Creek

Old Neck Creek is the longest and widest tributary creek of the Forge River. It is characterized by dense residential development on its western (or northern) shore and larger-lot residential development on its eastern (or southern) shore (Figure 9-16 and Figure 9-17). The western shore is hardened (*i.e.*, bulkheaded) for almost its entire length, whereas the eastern shore has a natural shoreline populated almost exclusively by *Phragmites* (Figure 9-16). There is virtually no natural buffer between development on the western shore and the creek and no tidal wetland vegetation.

Impairments to Old Neck Creek – Old Neck Creek has some of the same impairments as the other creek, *i.e.*, shoreline hardening and *Phragmites* growth. Minimal non-invasive tidal vegetation is present to provide habitat and nutrient reduction.

Figure 9-16. Old Neck Creek – Note Phragmites on South Side and Low-lying Homes on North Side

Figure 9-17. Small Lots, Bulkheading, and Phragmites along Shores of Old Neck Creek

9.1.12 Forge River Creeks - Home Creek

Home Creek is unusual relative to the other tributary creeks. Its southern upland contributing area (Figure 9-18 and Figure 9-19) is completed undeveloped and mostly wooded. Large portions of the southern upland area near the mouth of the creek are extensive tidal wetland. The head of the creek is also undeveloped and wooded. Its

northern shore is developed, though approximately half of the shoreline remains 'natural.' A significant portion of the northern shoreline is bulkheaded near the mouth of the creek. There is a *Spartina* marsh along portions of the northern shore in the middle portion of the creek. *Phragmites* has invaded the head of the creek and portions of the northern shoreline in the middle of the creek. The homes north of the creek are at low elevations as are their on-site wastewater systems thus posing the potential for wastewater discharge to be in close proximity to groundwater.

Impairments to Home Creek – Shoreline hardening, *Phragmites* and low-elevation on-site wastewater treatment systems are the primary impairments to Home Creek.

Figure 9-18. Undeveloped area along Home Creek

Figure 9-19. Tidal wetland adjacent to Home Creek

9.2 Forge River Marine Organisms

9.2.1 Background

The Forge River has been highly polluted since at least the 1950s when the Woods Hole Oceanographic Institution (Redfield, 1952) prepared their report. One would need to return to an era prior to the operation of duck farms on the Forge River (more than 75 years ago) for a view of aquatic conditions absent significant pollutants. It is, however, the nature of estuarine systems – like the Forge River with its narrow tributary creeks – that aquatic habitat tends to be limited by suitable benthic substrate and tidal wetlands. Narrow shallow creeks accumulate organic matter, which decomposes and gives rise to frequent blooms of *Ulva* (sea lettuce) and phytoplankton in the creeks. Decay of the algal blooms leads to the deposition of additional organic matter. The organic material deposited on creek bottoms shallows the creeks with anoxic muds. The nitrogen contribution from the duck farms, septic systems, and stormwater further stimulates the algal blooms with the consequent addition of more organic matter. Few marine organisms inhabit such bottom types. Most of the marine life is thus found along the creek edges where some sandy bottoms are located and where tidal wetland vegetation is present.

9.2.2 Existing Conditions

Habitats for Forge River marine organisms are rare. The estuary experiences severe oxygen depletions twice yearly (*i.e.*, during the spring and summer). Marine organisms do not survive in waters with little to no oxygen. The estuary may be somewhat more hospitable to pelagic organisms between these anoxic periods, though it continues to experience diurnal temperature and dissolved oxygen extremes.

Zooplankton driven into the estuary on the rising tides feed on the dense resident phytoplankton and serve as food for planktivorous fish, particularly the brackish water bait fish, the mummichog (*Fundulus heteroclitus*), the striped killifish (*Fundulus majalis*), and the sheepshead minnow (*Cyprinodon variegatus*) and the marine minnow, the silversides (*Menidia menidia*). Residents report that minnows and killifish have been more abundant in the last couple of years. Killifish are more tolerant of low oxygen levels than are silversides.

Researchers at SoMAS (Swanson, Gobler, & Brownawell, 2009) reported that benthic macroinvertebrates are sparsely distributed in the Forge River because of oxygen depletions and lack of suitable substrate. They are observed during the cooler (and better oxygenated) seasons in some of the sandier edge areas of some of the creeks as well as in the *Spartina* marshes. Typical estuarine shrimp, crabs, snails, and worms are occasionally

seen in the more oxygenated areas where hard bottom predominates. However, even these areas are subjected to periodic anoxic conditions that reduce their populations. *Ulva* blooms can also damage these populations by first smothering them with excess biomass and then through oxygen depletion as the *Ulva* dies and decomposes. Larger aquatic organisms can move quickly to more oxygenated waters along the estuary edges. In fact, the more mobile detritivores (*e.g.*, crabs and grass shrimp) can do well in waters with periodic die-offs.

9.2.3 Potential for Typical Estuarine Organisms

The Forge River might support a variety of typical benthic and pelagic estuarine organisms if its waters were more oxygenated and if more suitable benthic habitat became available. Much of the Forge River bottomland is loose anaerobic mud. Such substrate is unsuitable for all but certain types of exceptionally tolerant worms and a few species of gastropods. Typical estuarine organisms might return to the Forge River if water column oxygen levels were improved and anoxic mudflats replaced by sandy shoals. Unfortunately, it is unlikely that even with dredging, significant areas of sandy shoals could be created. Quiet estuarine systems like the Forge River and its tributary creeks are more likely to retain and regenerate muddy rather than sandy bottom even if muds were removed through dredging. Dredging is unlikely to remove *all* muds from the creeks or main body of the Forge River as the muds are many feet thick in places.

The information below is from the numerous technical reports prepared for the South Shore Estuary Reserve Council (SSER Council) in 1999. The reports, submitted to the Council's Living Resources Subcommittee, included information on crustaceans, diadromous fish, estuarine fish, mollusks, waterfowl, shorebirds and more. Although much of the information from those reports refers to Moriches Bay, it is useful for considering which species might migrate into an improved Forge River.

Crabs

Crabs that might be found in south shore estuaries include the blue crab (*Callinectes sapidus*), Jonah crab (*Cancer borealis*), rock crab (*Cancer irroratus*), lady crab (*Ovalipes ocellatus*), fiddler crabs (*Uca* spp.), green crabs (*Carcinus* spp.), spider crabs (*Libinia* spp.), hermit crabs (*Pagurus* spp.), mud crabs (*Neopanope sayi* and *Panopeus herbsti*), and the misnamed 'crab,' the horseshoe crab (*Limulus polyphemus*), which is in the Arachnid family. The report on crustaceans focused on blue crabs, a common, edible, and commercially important species. This species migrates within the estuary from deeper, warmer, wintering grounds to creeks, tidal wetlands and upper estuary areas in the spring, though salinity exerts an influence on their distribution. The presence of eelgrass beds,

macroalgae, and appropriate marsh creek habitat are important to blue crabs and other crustaceans, but are in limited supply in the Forge River. Small crabs prefer shallow estuarine waters with soft bottom, while larger crabs prefer deeper depths and harder bottoms. The report cites work by researchers suggesting that blue crabs are sensitive to dissolved oxygen levels below one part per million and can avoid hypoxic areas. Others cited in the report found that suspended sediments, ammonia, nitrites, and pH could have potentially adverse effects on blue crabs.

A number of different crab species are currently found in the Forge River. Their number and diversity, however, could increase with greater distribution of seagrass beds and vegetated saltmarshes, water quality improvements, and positive changes to the benthic environment.

Fish

A report was prepared for the SSER Council in July 1998 (SSER Council, Estuarine Finfish, 1998) on estuarine fish. They found that the following common and resident finfish species use the South Shore Estuary: mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), striped killifish (*Fundulus majalis*), northern pipefish (*Syngnathus fuscus*), sheepshead minnow (*Cyprinodon variegatus*), threespine (*Gasterosteus aculeatus*) and fourspine sticklebacks (*Apeltes quadracus*), and bay anchovy (*Anchoa mitchili*). These are all species that might be expected in the Forge River, at least during those times of year when oxygen concentrations are supportive. At other times, when dissolved oxygen is low, these fish likely migrate out to the Bay.

The report also found that the South Shore Estuary provides nursery habitat for commercially, recreationally, and ecologically important species including summer flounder (*Paralichthys dentatus*), blackfish (*Tautoga onitis*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*), Atlantic menhaden (*Brevoortia tyrannus*), butterfish (*Peprilus triacanthus*), and scup (*Stenotomus chrysops*). Summer flounder, an important estuarine species, spawns offshore in the winter. The larvae return to estuaries like the Forge River in April. There they settle in those portions of the estuary where salinity ranges from 24 - 35 ‰ and the substratum has a relatively high sand content (53 - 95%) (Burke, Miller, & Hoss, 1991). The Forge River creeks and the main body of the Forge River provide this kind of habitat only near the mouths of the creeks where salinity is higher and along the edges where the substrate is sandier. Tautog spawns in coastal estuaries in the spring and early summer (Steimle & Shaheen, 1999). Juveniles prefer habitats with structure and cover such as oyster reefs, boulders, or eelgrass beds. They have a particular affinity for areas with floating Ulva.

Like many estuarine fish, they will tolerate low oxygen levels (as low as 3 mg/L), but not anoxic conditions. The Forge River is thus not especially hospitable as there are no eelgrass beds and little other bottom 'structure' for cover. Although Ulva is present, it is usually associated eventually with very low oxygen. The Forge River similarly offers little suitable habitat for many of the other fish species found in Moriches Bay.

According to the South Shore Estuary report, some resident South Shore Estuary species, particularly the abundant bay anchovy and silversides, are prey species for most piscivorous fish (such as bluefish and striped bass) and birds, and rely on the South Shore Estuary for spawning and as a nursery. Other resident fish that use the South Shore Estuary for spawning and as nursery habitat include: mummichog, striped killifish, sticklebacks, naked goby (*Gobiosoma bosci*), grubby sculpin (*Myoxcephalus aenaeus*), longhorn and shorthorn sculpin (*Myoxocephalus octodecemspinosus* and *M. scorpius*), Northern pipefish (*Syngnathus fuscus*), winter flounder (*Pleuronectes americanus*), white perch (*Morone americana*), tomcod (*Microgadus tomcod*), weakfish (*Cynoscion regalis*), blackfish (*Tautoga onitis*), cunner (*Tautogolabrus adspersus*), northern puffer (*Sphoeroides maculatus*), sheepshead minnow (*Cyprinodon variegatus*), hogchoker (*Trinectes maculatus*), and oyster toadfish (*Opsanus tau*). Many of these species may be present in the Forge River during those periods when temperatures and dissolved oxygen concentrations are suitable. Some (like *Menidia* spp.) may use the *Spartina* beds present along some of the Forge River creeks and along the shoreline of the main branch of the Forge River for spawning and egg laying.

The report prepared by the SSER Council used an approach to describing the fish species inhabiting the South Shore Estuary based on physical habitat types that support broad groups of fish species. The habitats were differentiated by depth, bottom composition, presence of vegetation, and salinity trending from marine to freshwater. The estuarine fish habitats considered by the report included: inlets and deep water, mid-depth open water, subtidal shallows (vegetated and unvegetated), intertidal flats, intertidal wetland, and tributary mouths and creeks. Although the report recognized that these habitat types tended to blend with each other at the edges, the authors found the classifications useful in developing species assemblages. Of those habitats, only inlets, deep water, and mid-depth open water are unavailable in the Forge River. The report appendices list all the finfish species expected in the different habitat types of the South Shore Estuary including those habitats where Forge River fish would be expected.

The Forge River improvements listed as beneficial to crustaceans would be equally so for fish. Many estuarine fish require seagrass beds, vegetated saltmarshes, and sandy bottoms

for breeding and as a nursery. Improvements to oxygen concentrations are also critically important to increases in fish abundance in the Forge River.

Mollusks

The SSER Council received a report in May 1999 on Molluscan Shellfish (SSER Council, Molluscan Shellfish, 1999). The report focuses on the hard clam (*Mercenaria mercenaria*) because of its substantial commercial and recreational value. The report appendix identifies the major shellfish species present in the south shore estuary. Hard clams and softshell clams (*Mya arenaria*) prefer sandy substrates, though they can populate mud bottoms as long as there is sufficient oxygen in the overlying water column. The blue mussel (*Mytilus edulis)* is typically found on hard bottom in areas with rapid water movement. The ribbed mussel (*Geukensia demissa*) is usually attached to vegetated tidal wetland marshes. Oysters (*Crassostrea virginica*), which are usually found on hard bottom, can tolerate low salinities. Most molluscan shellfish are intolerant of high suspended solids loads. Shallow depths are preferred as molluscs favor higher primary productivity, though it can also be a negative as shellfish are exposed to low winter temperatures on tidal flats. The composition of the SSER phytoplankton community has changed over the last several decades. Researchers have found that phytoplankton populations in the 1950's shifted to dominance by algal species smaller than the food particle size normally consumed by filter-feeding shellfish, while the species represented in more recent algal blooms (*e.g.*, Brown Tide) affect shellfish through mechanical inhibition of filter feeding. The report found that the composition of shellfish species changed: hard clam commercial production dominated the industry in the 19th century, again in the 1940's, and again in the 1970's, while oyster production peaked in the 1920's.

The Forge River is not conducive to molluscan shellfish for many of the same reasons it is not hospitable to crustacean shellfish and fish. Sustained low oxygen levels are a universal problem for marine organisms. The soft bottom will not support hard clams, oysters, or blue mussels or the settling larvae of most molluscs. Oysters and mussels can clear high sediment loads, but not clams. Oysters will tolerate the lower salinities of the creeks and head waters, but less so the other species. High nutrient loading produces the phytoplankton blooms on which shellfish thrive, but the wrong alga (*e.g.*, Brown Tide) can shut down feeding and even cause juvenile mortality.

There is little likelihood that shellfish would naturally populate the Forge River, given its muddy substrate and low oxygen. A healthy population of filter feeding shellfish in the Forge River, however, could help manage the algal blooms that contribute to the dissolved

oxygen deficit. Thus, suspended culture of certain shellfish (oysters and possibly clams) with supplemental oxygen could be valuable to the recovery of the Forge River.

9.3 Wetlands

9.3.1 Freshwater Wetlands

Freshwater wetlands are present along both the East and West Mill Ponds. The large freshwater wetland adjoining West Mill Pond is described above in section 9.1.3 (Figure 9-3). The wetland is 'protected' by a forested area that surrounds it. The wetland is fed by groundwater seeps from the surrounding higher elevations. Portions of the wetland are characterized by relatively undisturbed hummock-type vegetation interspersed with small open water areas. Floating and rooted aquatic vegetation was observed along with areas of sandy bottom and clear water. *Phragmites* was present along the eastern edge of the wetland adjoining the stream channel and opposite the duck farms.

9.3.2 Tidal Wetlands

Spartina marshes can be the most highly productive portions of estuaries. These marshes typically provide breeding and juvenile habitat for numerous molluscan, crustacean, and fish species. The largest area (63.5 acres) of *Spartina* marsh is found in the Lower Forge West subwatershed (Table 9-1). Home Creek is also home to large areas of *Spartina* marsh (17.7 acres). Other areas with significant *Spartina* marsh include Lons Creek (4.1 acres) and the Middle Forge East sub watershed (8.1 acres), where the marsh is found along the east side of the main body of the Forge River. *Spartina* is virtually absent in the Upper Forge East and Upper Forge West subwatersheds. Poospatuck Creek has only 0.8 acres, Old Neck Creek only 1.3 acres, and Ely Creek only 1.9 acres of *Spartina* marsh.

Phragmites typically grows in disturbed areas where salinities are low and frequently where stormwater enters estuaries. The highly invasive reeds provide very limited aquatic habitat and actually displace other more valuable marsh vegetation. The plants do stabilize the soils they grow in and provide nutrient and contaminant uptake.

Almost half of the *Phragmites* (23 of 54 acres) in the Forge River watershed is located in the Lower Forge subwatershed. The creeks have between 1.3 and 5.9 acres of *Phragmites* along their shores; Ely Creek has the most at 5.9 acres. Ely Creek, the shallowest of the creeks, also has the greatest acreage of mudflats (4.6 of the total 12.4 acres) of all the creeks.

The subwatersheds have also been subjected to deposition from stormwater runoff and bank erosion. Table 9-1 lists 'deposits' in each of the subwatersheds. The greatest acreage of

'deposits' was mapped in Poospatuck Creek (almost 1/3 of all mapped deposits). Significant deposits were also mapped in the Ely Creek and West Mill Pond subwatersheds.

Table 9-1. Wetland and related habitats by subwatershed (acres)

SUBWATERSHED	Deposits	Mudflat	Pannes, Pools	*Phragmites*	*Spartina*	Upper Marsh
EAST MILL POND	0.0404	0.1573				
ELY CREEK	0.1313	4.5766	0.0822	5.8831	1.8996	3.0470
HOME CREEK	0.0105	0.1476	0.5137	4.7657	17.7378	0.4734
LONS CREEK	0.0043	0.1985		2.4011	4.1216	0.3566
LOWER FORGE EAST		0.6441		0.6092	0.3435	
LOWER FORGE WEST			0.6950	23.0000	63.4956	3.1710
MID FORGE EAST		0.2536		6.2277	8.0683	1.0284
MID FORGE WEST		0.3012		0.1479	4.0104	0.3548
OLD NECK CREEK	0.0726	0.3571		4.5867	1.3160	0.1341
POOSPATUCK CREEK	0.2121	0.3834		1.3431	0.7817	0.0139
UPPER FORGE EAST	0.0148	2.7374	0.0024	3.4176		0.0439
UPPER FORGE WEST	0.0273	0.2327		1.0316		
WEST MILL POND	0.1168	0.8343	0.0141	0.2712		
WILLS CREEK	0.0466	1.7053	0.2025	0.6072	0.5457	0.0289
TOTALS	**0.6363**	**12.3718**	**1.5099**	**54.2921**	**102.3202**	**8.6520**

(Source: Cameron Engineering & Associates, LPP)

9.4 Significant Upland Adjacent to Aquatic Habitat

There are significant open space parcels inside the Forge River watershed. Some are especially important, as they are located at the headwaters of the Forge River creeks. Large tracts of undisturbed land in these locations help maintain the higher quality groundwater that feeds the heads of these creeks. Each of these areas is listed below with its associated waterbody.

- West Mill Pond – a large open space north and northwest of Sunrise Highway drains to this pond
- East Mill Pond – two tributary forks are surrounded by forested areas to the northeast that buffer the headwaters from adjacent agricultural and residential uses.
- Ely and Old Neck Creeks – open space north of Montauk Highway ultimately drains into these creeks
- Lons Creek – there is a large sparsely developed area to the north of the creek
- Home Creek – the headwaters of the creek drain the northern portion of the William Floyd Estate, which surrounds the southern portion of the creek and is home to a large tidal wetland at the mouth of the Forge River.

One open space area that is particularly close to the open water of the Forge River is the oak forest north of the West Mill Pond. It is relatively free of exotics and invasives (Figure 9-20) and connects to a well-preserved freshwater wetland that drains to West Mill Pond. This is part of the 154 acres recently placed into public ownership as open space to protect some of the freshwater sources of the Forge River.

Figure 9-20. Oak Forest North of West Mill Pond and Adjacent Freshwater Wetland

9.5 Living Aquatic Resources Impairments Summary

Two conditions severely limit the living aquatic resources in the Forge River: extensive unconsolidated and anoxic sediments and a hypoxic and sometimes anoxic water column. The sediments are inhospitable to most benthic organisms. The frequent and lengthy periods of low or zero dissolved oxygen limit the presence of pelagic species to those that are sufficiently mobile to move out of the estuary. Estuarine organisms are limited primarily to edge areas where substrates remain sandy and vegetated wetlands persist and to open water areas during periods when DO is adequate.

Tidal wetlands are limited to areas where there has been no shoreline hardening and elevations remain suitable. Upland development in the riparian zone extends along large lengths of shoreline replacing high marsh and adjacent natural uplands. Large stands of *Phragmites* have invaded certain portions of the estuary, primarily the low salinity area between the railroad trestle and Montauk Highway and in the especially shallow Ely Creek. Large areas of *Spartina* marsh remain, primarily in the southern reaches of the estuary.

10 Sediments

10.1 Dredging History

The Forge River was first dredged in 1965 (Swanson, Brownawell, Wilson, & O'Connell, 2010). At this time, dredging operations were conducted only on the main channel. Approximately 265,900 cubic yards of sediment were removed for the purposes of navigation and pollution control. The dredging operation established a channel that was 100 feet wide and seven feet deep. Subsequently, from 1967 to 1973, the creeks of the Forge River estuary were dredged, thus establishing several secondary channels. The creeks were dredged to depths varying from approximately six to eight feet. These channels are visible in the bathymetry map found on the next page (Figure 10-1).

In 1940, the United States Army Corps of Engineers established the Intracoastal Waterway. It extends from Patchogue to Shinnecock Canal with an approximate width of 100 feet and a nominal depth of five feet. A channel connecting the mouth of the Forge River and the Intracoastal Waterway was dredged in 1999.

Suffolk County conducts much of the maintenance dredging in the county's harbors, bays, and lagoons. The County established the Dredging Projects Screening Committee to investigate the feasibility and desirability of proposed County dredging projects and to recommend to the County Legislature projects that further the public interest. In 2006, the County Legislature determined that environmental factors and marine productivity should be added to the criteria used to determine if a dredging project is in the public interest. The County specifically determined that dredging might be necessary to increase the flushing of harbors to protect marine ecology and productivity.

Additional dredging has been done in Moriches Bay channels and in the ocean inlet. The east-west Moriches channel was dredged from 2002 to 2003 when approximately 80,000 cubic yards of spoil were removed and placed on East Inlet Island. Researchers at Stony Brook University's SoMAS (Wilson, Swanson, Brownawell, Flood, & Gobler, 2009) suggested that such dredging in Moriches Bay and the inlet have increased the tidal range in Forge River. Adding to the tidal range increases circulation and flushing and therefore, water quality.

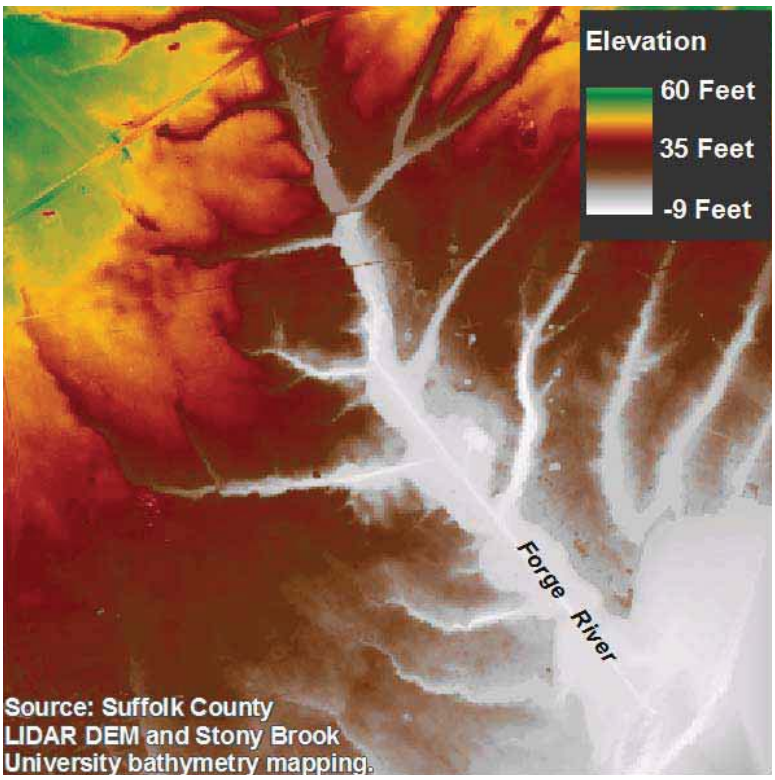
10.2 Sediment Deposits

Sediments have accumulated at the mouths of several of the creeks. These 'sills' have arisen as sediments moving out of the creeks are shaped by normal tidal circulation into 'spits' at the mouths of the creeks. Some of the sediments are discharged with stormwater runoff

through piped systems and overland. Some sediment derives from bank erosion. Forge River tidal circulation appears to have created these sills primarily in the western creeks. A sediment deposit has formed on both sides of the railroad bridge from sediment movement and velocity changes due to changing water depths.

A large sediment deposit is also present at the head of the Forge River just below Montauk Highway. This deposit formed from sand and grit carried in stormwater runoff as well as from suspended material carried from the East and West Ponds. Vegetation has taken root on this deposit, which extends almost across the head of the Forge River.

Figure 10-1. Forge River Dredging



10.3 Creek Dredging and Stagnant Basins

Some of the dredging that was conducted in the creeks created deep areas where the bottom elevations are lower than the elevations at the mouth of the creeks (Figure 10-1). These 'basins,' present in three of the western creeks, can contribute to water quality problems. Fine materials deposit in the basins and are degraded by bacteria, which lowers oxygen concentrations. Hypoxia becomes a problem, as there is insufficient circulation to replace oxygen-depleted waters.

10.4 Sediment Quality

The sediments of the Forge River through most of its length and its creeks are anoxic muds that do not support aquatic macro-benthic life. The mud is deep, unconsolidated, and unusually high in organic content. Organic matter is continuously added to the sediment primarily from deposition of decaying algal blooms.

In the summer of 2006, scientists from the School of Marine and Atmospheric Sciences (SoMAS) at Stony Brook University conducted a Forge River sediment investigation (Brownawell, Wang, Ruggieri, Sanudo-Wilhelmy, & Swanson, 2009). The sediment samplings were primarily drawn from deeper, formerly dredged channels that were readily accessible. The purpose of the research was to understand the depth, composition, and toxicity levels of the river sediments.

The researchers found that the depth to the sand layer varied from 2.3 to 9.2 feet across the Forge River. The depth to the sand layer in most samplings was greater than 7.9 feet. Above this transition zone (*i.e.*, the zone where sand was encountered), the sediments were soupy, dark brown to black in color and unconsolidated. Below the transition zone, the sediments were sandy, gray to light brown, and significantly more consolidated than the layer above. The researchers concluded that the transition zone represents the depth of the last major dredging of the Forge River, which was conducted from 1965 to 1973. Dredging of the main channel was conducted in 1965 while the creeks were dredged from 1967 through 1973. It is important to note that no DDT or PCB residues were identified below the transition zone. Because these compounds were not used until several years after World War II, the sediments below the transition zone must predate the 1950s when DDT and PCBs were not used and thus would not be found in the sediments. This suggests that the 1965-1973 dredging may have removed the sediment layers deposited from the 1950's through the mid 1960's when DDT and PCB residues would have been expected in the sediments.

The SoMAS researchers found no detritus (*i.e.*, organic matter from dead and decaying organisms) in the sediments. They concluded that the source of organic matter in the sediments is from algal growth and decay and not upstream or upland sources. The percentage of total organic carbon in the sediment samples was also measured. The researchers found high percentages of total organic carbon, varying from 7.5 to 12.1 percent. This level is high even by comparison with the average seven percent total organic carbon measured in Jamaica Bay. Jamaica Bay sediments have a high organic content due to the discharge of sewage effluent to the Bay, and consequently, a high rate of eutrophication.

The high percentage of total organic carbon in the Forge River is evidence of extremely high algal production that, in turn, is due to heavy nitrogen loading. Benthic bacteria degrade the

sediment organics, remineralizing it and releasing it back into the water column, where it once again serves as a nutrient for additional algal production. The high total organic carbon content in the sediments of East Mill Pond may be due in part to leaf litter, though the pond is also subject to high algal production.

The researchers from SoMAS measured a relatively – though not excessively – high metals concentration in the sediments. Elevated metals concentrations, they suggest, are due primarily to the high total organic carbon content and fine grain size of the sediments, which increases adsorption of metals. In addition, the sediments have a high sulfide content, which causes the scavenging of certain metals such as molybdenum, cadmium, silver, zinc, lead and, possibly, copper. Only the molybdenum and cadmium levels were high relative to other estuaries on Long Island. However, since the upland areas of the Forge River have no industrial history, the metal sources are likely not anthropogenic. Polyaromatic hydrocarbons (PAHs) were also measured in the sediment samples. The PAHs are most likely from combustion sources and atmospheric deposition. Concentrations of PAHs are within the ranges measured in the sediments of other estuaries on Long Island.

The concentrations of DDT, a pesticide banned in 1972 for its negative effects on the reproductive systems of wildlife (*i.e.*, especially birds), are low in the Forge River sediments. Past dredging, as discussed above, may have removed historic (1950s-1960s) DDT deposits. Slightly high levels, however, were detected in the sediments of East Mill Pond. Concentrations of PCBs are also low indicating atmospheric sources of these chemicals. The researchers found virtually no other pesticides in the sediments above detection limits.

10.5 Sediment Impairments Summary

The Forge River was dredged in 1965 and the creeks from 1967 to 1973. A channel connecting the mouth of the Forge River and the Intracoastal Waterway was dredged in 1999. In addition, the East-West Moriches channel was dredged during 2002 and 2003.

Forge River sediments are primarily unconsolidated muds that represent decades of organic deposits from algal blooms, leaf fall, and duck farm waste. The sediments are highly enriched with organics, but contain little pesticide and trace metal contamination. Historic dredging may have removed contaminants in the 1960s and early 1970s. Overdredging of some of the creeks created basins where tidal exchange is limited and accumulation of decaying organic material further lowers dissolved oxygen. Bacterial action remineralizes organic nitrogen to nitrites and nitrates into the overlying water column, but bacterial production is limited by low dissolved oxygen concentrations.

11 Water Quality

11.1 Waterbody Standards

The water quality of the Forge River has been formally assessed by the State of New York as part of Clean Water Act requirements. A large component of this assessment is based upon water quality monitoring. This section describes the State's assessment of the Forge River and water quality monitoring efforts, which have been performed in the Forge River system.

11.2 Waterbody Classification and Designated Uses

Each waterbody in the State of New York is classified based on current and historical uses (NYSDEC, Part 701: Classifications-Surface Waters and Groundwaters). These classifications are designed to consider the use and value of the waterbody for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. Each use is assigned a set of water quality standards that specify the chemical and physical characteristics (*e.g.*, mercury concentrations and temperature) required to support the designated use.

The waters of the Forge River north of Montauk Highway are classified as Class C as shown in Figure 11-1. As defined by Part 701.08 of the Rules and Regulations of the State of New York: "*the best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife 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*."

The tidal portion of the Forge River, as shown on Figure 11-1, is classified as SA waters. As defined by Part 701.10 of the Rules and Regulations of the State of New York, "*the best usages of Class SA waters are shellfishing for market purposes, primary and secondary contact recreation, and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival*."

The creek tributaries to the Forge River as well as the northern tidal portion of the Forge River are classified as Class SC as shown in Figure 11-1. As defined by Part 701.12 of the Rules and Regulations of the State of New York, "*the best usage of Class SC waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife 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*."

Water quality standards specific to Class SA and SC waters related to the eutrophication and bacteria issues seen in the Forge River are provided in Table 11-1. Numerous other

water quality standards, such as metals and pesticides, also apply to Class SA and SC waters but are not documented here. The definition of these can be found in Part 703 of the Rules and Regulations of the State of New York.

Figure 11-1. Waterbody Classifications within the Forge River System

11.2.1 Special Water and Habitat Resources

The classifications assigned to the Forge River are similar and generally intended to protect fish, shellfish, and wildlife propagation and survival. The water quality should be suitable for primary and secondary contact recreation, although other factors may limit use for these purposes. Class SA waters are also intended to support shellfishing for market purposes. The Forge River has not been designated as a system with *Special Water or Habitat Resources Warranting Special Protection or Restoration.*

Discharge from the Forge River enters Moriches Bay, which is designated as Complex #13 of the *Significant Habitats and Habitat Complexes of the New York Bight Watershed* (NYSDEC, New York Natural Heritage Program). This complex includes regionally significant habitat for fish and shellfish, migrating and wintering waterfowl, colonial nesting water birds, beach-nesting birds, migratory shorebirds, raptors, and rare plants. Poor water quality discharging from the Forge River can contribute to the degradation of aquatic habitat in Moriches Bay. Moriches Bay is designated as a Significant Coastal Fish and Wildlife Habitat.

Table 11-1. Water Quality Standards for Class SA and SC Waters

Parameter	Standard
Turbidity	No increase that will cause a substantial visible contrast to natural conditions.
Suspended, colloidal and settleable solids	None from sewage, industrial wastes, or other wastes that will cause deposition or impair the waters for their best usages.
Total dissolved solids	1,000 mg/L
Nitrogen, total as N	10 mg/L
Ammonia and Ammonium	35 µg/L (chronic), 250 µg/L (acute)
Phosphorus and nitrogen	None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.
pH	The normal range shall not be extended by more than one-tenth (0.1) of a pH unit.
Total coliform (Class SA)	The median most probable number (MPN) value in any series of representative samples shall not be in excess of 70.
Total coliform (Class SC)	The monthly median value and more than 20 percent of the samples, from a minimum of five examinations, shall not exceed 2,400 and 5,000, respectively.
Fecal coliform (Class C, SC)	The monthly geometric mean, from a minimum of five examinations, shall not exceed 200.
Dissolved Oxygen *	A daily average minimum concentration of 4.8 mg/L and an instantaneous minimum of 3.0 mg/L.
*An interpretative guidance for the Marine Dissolved Oxygen Standard specifies a daily average minimum DO concentration of 4.8 mg/L can be violated for a limited number of days based on a calculation described in Part 703.3 of the Rules and Regulations of the State of New York.	

11.2.2 303(d) Listed Impairments

The Forge River has a history of water quality impairments and has experienced chronic hypoxia and fish kills. In 2006, using methodology established by the Federal Clean Water Act, the river was categorized as a waterbody that did not meet water quality standards, and was placed on New York State's "303(d) list." The Upper Forge River is included in the 303(d) list as part of the tidal tributaries to West Moriches Bay estuary system (Waterbody ID 1701-0312) and is considered to have impairments from pathogens, nitrogen, and dissolved oxygen/oxygen demand. The Lower Forge River and Cove (Waterbody ID 1701-0316) is considered to be impaired due to pathogens (see Appendix C for Priority Waterbody listing).

A Total Maximum Daily Load (TMDL) is required for all water bodies on the 303(d) list. A TMDL is the maximum pollutant loading a waterbody can tolerate and still support all of its intended uses. TMDL development work may include water quality monitoring, modeling, and assessment. In addition to calculating pollutant loading, a TMDL should include a strategy for limiting pollutants and restoring water quality. Development of a TMDL can provide the basis for a long-term strategy for the restoration of the stream's ecological health. A request for proposals for the development of a TMDL is expected in 2011.

11.3 Water Quality Monitoring

The Forge River was monitored at 38 stations by the SCDHS over the period from June 2006 through October 2009. A map and description of the 38 stations is provided in Figure 11-2 and Table 11-2 respectively. The purpose of the sampling varies by station, *e.g.*, long term trend evaluation vs. intensive survey. For this reason, the parameters and frequency of monitoring are different for many of the stations. A summary of the station monitoring characteristics is provided in Table 11-3. The monitoring stations are well distributed within the Forge River, sampling areas that may have different characteristics due to factors such as inflows, bathymetric profile, and tidal mixing with Moriches Bay. Notable stations include:

- Bi-weekly monitoring during May through October of 2006 and 2007 at FRG01, FRG02, FRG03, FRG07, FRG08, FRG09, FRG010, FRG011, FRG012, FRG013, FRG015, FRG019, FRG20, FRG24, FRG25, FRG26, FRG27, and FRG28.
- Monitoring of East and West Mill Pond discharges (primary surface water discharges to Forge River).
- Monitoring of nutrients at the two duck farms.
- Continuous monitoring at Station FRG029 from June 2006 through May 2009.

Figure 11-2. Forge River Water Quality Monitoring Locations

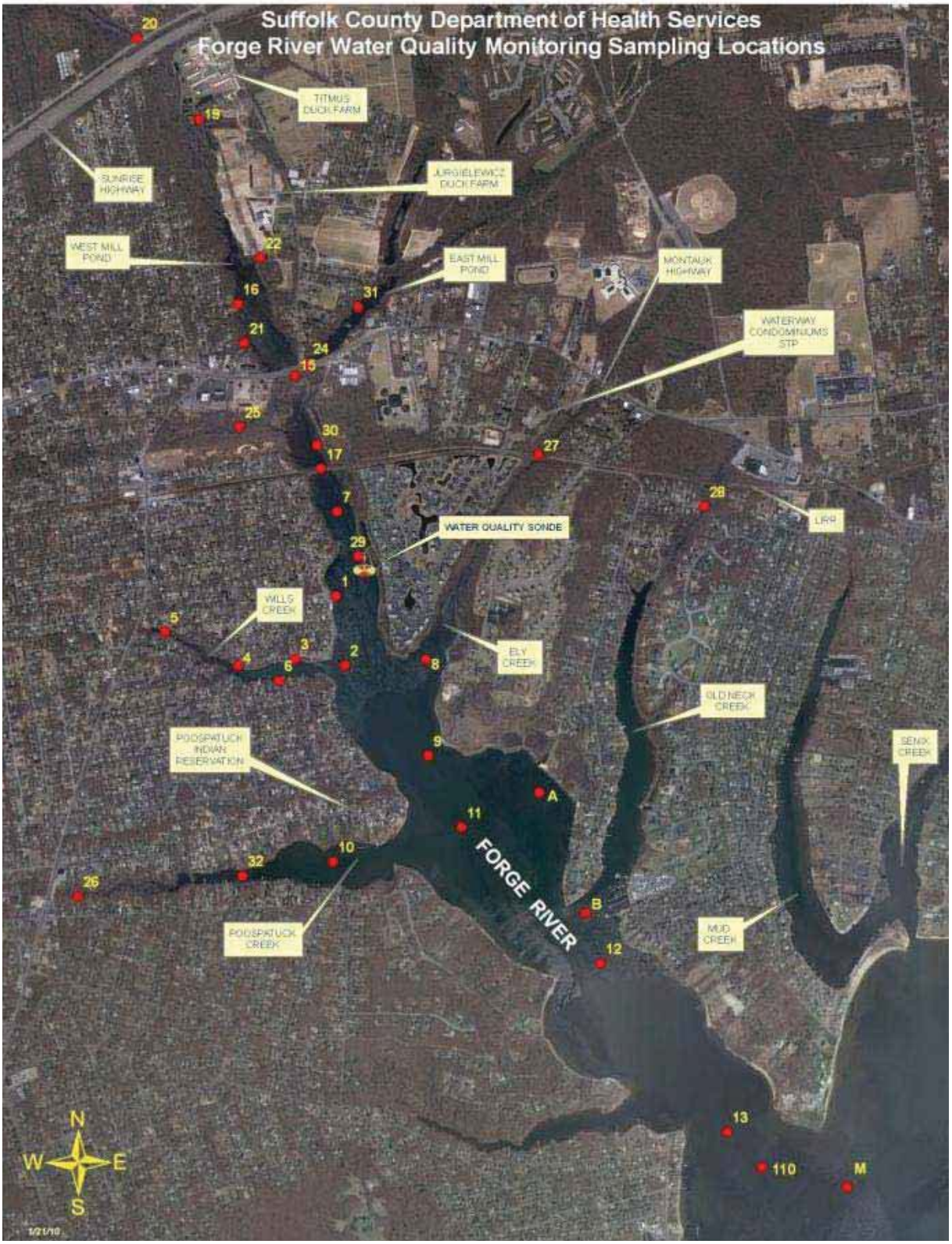


Table 11-2. Forge River SCDHS Monitoring Stations

Station ID	Name	Latitude	Longitude	Location/Description
FRG001	Forge River	40.79779	-72.83112	Mid river off the town marina boat ramp
FRG002	Forge River	40.79515	-72.83075	At the end of the finger pier off the mouth of Wills Creek
FRG003	Forge River	40.79542	-72.83321	Just inside the mouth of Wills Creek
FRG004	Wills Creek	40.79520	-72.83610	Midway point of Wills Creek
FRG005	Wills Creek	40.79650	-72.83972	Pond outlet to Wills Creek
FRG006	Wills Creek	40.79460	-72.83404	Off the Lupski property, 71 Overlook Dr.
FRG007	Forge River	40.80100	-72.83101	Approximately 200 yds south of LIRR
FRG008	Forge River	40.79533	-72.82668	At the mouth of Ely Creek
FRG009	Forge River	40.79168	-72.82661	Mid river between mouth of Ely and Poospatuck creeks
FRG010	Forge River	40.78769	-72.83146	Just w/o the mouth of Poospatuck Creek
FRG011	Forge River	40.78894	-72.82501	Mid river off Poospatuck Creek
FRG012	Forge River	40.78369	-72.81814	Mid river just south of Old Neck Creek Marina
FRG013	Forge River	40.77721	-72.81194	Mid river at Forge River mouth
FRG015	West Mill Pond	40.80618	-72.83305	From weir on south side Montauk Hwy
FRG016	Forge River	40.80895	72.83585	On the west side of West Mill Pond off #15 Rutland Road
FRG017	Forge River	40.80264	72.83179	Under railway bridge S. of Montauk Hwy
FRG019	Titmus Duck Farm	40.81597	-72.83767	East side of Forge River at SW corner of farm
FRG020	Forge River	40.81910	-72.84072	On the north side of Rt 27 (Sunrise Hwy.)
FRG021	Forge River	40.80746	-72.83556	On the west side of West Mill Pond at the end of Henry St.
FRG022	Jurgielewicz Duck Farm	40.81069	-72.83471	From the chlorine contact tank
FRG024	East Mill Pond	40.80666	-72.83240	From weir on south side Montauk Hwy
FRG025	Swift Stream	40.80426	-72.83584	Approximately midway between Mastic Road and the Forge River
FRG026	Poospatuck Creek	40.78650	-72.84424	Approx. 100 yds east of Mastic Road, between Meadowmere Ave and Riverside Ave.
FRG027	Ely Creek	40.80306	-72.82092	At the south side of the LIRR
FRG028	Old Neck Creek	40.80101	-72.81267	At the south side of the LIRR
FRG029	Forge River	40.79929	-72.83000	YSI sonde deployment site - Waterways Condominium floating dock
FRG030	Forge River	40.80354	-72.83196	E/S river between Montauk Hwy and train trestle
FRG031	East Mill Pond	40.80878	-72.82983	Middle of East Mill Pond, just N/O Montauk Hwy.
FRG032	Poospatuck Creek	40.78720	-72.83600	At the head of tidal portion of Poospatuck Creek
FRGA	Forge River	40.47357	-72.49291	MSRC Sediment Station
FRGB	Forge River	40.47185	-72.49059	MSRC Sediment Station
FRGM	Forge River	40.46585	-72.47772	MSRC Sediment Station
FRK01	Lower River	----	----	MSRC Kayak Station - sediment grab for VOC only
FRK03	East Mill Pond	----	----	MSRC Kayak Station - sediment grab for VOC only
FRK04	West Mill Pond	----	----	MSRC Kayak Station - sediment grab for VOC only
080110	Forge River Mouth	40.77667	-72.81138	At the entrance to Forge River, 0.2 mi southwest of Masury Pt.
255-5	West Mill Pond	----	----	OWR sampling site at outflow from pond
256-5	East Mill Pond	----	----	OWR sampling site at outflow from pond

Table 11-3. Forge River Monitoring Station Details

Bay Station	Site/Embayment	Period of Record	Frequency	Parameters Sampled
FRG001	Forge River	6/15/05 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG002	Forge River	6/15/05 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG003	Forge River	6/15/05 - 5/6/09	Frequent	General[a], metals[b], organics[c]
FRG004	Wills Creek	6/15/05 - 5/6/09	Frequent	General[a], metals[b], organics[c]
FRG005	Wills Creek	3/20/08 - 10/15/09	Infrequently	General[a], metals[b]
FRG006	Wills Creek	6/15/05 - 6/6/06	Infrequently	General[a]
FRG007	Forge River	6/30/05 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG008	Forge River	6/30/05 - 5/6/09	Frequent	General[a], metals[b], organics[c]
FRG009	Forge River	6/30/05 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG010	Forge River	6/30/05 - 5/6/09	Frequent	General[a], metals[b], organics[c]
FRG011	Forge River	6/30/05 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG012	Forge River	6/30/05 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG013	Forge River	6/30/05 - 10/15/09	Frequent	General[a], organics[c]
FRG015	West Mill Pond	9/2/05 -10/15/09	Frequent	General[a], metals[b], organics[c]
FRG016	Forge River	9/2/05	Infrequently	General[a]
FRG017	Forge River	9/2/05 - 6/19/06	Infrequently	General[a]
FRG019	Titmus Duck Farm	12/12/05 - 5/6/09	Frequent	General[a], metals[b]
FRG020	Forge River	12/12/05 - 10/15/09	Frequent	General[a], metals[b]
FRG021	Forge River	12/12/05 - 1/10/06	Infrequently	General[a]
FRG022	Jurgielewicz Duck Farm	12/12/05 - 5/6/09	Frequent	General[a]
FRG024	East Mill Pond	2/8/06 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG025	Swift Stream	2/8/06 - 10/15/09	Frequent	General[a], metals[b]
FRG026	Poospatuck Creek	4/20/06 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG027	Ely Creek	4/20/06 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG028	Old Neck Creek	5/9/06 - 10/15/09	Frequent	General[a], metals[b], organics[c]
FRG029	Forge River	12/5/07 - 10/17/08	Infrequently, grab samples, continuous probe	General[a]
FRG030	Forge River	12/19/06	Infrequently	General[a]
FRG031	East Mill Pond	12/19/06	Infrequently	General[a]
FRG032	Poospatuck Creek	5/2/07 - 5/6/09	Relatively frequently	General[a]
FRGA	Forge River	8/8/06 - 12/21/06	Infrequently	General[a], organics[c]
FRGB	Forge River	8/8/06 - 12/21/06	Infrequently	General[a], organics[c]
FRGM	Forge River	8/8/06 - 12/21/06	Infrequently	General[a], organics[c]
FRK01	Lower River	6/5/06, 12/21/06	Infrequently	General[a], organics[c]
FRK03	East Mill Pond	6/5/06, 12/21/06	Infrequently	General[a], organics[c]
FRK04	West Mill Pond	6/5/06, 12/21/06	Infrequently	General[a], organics[c]
080110	Forge River Mouth	6/16/06-5/11/09	Frequent	General[a]
255-5	West Mill pond	5/11/66 - 6/15/05	Relatively frequently	General[a]
256-5	East Mill Pond	3/17/70 - 6/15/05	Relatively frequently	General[a]

[a] Secchi Depth, Temperature, Dissolved Oxygen, Salinity, Conductivity, pH, Total Coliform, Fecal Coliform, NH3, NO2, NO3, NOx, DN, TN, DP, TP, o-PO4, TSS, Chl-a, TOC, DOC, Flow, TOC, COD

[b] 33 metals analyses such as aluminum, cadmium, mercury, selenium

[c] 259 organic analytes including volatile organic carbon constituents (VOCs), herbicides, and pesticides.

11.4 Marinas and Recreational Boating

Marinas and recreational boating can have a deleterious impact on water quality. The potential impacts of boating include illegal sanitary discharge from on-board heads and leakage of petroleum products associated with engine use.

Moriches Bay is now a state-designated no-discharge zone (NDZ), as are the other south shore bays. Vessels operating in NDZs are required to have specific marine sanitation devices that prevent the discharge of sanitary waste to receiving waters. Vessels are further required to utilize the services of pump-out stations or boats to dispose of their sewage.

The Town provides a self-serve pump-out station on the Forge River to collect sanitary waste from vessels. As most boaters are conscientious about using such services, discharge of sanitary waste from vessels is assumed minimal and is not included as a significant contribution. Leakage of fuel and lubricants is always a concern. Slips are generally located in areas where water depth is such that there is open water even at low tide to keep vessels afloat. As such, slips are not usually located where tidal vegetation would grow. It is possible for marinas to coexist with natural vegetated shorelines, though marina shorelines are usually bulkheaded.

11.5 Total and Fecal Coliform Bacteria

Fecal coliform bacteria concentrations are a concern for recreational and shellfishing regulatory compliance. Coliform are commonly used as an indicator of wildlife and waterfowl contamination, discharge from wastewater treatment plants, stormwater, or contributions from failing septic systems and cesspools via groundwater. Genotyping can determine whether the sources are human or animal, but it is costly and has not been used for the Forge River. Failing cesspools and septic systems, often many decades old, contribute to fecal coliform contamination of Forge River creeks via groundwater. The New York State total coliform water quality standard for SA waters is a median of 70/100 mL in any series of representative samples. The number of exceedances of 70/100 mL for the SA stations from 2005-2010 in the Forge River is provided in Table 11-4. The SC waters in the Forge River have a lower standard based on a minimum count of five samples per month as described in Table 11-1 of this document. No station violated both components of the standard. Figure 11-3 through Figure 11-8 show the observed total coliform values for the Forge River stations. The spatial distribution of coliform exceedances is provided in Figure 11-9. While an elevated number was measured near the duck farms, review of Figure 11-3 through Figure 11-8 shows that coliform contamination is widespread throughout the watershed.

Table 11-4. Exceedances of Total Coliform Standard (Days in Excess of 70 MPN/100 mL)

Station	Occurrences	Class	Years
FRG009	15 (23)	SA	2005, 2006, 2007, 2008
FRG011	12 (15)	SA	2005, 2006, 2007, 2008, 2009
FRG012	13 (17)	SA	2005, 2006, 2007, 2008, 2009
FRG013	5 (14)	SA	2005, 2006, 2007, 2008, 2009
FRGB	0 (1)	SA	2006
FRGM	0	SA	n/a

Figure 11-3. Total Coliform Time Series for the Middle Forge River

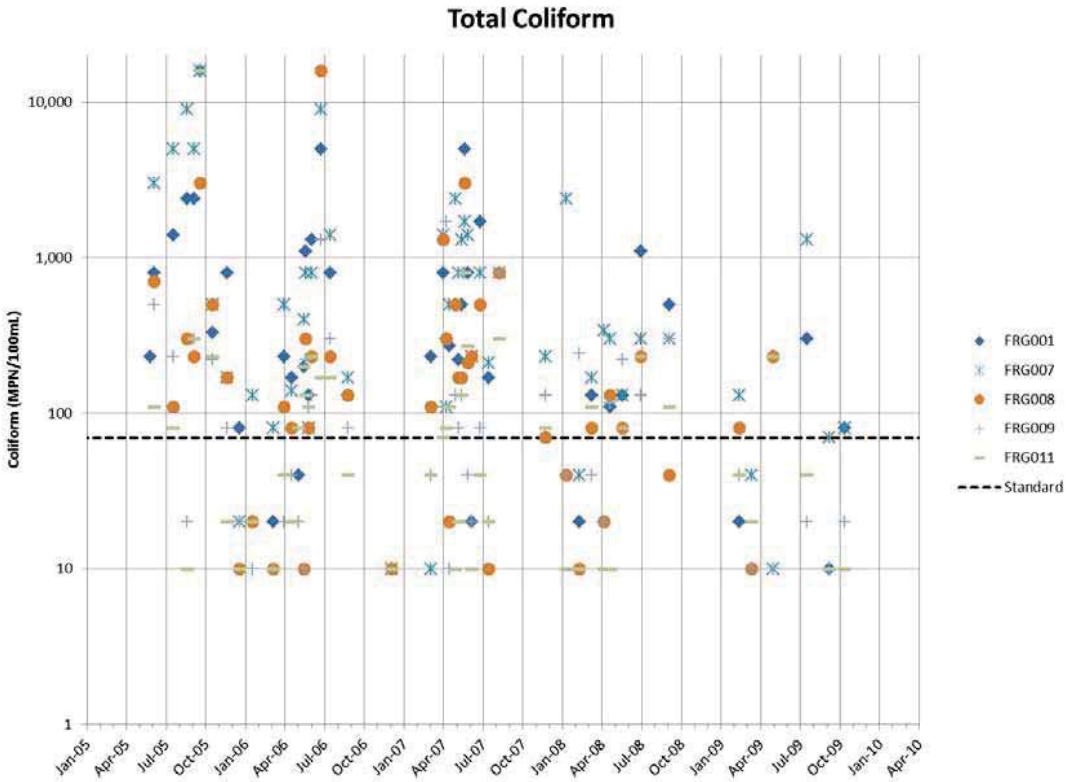


Figure 11-4. Total Coliform Time Series for the Lower Forge River

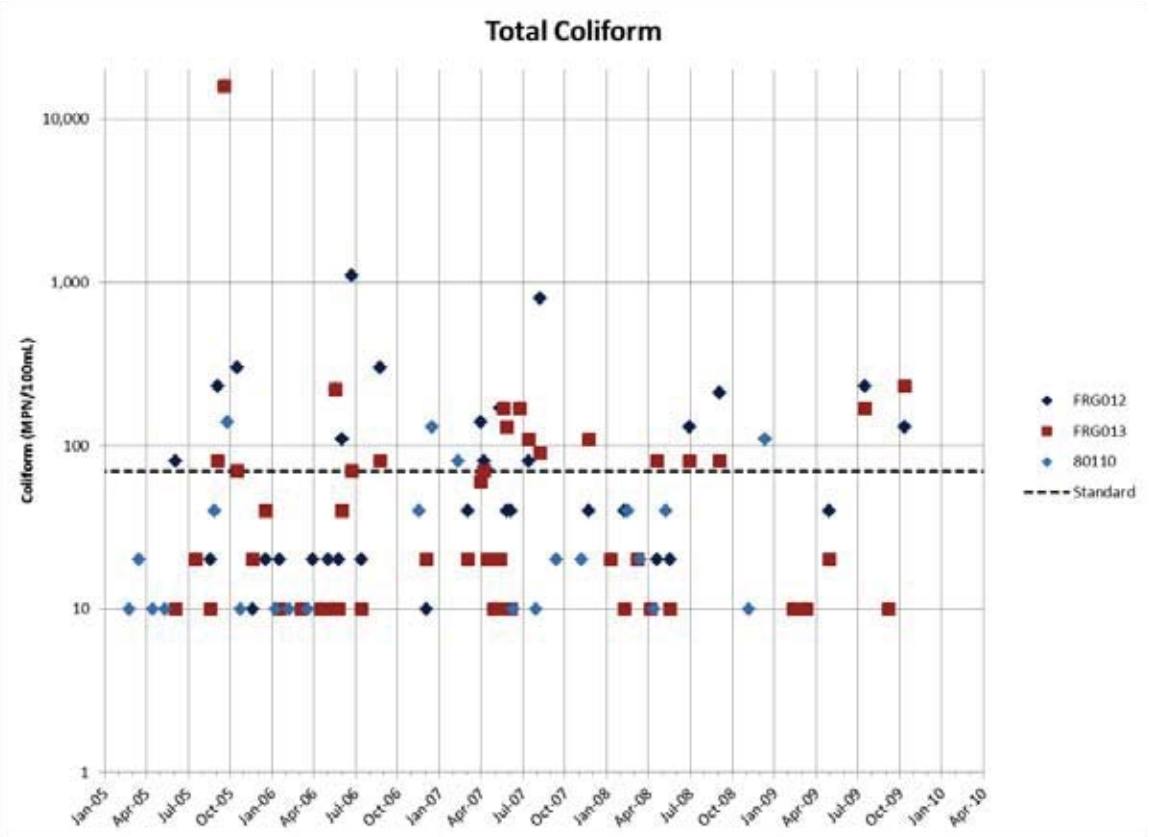


Figure 11-5. Total Coliform Time Series for Forge River creeks

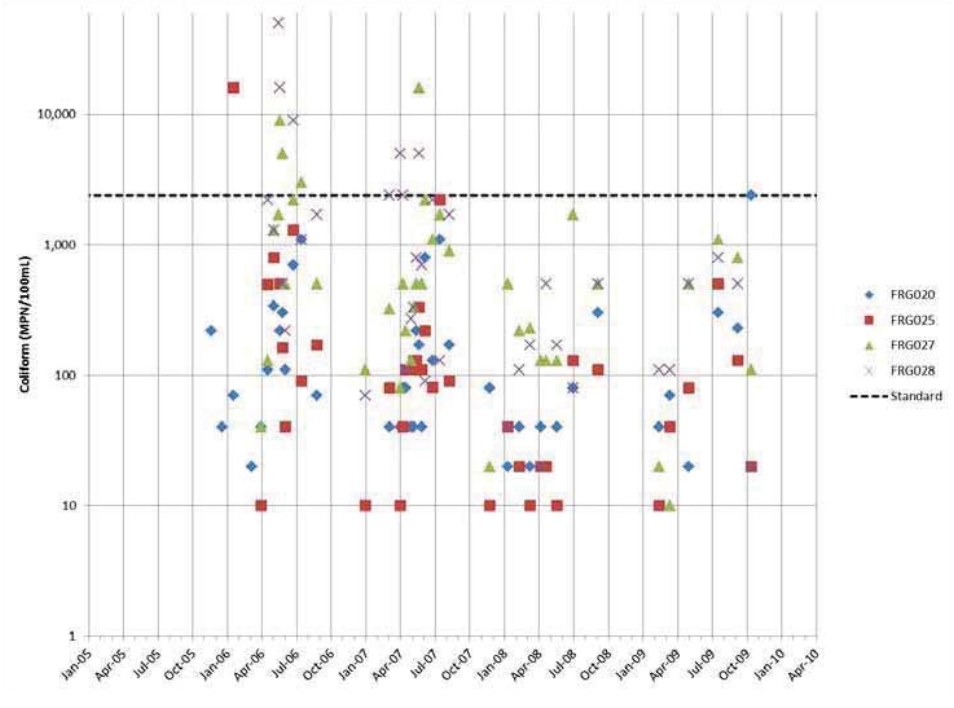


Figure 11-6. Total Coliform Time Series for Wills Creek

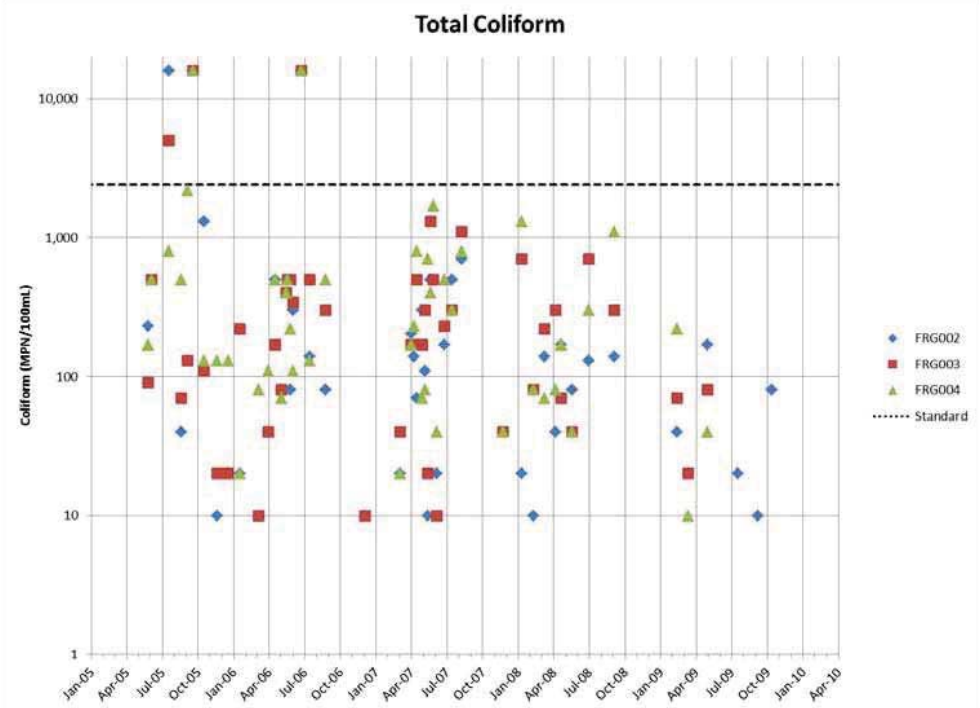


Figure 11-7. Total Coliform Time Series for Poospatuck Creek

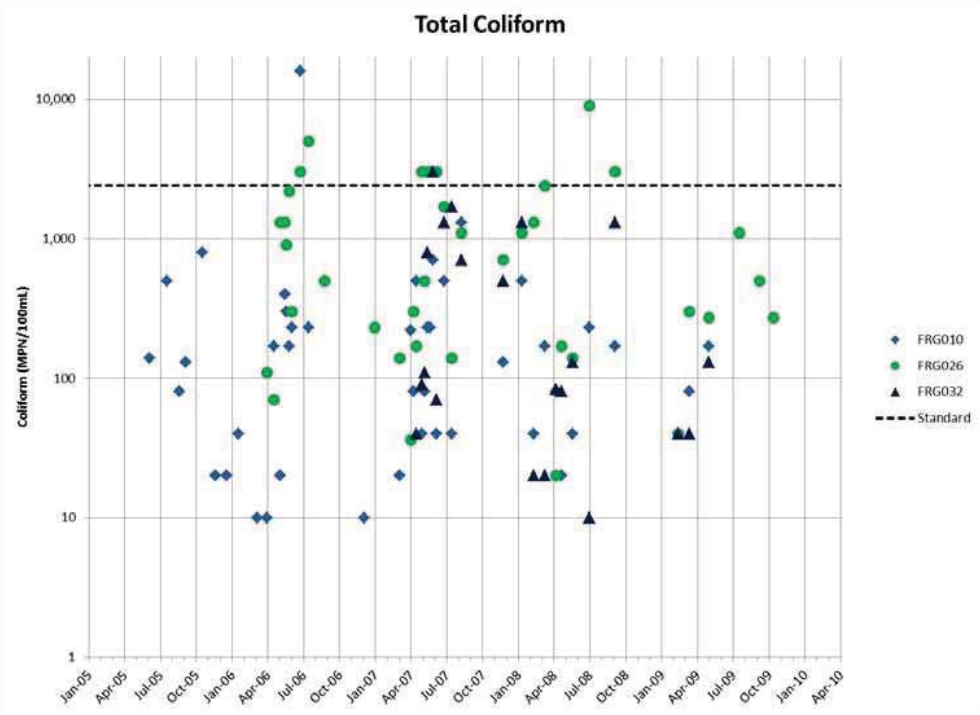


Figure 11-8. Total Coliform Time Series Near and Below the Duck Farms

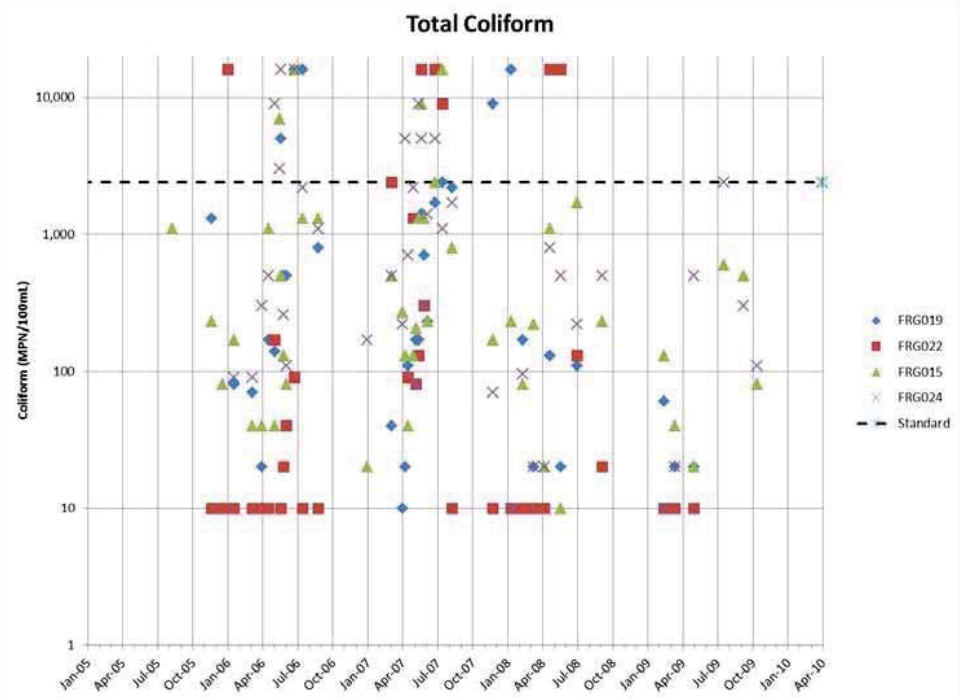
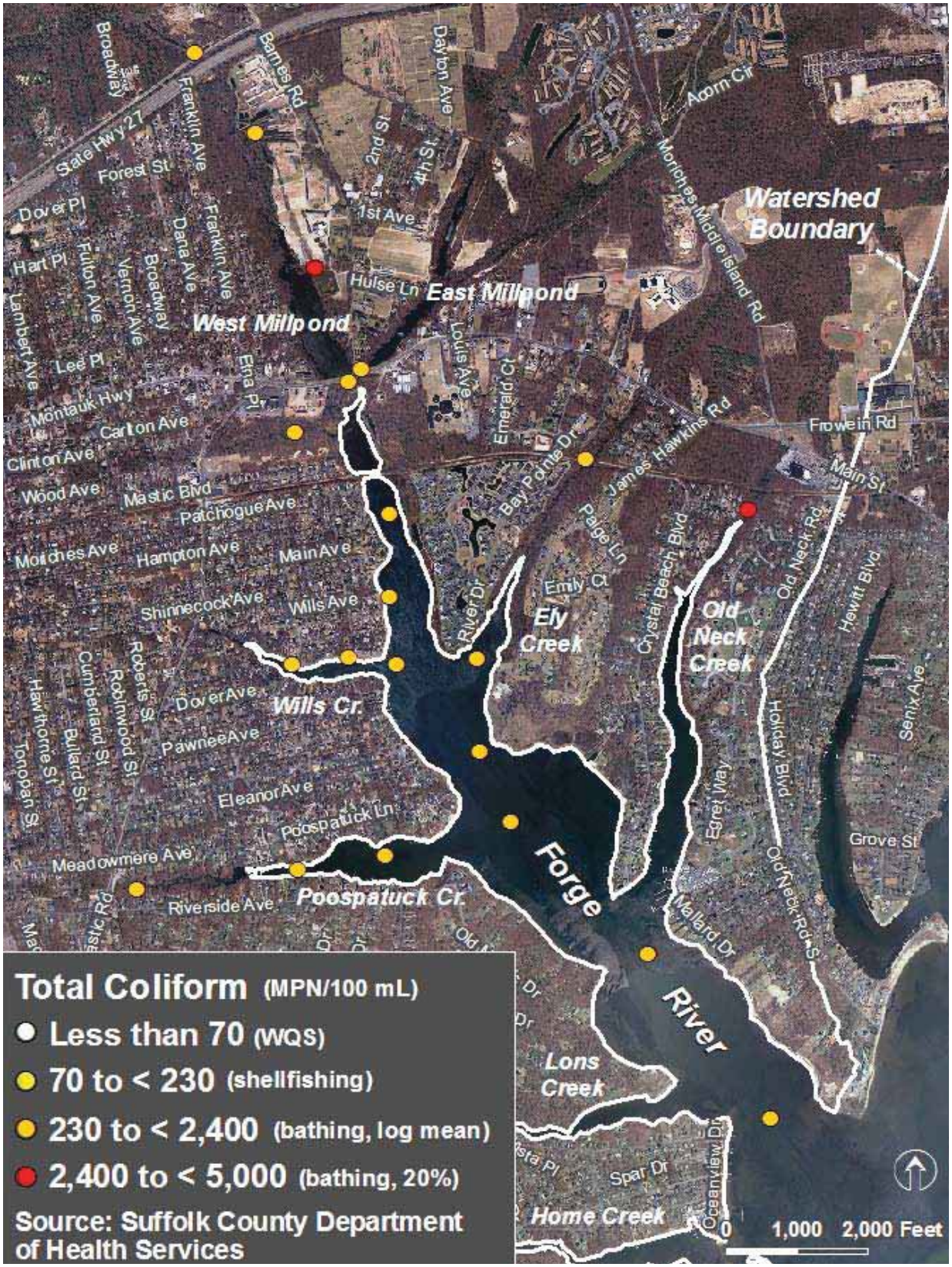


Figure 11-9. Spatial Distribution of Total Coliform in the Forge River



11.6 Chlorophyll

11.6.1 Standards

While there is no numerical water quality standard for chlorophyll-a, measurements at Moriches Bay can be used as a benchmark for interpreting Forge River chlorophyll-a values. For the period from 1995 through 2008, the average chlorophyll-a concentration at Station 080110 was 12.2 µg/L. Recommended impairment levels for chlorophyll-a in freshwater are typically in the range 25 to 50 µg/L. The Carlson Trophic State Index was developed to characterize lake conditions. Under this classification system, chlorophyll-a concentrations exceeding 40 µg/L are an indication of hyper-eutrophic conditions. Given these benchmarks, algal populations in many parts of the Forge River are exceptionally high.

11.6.2 Monitoring Results

Chlorophyll-a concentrations were measured primarily in the middle and lower Forge River. Frequent sampling was also performed at three stations in Wills Creek and one station in Poospatuck Creek. The time series of chlorophyll-a measurements is provided in Figure 11-10 through Figure 11-13. Wills Creek and Poospatuck Creek chlorophyll-a measurements (Figure 11-10 and Figure 11-11) were frequently reported between 100 and 300 µg/L and numerous times even higher. These are exceptionally high values reflecting the presence of dense blooms of phytoplankton. Values for the Middle Forge River are similarly high (Figure 11-12). Chlorophyll-a in the Lower Forge River was considerably lower, but still five to ten times higher than in Moriches Bay reflecting the presence of eutrophied waters throughout the Forge River estuary.

Figure 11-10. Chlorophyll-a Time Series for Wills Creek

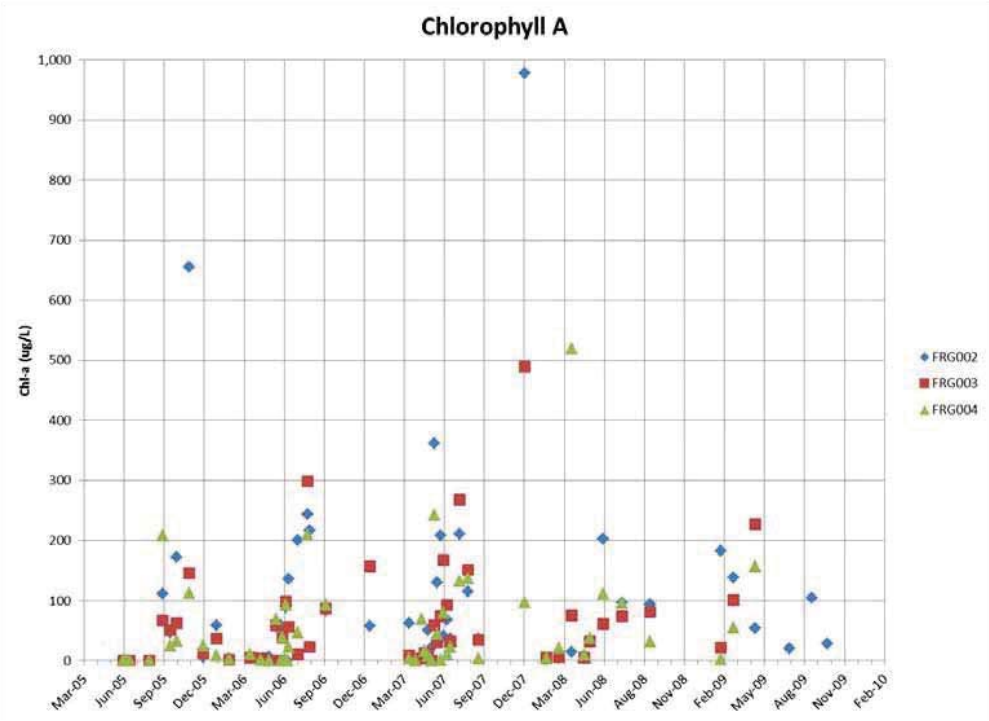


Figure 11-11. Chlorophyll-a Time Series for Poospatuck Creek

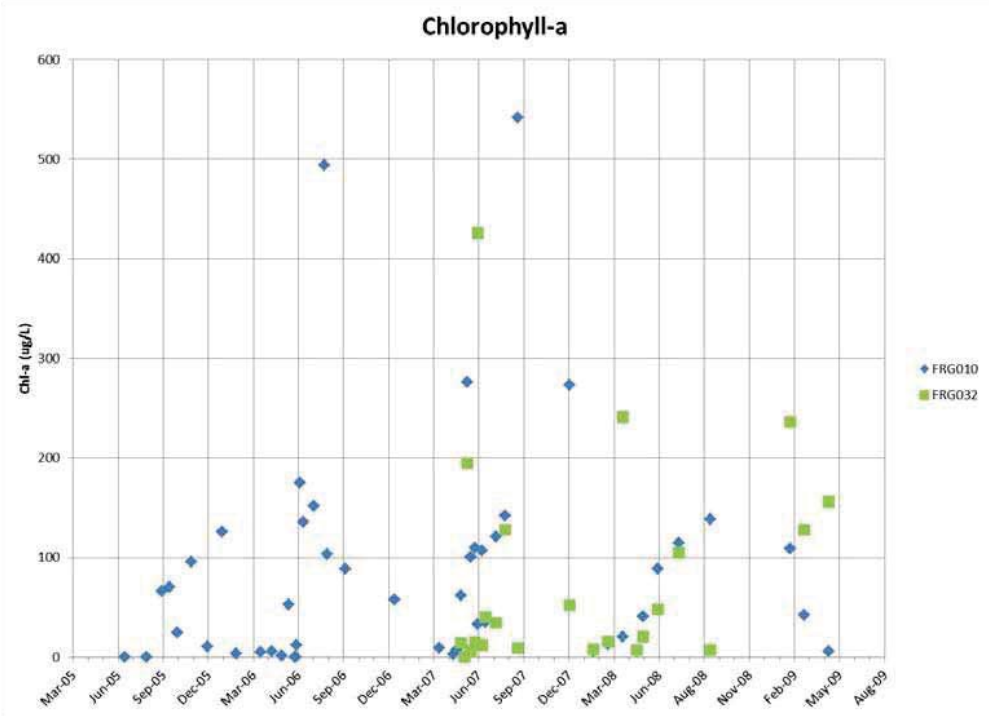


Figure 11-12. Chlorophyll-a Time Series for Middle Forge River

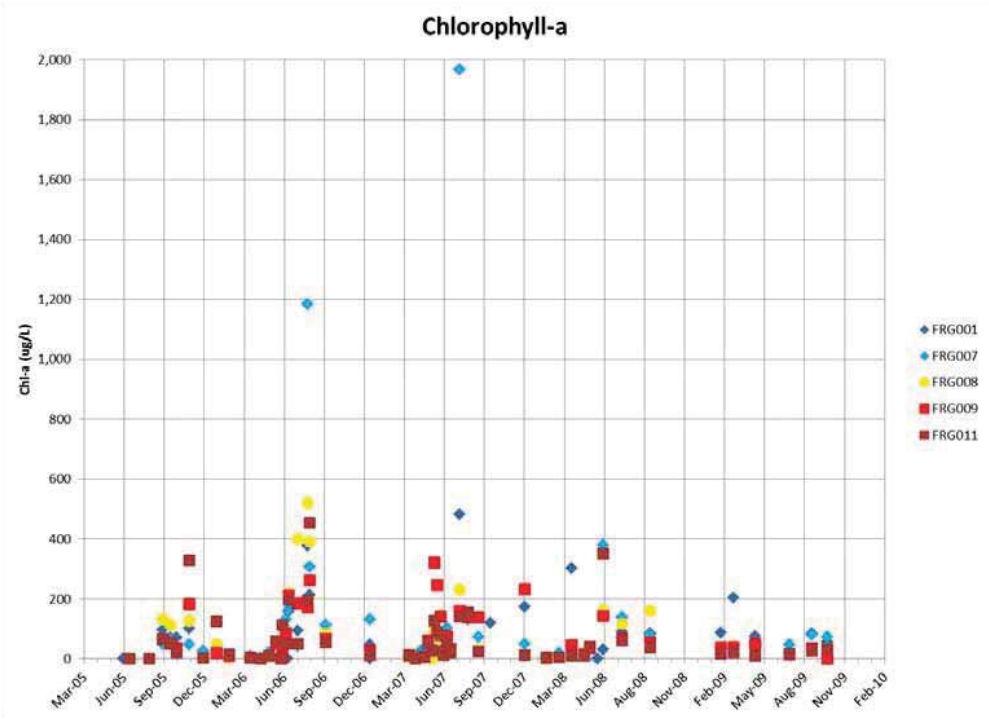
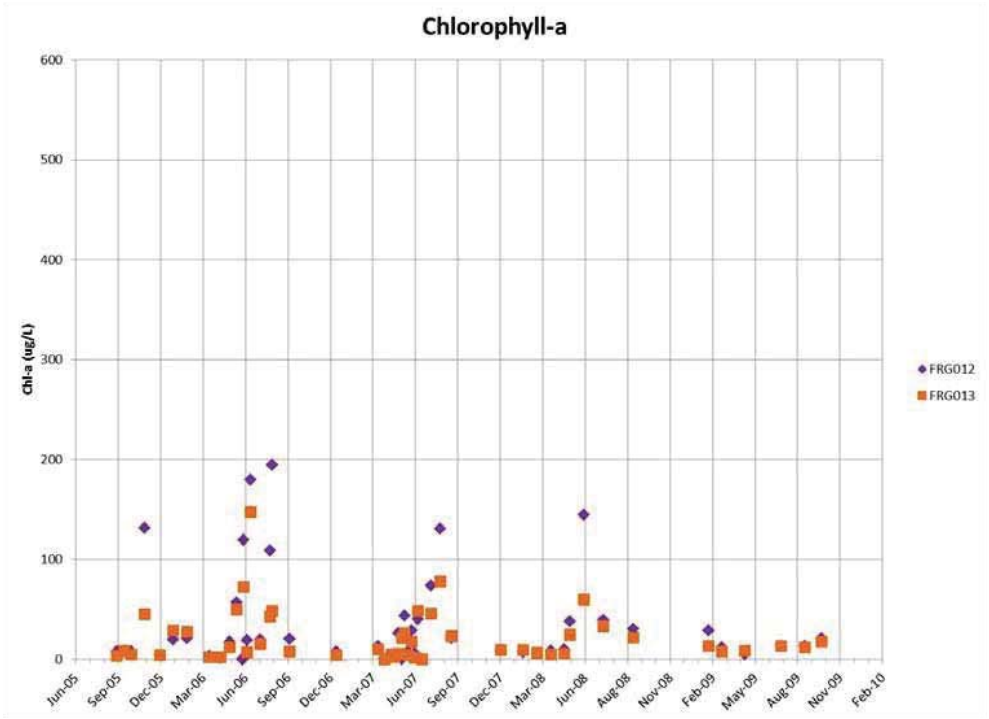


Figure 11-13. Chlorophyll-a Time Series for Lower Forge River



11.7 Dissolved Oxygen

11.7.1 Standards

The NYSDEC has determined that a daily average minimum dissolved oxygen (DO) concentration of 4.8 mg/L should be the Marine Dissolved Oxygen Standard for healthy estuaries based on a calculation described in Part 703.3 of the Rules and Regulations of the State of New York.

Calculating the frequency that this standard is violated helps identify where problems are (Table 11-5). The number of violations divided by the total number of observations yields the percent non-compliance. This analysis was performed using the Forge River station for the period from June 2005 through October 2009. The results of this analysis are provided in Figure 11-14, Figure 11-15, Figure 11-16, and Figure 11-17. Each of the figures shows the percent of the average DO observations (for that season) below the standard of 4.8 mg/L. The data reveal that DO in the winter (Figure 11-14) is generally above the minimum value. In the spring, conditions (Figure 11-15) have deteriorated in upper reaches of the Forge River, by the West Mill Pond discharge, in Wills and Poospatuck Creeks. By summer (Figure 11-16), conditions worsen in the same creeks as well as in the middle of main body of the Forge River. By the fall (Figure 11-17), average DO is again above the minimum standard value of 4.8 mg/L.

Table 11-5. Summary of Dissolved Oxygen Non-Compliance (single measurement < 4.8 mg/L)

Station	Winter			Spring			Summer			Fall		
	Observation	Violations	%	Observation	Violations	%	Observation	Violations	%	Observation	Violations	%
FRG001	9	0	0%	31	4	13%	15	2	13%	6	0	0%
FRG002	9	0	0%	30	4	13%	14	2	14%	6	0	0%
FRG003	9	0	0%	26	5	19%	12	2	17%	5	0	0%
FRG004	9	0	0%	31	8	26%	11	4	36%	4	0	0%
FRG005	3	1	33%	3	1	33%	4	4	100%	1	1	100%
FRG006	-	-	-	4	4	100%	2	0	0%	-	-	-
FRG007	9	0	0%	23	2	9%	14	4	29%	6	0	0%
FRG008	9	0	0%	23	0	0%	12	1	8%	5	0	0%
FRG009	9	0	0%	25	1	4%	14	1	7%	6	0	0%
FRG010	9	0	0%	23	4	17%	12	2	17%	5	0	0%
FRG011	9	0	0%	25	1	4%	14	2	14%	6	0	0%
FRG012	9	0	0%	24	1	4%	14	1	7%	6	0	0%
FRG013	9	0	0%	22	1	5%	14	0	0%	6	0	0%
FRG015	10	0	0%	20	4	20%	11	3	27%	3	1	33%
FRG016	-	-	-	-	-	-	1	1	100%	-	-	-
FRG017	-	-	-	3	0	0%	1	0	0%	-	-	-
FRG019	9	0	0%	18	0	0%	7	0	0%	2	0	0%
FRG020	9	0	0%	19	0	0%	10	0	0%	3	0	0%
FRG021	1	0	0%	-	-	-	-	-	-	1	0	0%
FRG022	4	0	0%	6	0	0%	2	2	100%	1	0	0%
FRG024	9	0	0%	20	0	0%	10	1	10%	2	0	0%
FRG025	7	0	0%	19	0	0%	10	0	0%	2	0	0%
FRG026	7	5	71%	20	15	75%	10	10	100%	2	2	100%
FRG027	7	1	14%	20	0	0%	10	0	0%	2	0	0%
FRG028	7	0	0%	19	6	32%	10	3	30%	1	0	0%
FRG029	-	-	-	-	-	-	-	-	-	1	0	0%
FRG030	-	-	-	-	-	-	-	-	-	1	0	0%
FRG031	-	-	-	-	-	-	-	-	-	1	0	0%
FRG032	5	0	0%	12	1	8%	5	5	100%	1	0	0%
FRGA	-	-	-	-	-	-	1	0	0%	1	0	0%
FRGB	-	-	-	-	-	-	1	0	0%	1	0	0%
FRGM	-	-	-	-	-	-	1	0	0%	1	0	0%
Total	**177**	**7**	**4%**	**466**	**62**	**13%**	**242**	**50**	**21%**	**88**	**4**	**5%**

Figure 11-14. Percent of Average Winter Dissolved Oxygen below 4.8 mg/L Standard

Figure 11-15. Percent of Average Spring Dissolved Oxygen below 4.8 mg/L Standard

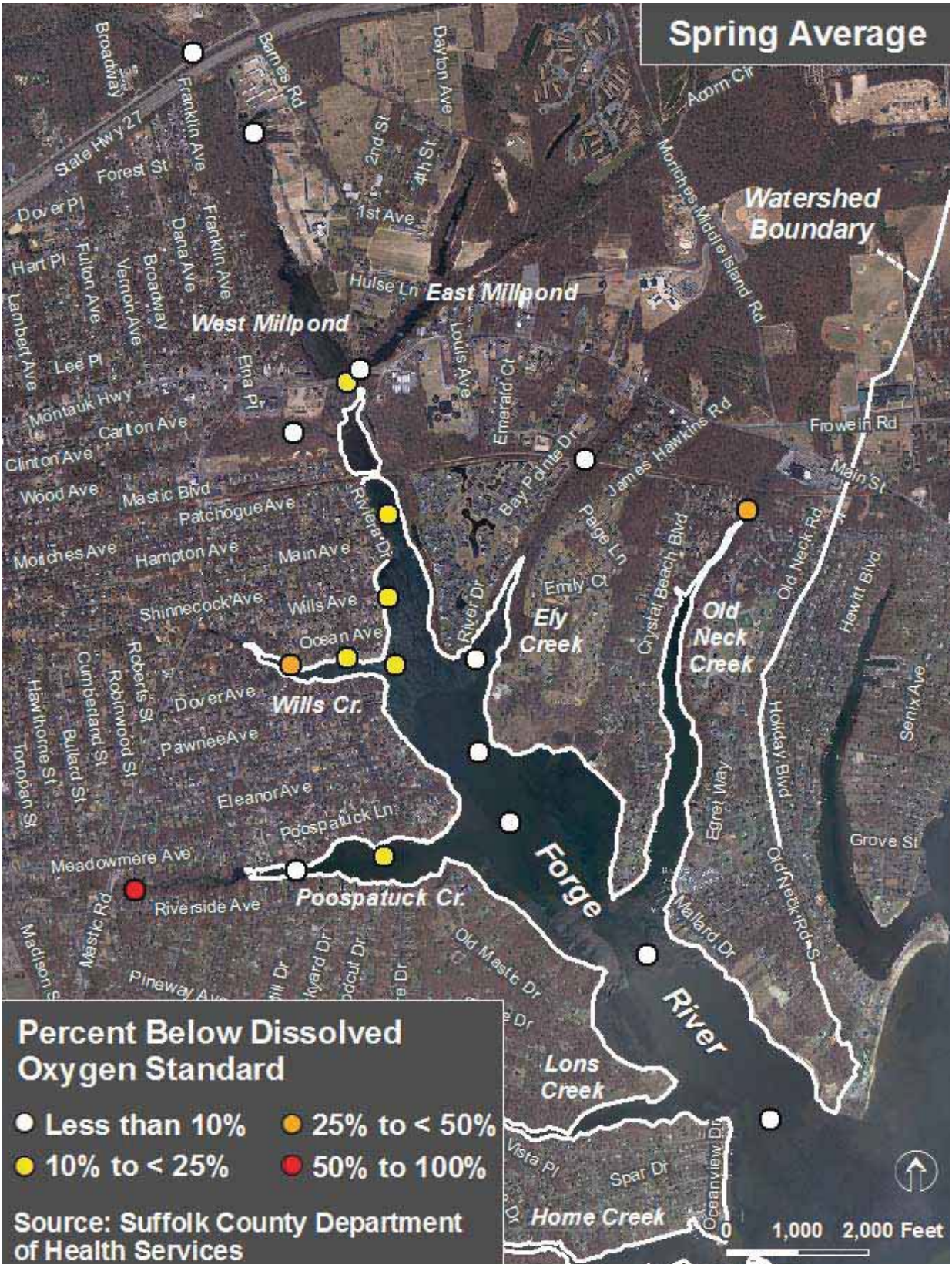


Figure 11-16. Percent of Average Summer Dissolved Oxygen below 4.8 mg/L Standard

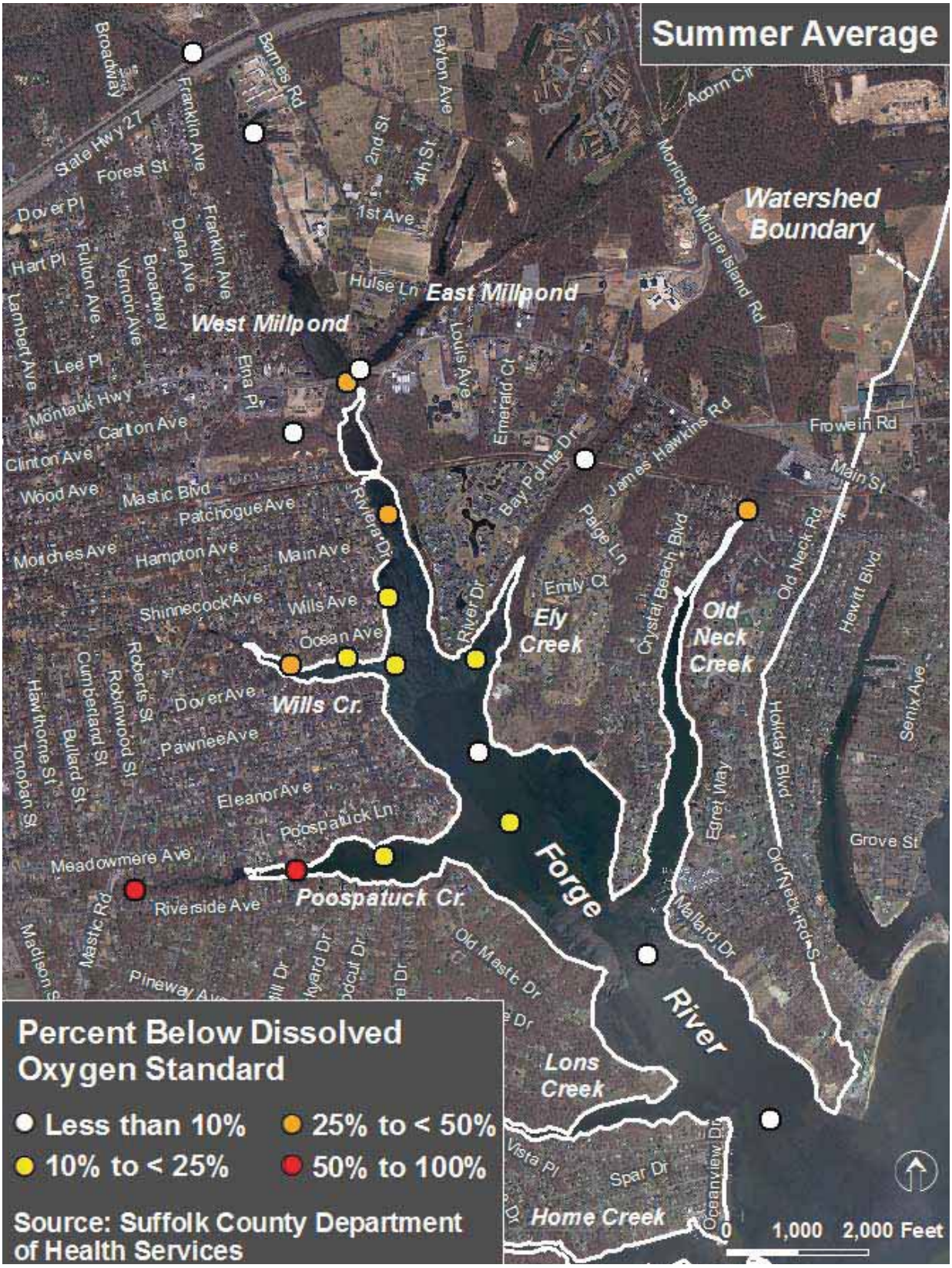


Figure 11-17. Percent of Average Fall Dissolved Oxygen below 4.8 mg/L Standard

11.8 Monitoring Results

The figures on the following pages show the trends in surface dissolved oxygen in the locations sampled by SCDHS. Figure 11-18 shows surface dissolved oxygen concentrations at the East Mill and West Mill Pond SCDHS stations. Releases from East Mill Pond are generally above 4.8 mg/L. The West Mill Pond discharge experienced frequent low dissolved oxygen conditions beginning in 2007. These may be due to the death and decay of the extensive algal mats observed in the pond.

Figure 11-19 shows the surface dissolved oxygen concentrations at the frequently monitored SCDHS creek stations, with the exception of Wills and Poospatuck Creek. Dissolved oxygen in Old Neck Creek showed frequent low dissolved oxygen in 2006 and early 2007. Conditions appear to have improved in recent years. The remaining creek stations had observed dissolved oxygen above 4.8 mg/L. Figure 11-20 shows the surface dissolved oxygen concentrations at duck farm releases. It can be seen that dissolved concentrations below Titmus Farms (Barnes Road) were above 4.8 mg/L. Observations below Jurgielewicz Farms had three low dissolved oxygen readings in 2006. Monitoring data from 2007 to present were not available.

Surface and bottom dissolved oxygen measurements were collected by SCDHS in Wills Creek, Poospatuck Creek, the middle Forge River, and lower Forge River. Dissolved oxygen data for these stations are shown in

Figure 11-21 through Figure 11-24. Each of these stations realized frequent low dissolved oxygen concentrations. While many of these measurements are from bottom depths, where dissolved oxygen is more likely to be low due to stratification, lower algal production and microbial oxygen demand, many low measurements are also from the surface. The maximum saturation level of dissolved oxygen is in the range of 12.0 to 14.5 mg/L depending on ambient temperature and salinity. Numerous measurements of dissolved oxygen exceeded saturation. These high concentrations most likely occur from photosynthesis during algal blooms.

Both Wills Creek and Poospatuck Creek show headwater inflows with dissolved oxygen less than 4.8 mg/L. The inflows to these creeks show elevated levels of nitrogen, possibly from poorly functioning septic systems. The high nitrogen may be driving algal growth (both phytoplankton and macroalgae like *Ulva*), which leads to high biological oxygen demand (BOD) from the microbial decay of this algal production. Finally, deposition of

other organic matter to the sediments like leaf fall and material carried by stormwater can be a source of sediment oxygen demand.

The middle Forge River experiences the most frequent periods of low dissolved oxygen. This part of the river receives much of the nitrogen load, supports high algal productivity, and has limited exchange with Moriches Bay. Review of the data collected in the lower Forge River show less frequent low dissolved oxygen, likely due to improve mixing and exchange with Moriches Bay. Data was also collected by SCDHS within Moriches Bay. These data are shown in

Figure 11-25. Dissolved oxygen concentrations are above 4.8 mg/L with the exception of one bottom depth observation.

Maps of the average dissolved oxygen were prepared to provide a spatial perspective to the analysis. Besides nitrogen supply, algal growth is light and temperature dependent. In addition, dissolved oxygen is temperature dependent with solubility being lower at higher temperatures. For these reasons, dissolved oxygen is presented on a seasonal basis. The seasonally averaged results are shown in Figure 11-14 through Figure 11-17.

During the winter, low water temperatures increase the solubility of oxygen. Algal growth is also low due to the colder temperatures and limited sunlight. As shown in Figure 11-14, the observations generally reflect the high dissolved oxygen concentrations. Of note are the higher number of violations seen at the headwaters of Poospatuck Creek and Ely Creek. Only one of seven dissolved oxygen measurements in Ely Creek was below the NYSDEC's standard of 4.8 mg/L, indicating a limited problem. However, five of seven measurements on Poospatuck Creek were below 4.8 mg/L during the winter, indicating a significant problem.

Conditions during the summer are similar, with Old Neck Creek and Wills Creek having a moderate number of violations and Poospatuck Creek having frequent violations. Stations in the main branch of the Forge River above Ely Creek also experience frequent violations as shown in Figure 11-16.

The frequency of dissolved oxygen violations during the fall is less than ten percent at all stations (Figure 11-17). Review of the seasonal violation maps shows persistent low dissolved oxygen in Poospatuck Creek and somewhat less so in Wills Creek and Old Neck Creek. The main branch of the Forge River is moderately impacted above Ely Creek with conditions improving in the lower reaches, due likely to the mixing and flushing from Moriches Bay.

The frequent violations in Poospatuck Creek, even during winter, suggest that algal blooms are only partially to blame for low dissolved oxygen measurements. Inflows to the creek may have low dissolved oxygen or the dissolved oxygen demand from sediments in this part of the system may be so large that dissolved oxygen consistently remains below 4.8 mg/L. Poor circulation may limit tidal exchange as well.

Figure 11-18. Mill Pond Discharge Dissolved Oxygen Time Series

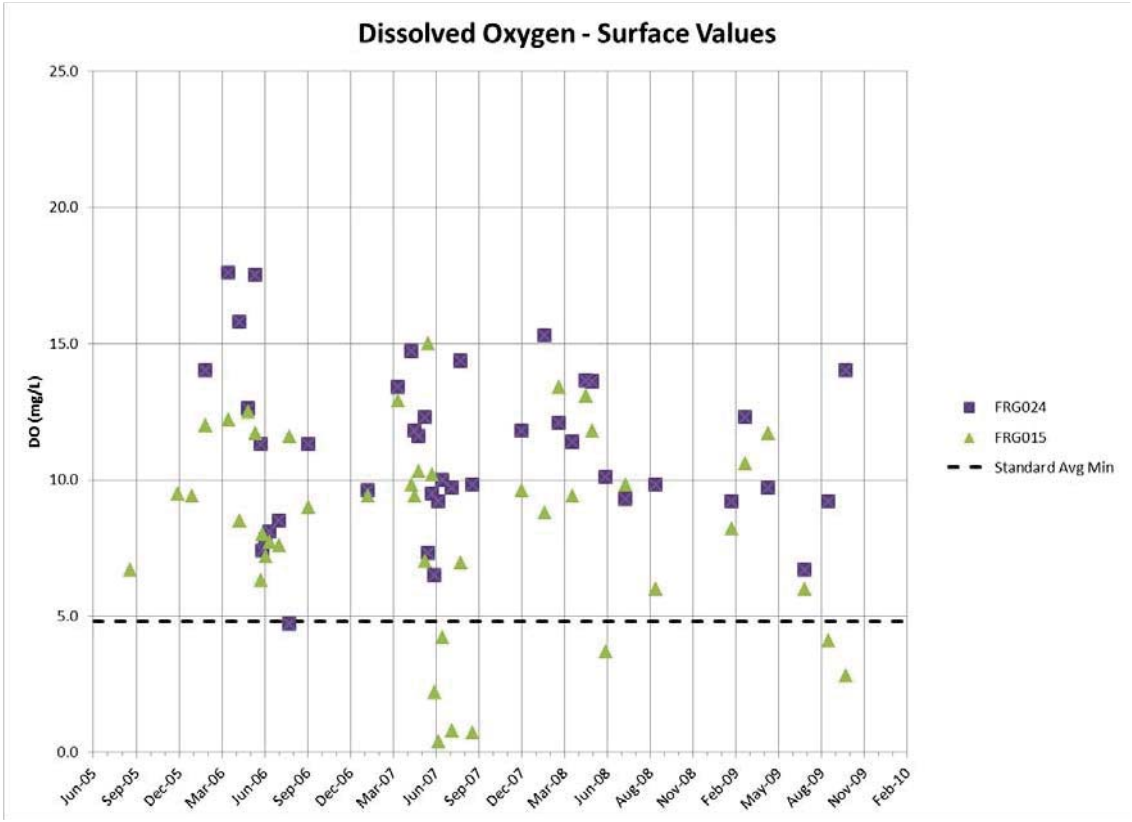


Figure 11-19. Creek Dissolved Oxygen Time Series

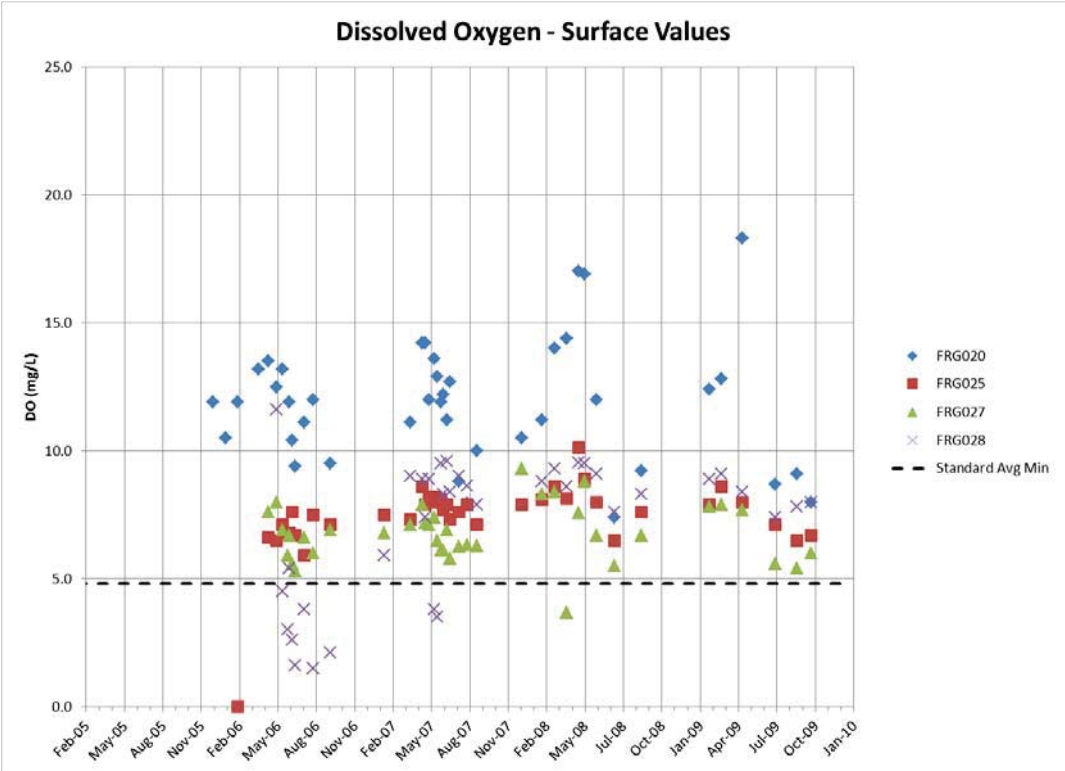


Figure 11-20. Duck Farm Discharge Dissolved Oxygen Time Series

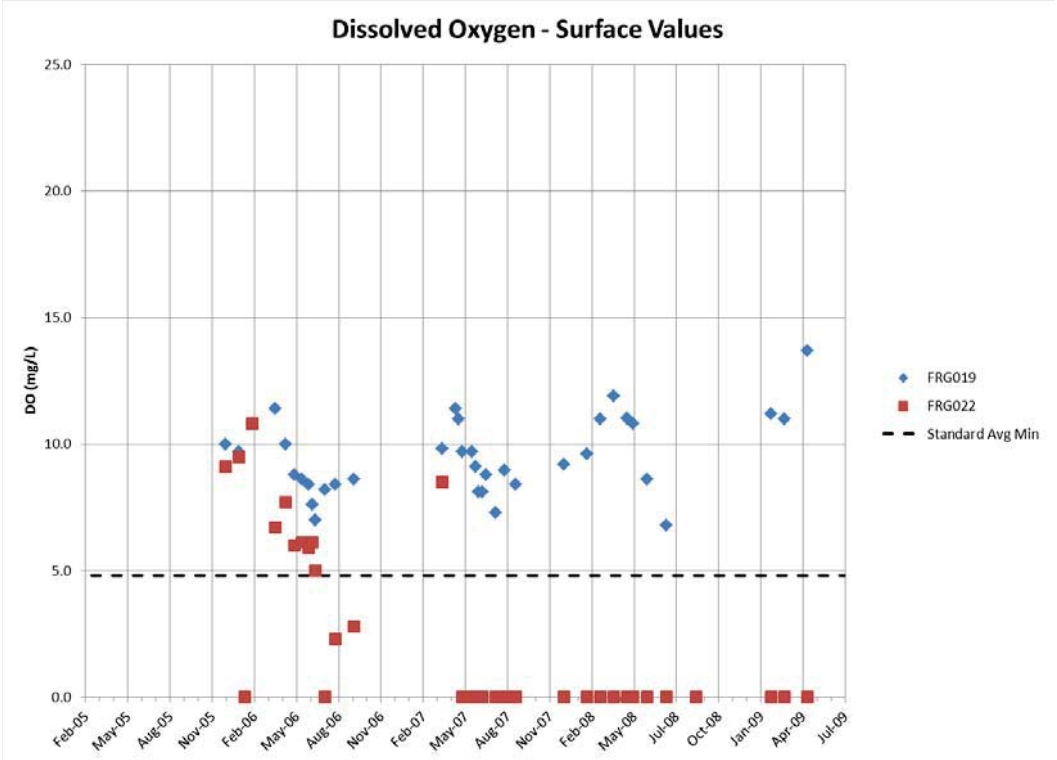


Figure 11-21. Dissolved Oxygen Time Series for Wills Creek

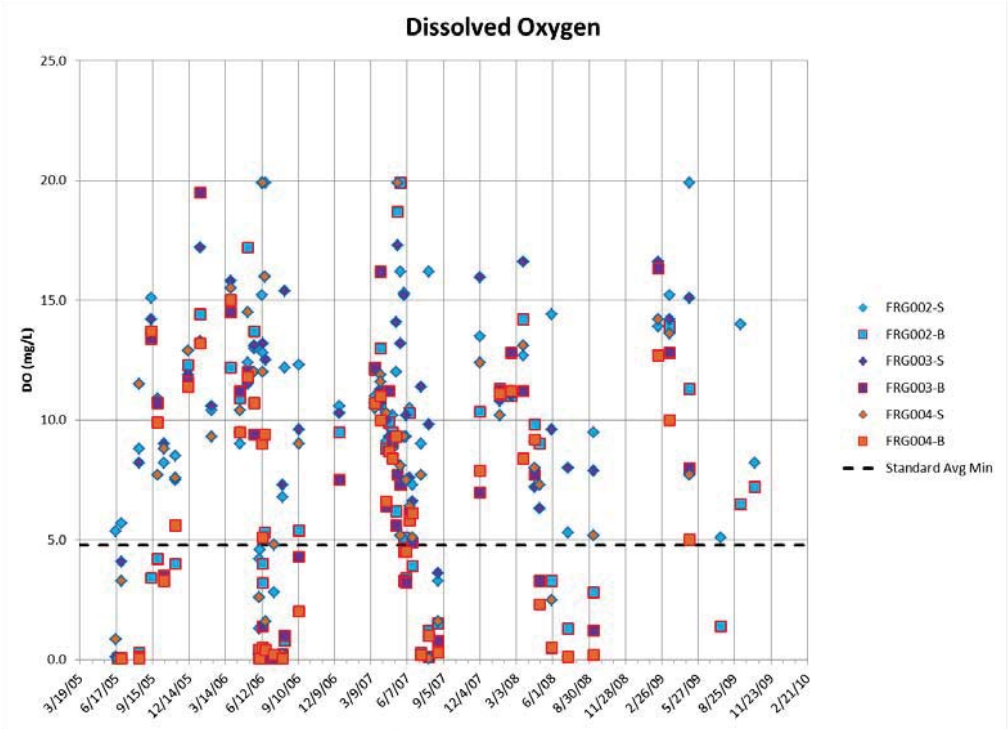


Figure 11-22. Dissolved Oxygen Time Series for the Poospatuck Creek

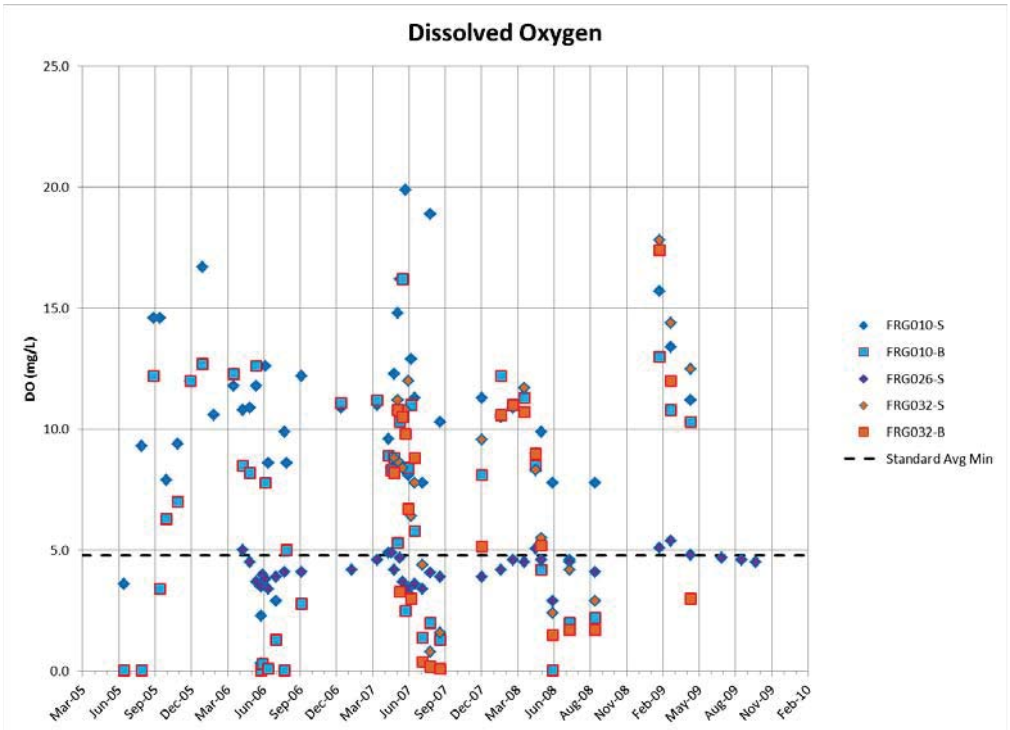


Figure 11-23. Dissolved Oxygen Time Series for the Middle Forge River

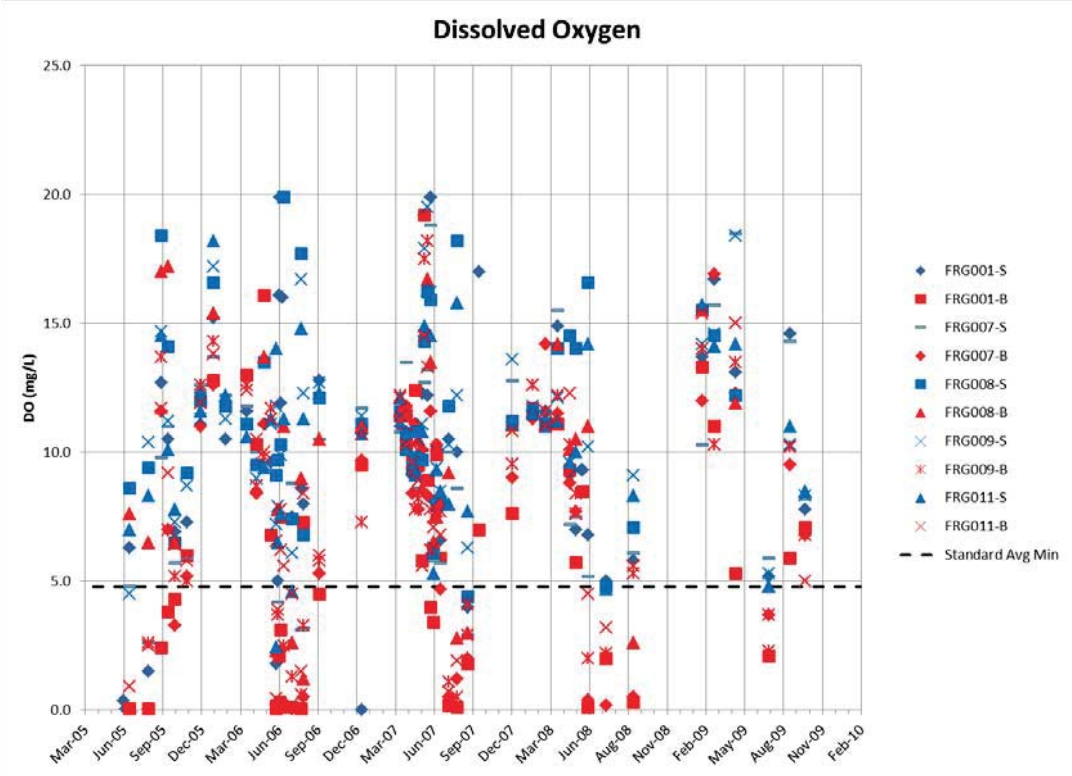


Figure 11-24. Dissolved Oxygen Time Series for the Lower Forge River

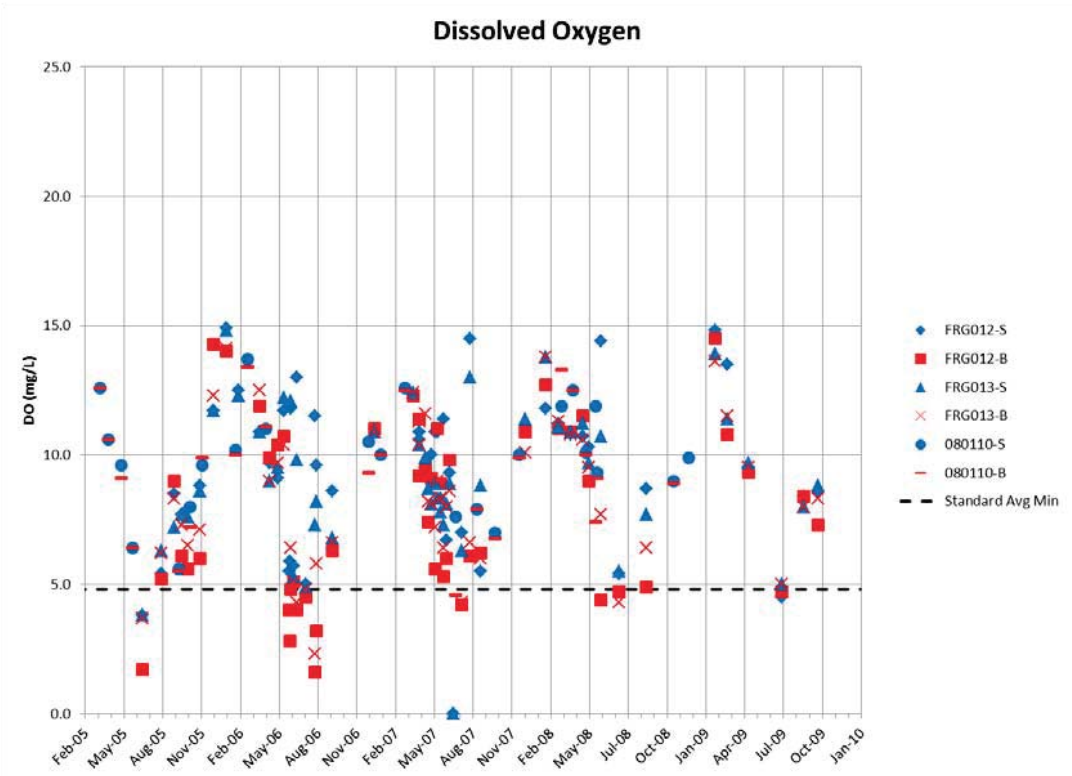
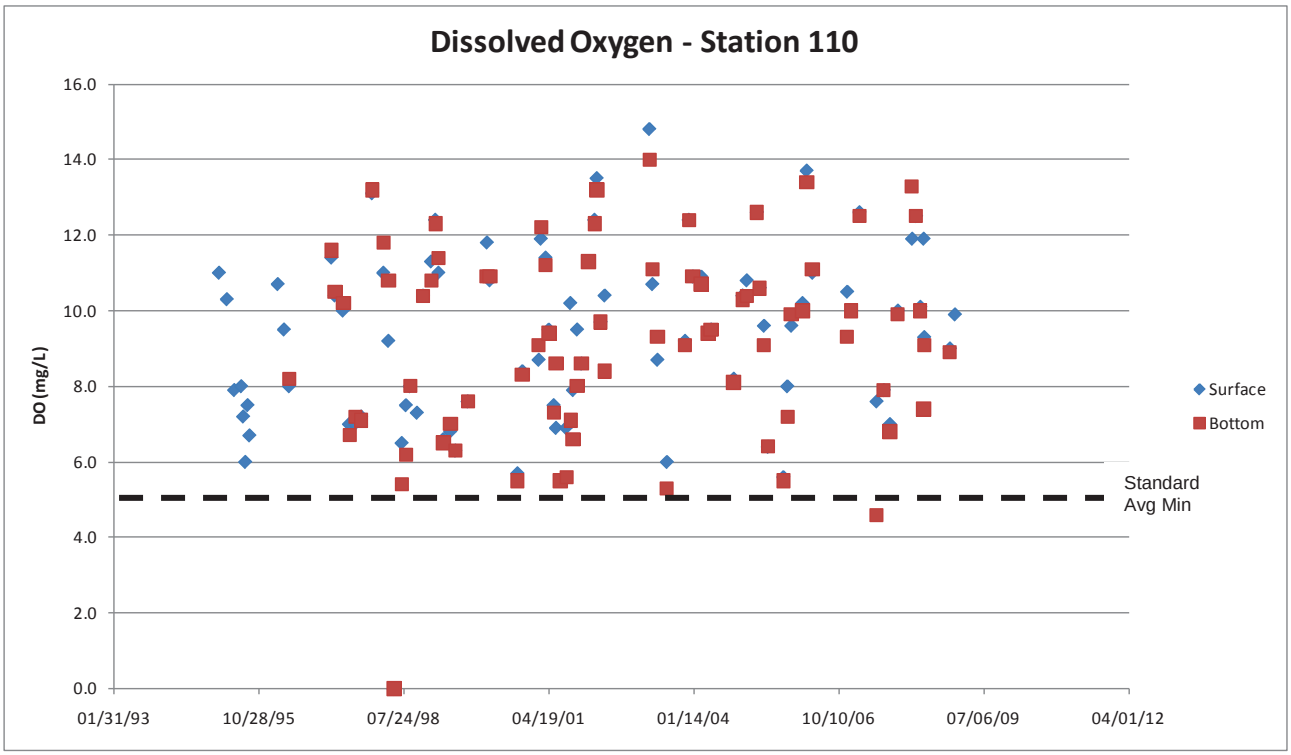


Figure 11-25. Dissolved Oxygen Time Series for Moriches Bay



11.8.1 Continuous Monitoring Results

Additional dissolved oxygen monitoring was performed by SCDHS using a submerged sonde located near Station 29. This sonde continuously measured dissolved oxygen at 15-minute increments from June 2006 through September 2009. The sonde is tethered above the bottom near Station FRG-029 in the main branch of the Forge River above Ely and Wills Creeks.

The sonde measured temperature, salinity, dissolved oxygen, and chlorophyll-a. This type of data is useful since it provides a more complete picture of how conditions vary on a day to day basis. In addition, the dissolved oxygen response of an algal bloom may lag the bloom by days as the die-off occurs and decay of the resulting organic matter begins. Daily average dissolved oxygen and chlorophyll-a were calculated to evaluate the dissolved oxygen response to algal levels. Dissolved oxygen saturation was also calculated. The calculations for 2007 through 2008 are provided in Figure 11-26.

Figure 11-26 shows that dissolved oxygen falls below 4.8 mg/L for extended periods. High dissolved oxygen periods also occur, indicating super-saturated conditions. Neither extreme is desirable and can have negative effects on aquatic life. Figure 11-27 and Figure 11-28 focus on the summer periods for 2007 and 2008. A consistent pattern of high algal

concentrations and super-saturation followed by a rapid drop in chlorophyll-a and dissolved oxygen can be seen. Sediment oxygen demand is likely to have some impact on dissolved oxygen levels but Figure 11-27 and Figure 11-28 demonstrate that algal blooms play a significant role in the dissolved oxygen cycle seen in the Forge River.

Figure 11-26. Comparison of Dissolved Oxygen, Maximum Dissolved Oxygen Saturation, and Chlorophyll-a

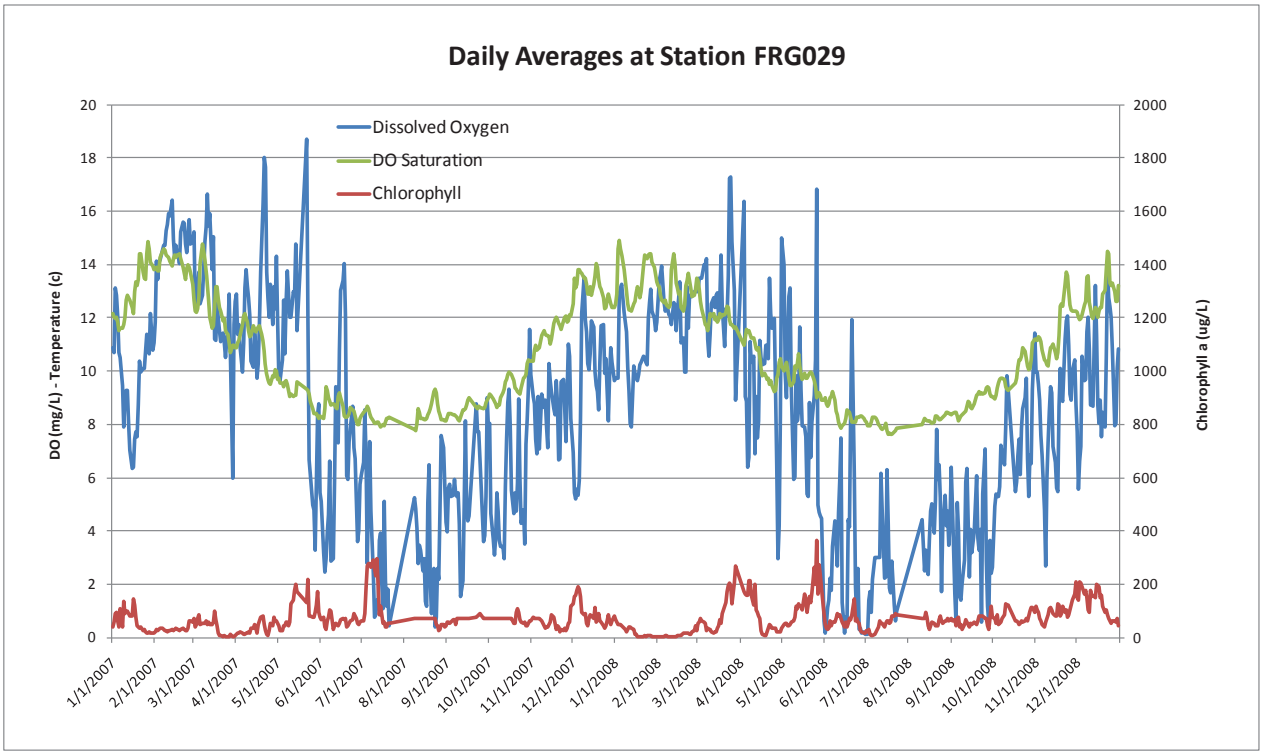


Figure 11-27. Comparison of DO, Maximum DO Saturation, Chlorophyll-a Concentrations – Summer 2007

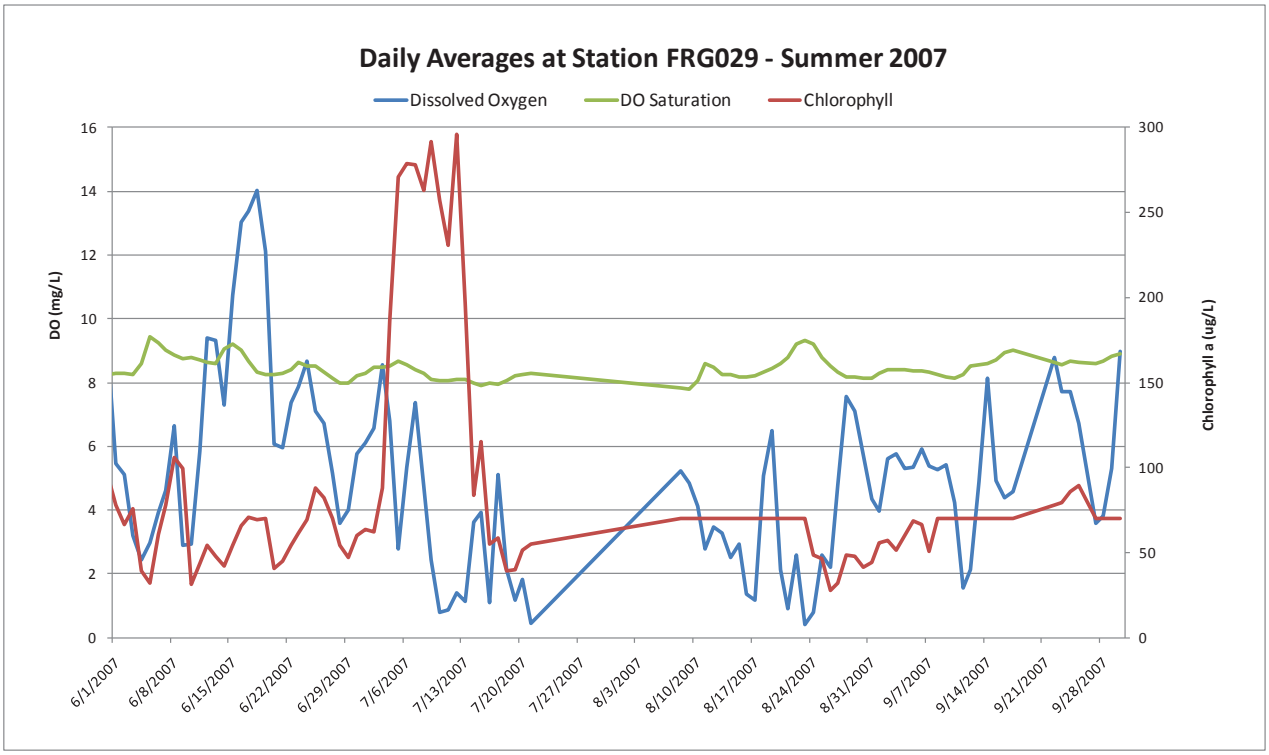
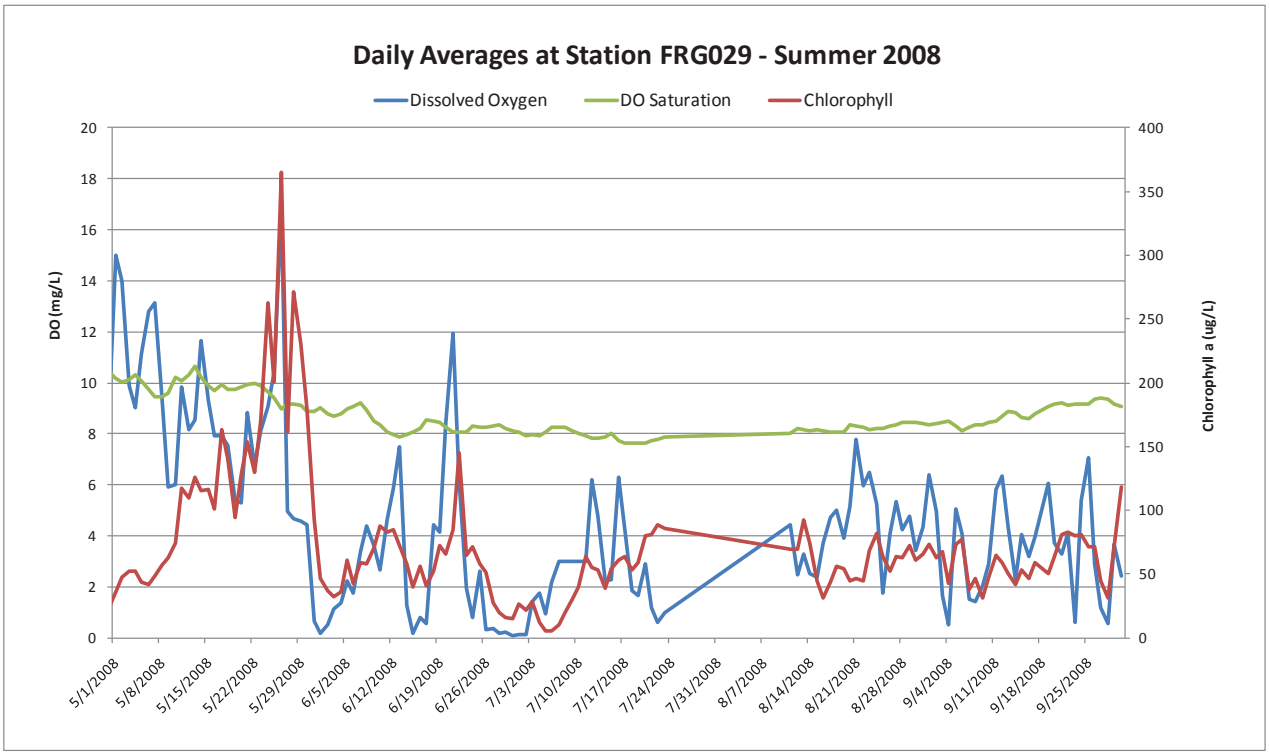


Figure 11-28. Comparison of DO, Maximum DO Saturation, Chlorophyll-a Concentrations – Summer 2008.



11.9 Nitrogen

11.9.1 Standard

There is no New York State standard value for nitrogen in marine waters. Nitrogen, however, is the primary cause of eutrophication in marine waters and subsequent negative impacts on dissolved oxygen (Swanson, O'Connell, Brownawell, Gobler, & Wilson, 2009). Development of a Total Maximum Daily Load (TMDL) for nitrogen is, therefore, a means of establishing a 'standard' for a particular body of water. The TMDL for nitrogen is that value of nitrogen input that can be absorbed by the waterbody without experiencing significant detrimental effects. A TMDL will be established for the Forge River in the near future.

11.9.2 Monitoring Results

Statistical analyses, time series plots, and loading estimates were used to help define the relationship between nutrient levels and eutrophic conditions. Basic statistics and time series plots for nitrate, total nitrogen, and dissolved oxygen were generated for each of the stations. SCDHS stations were grouped into sets with similar locations or characteristics for the development of the statistics and for time series plots. These groupings include headwater reaches, duck farm discharge, pond discharge, Poospatuck Creek, Wills Creek, the Middle Forge River, and the Lower Forge River. Data for these groupings were plotted to characterize different components of the system (*e.g.*, headwaters, runoff discharge, etc.).

Nitrogen Time Series

The loading evaluation performed by Stony Brook University researchers indicates that the majority of runoff from the Forge River watershed is captured and subsequently released from the East Mill Pond and West Mill Pond. Nitrogen concentrations from these ponds are provided in Figure 11-29. Additional loading from the watershed enters at the creek tributaries to the Forge River. The nitrogen concentrations for the major creeks, with the exception of Wills and Poospatuck Creeks, are shown in Figure 11-30. The pond and creek concentrations reflect both nitrogen in runoff and shallow groundwater contributions. Releases from the Titmus and Jurgielewicz Duck Farms are also discharged to surface waters. The nitrogen concentrations at these two stations are provided in Figure 11-31.

Nitrogen also enters the Forge River from its creeks. Wills Creek and Poospatuck Creek discharge to the middle portion of the Forge River and were monitored frequently. The time series of nitrogen concentrations for Wills Creek and Poospatuck Creek are provided in Figure 11-32 and

Figure 11-33, respectively.

SCDHS monitoring stations in the Middle Forge River reflect the inputs from the East Mill and West Mill Ponds and the duck farms. The time series of nitrogen concentrations for the Middle Forge River monitoring stations are provided in Figure 11-34.

SCDHS stations in the lower Forge River receive nitrogen loadings from upstream but also have an exchange with Moriches Bay. Data indicate lower concentrations than those seen in the creeks or Middle Forge River. The time series of nitrogen concentrations for the Lower Forge River are provided in Figure 11-35.

Average Surface Water Nitrogen

Figure 11-36 shows the distribution of average surface water nitrogen throughout the Forge River estuary. Nitrogen concentrations clearly increase with distance from the mouth of the estuary and near the heads of the tributary creeks. Nitrogen is relatively high even in the main body of the estuary.

Figure 11-29. Pond Discharge Nitrogen Time Series (East & West Mill Ponds)

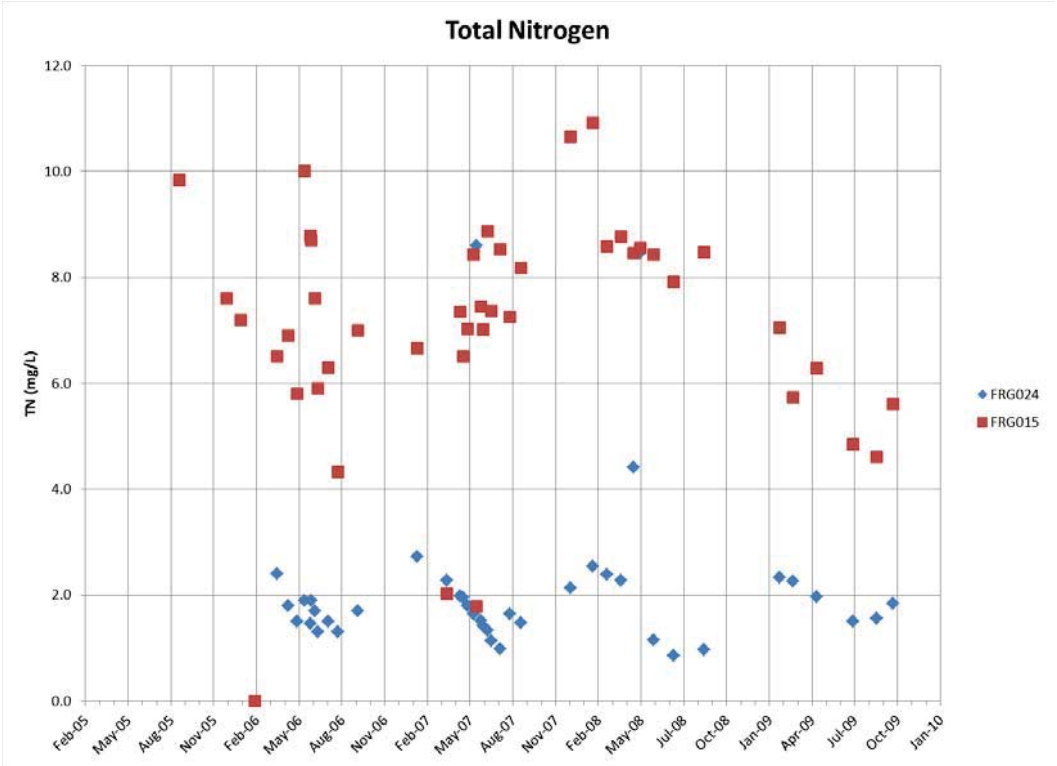


Figure 11-30. Creek Nitrogen Time Series

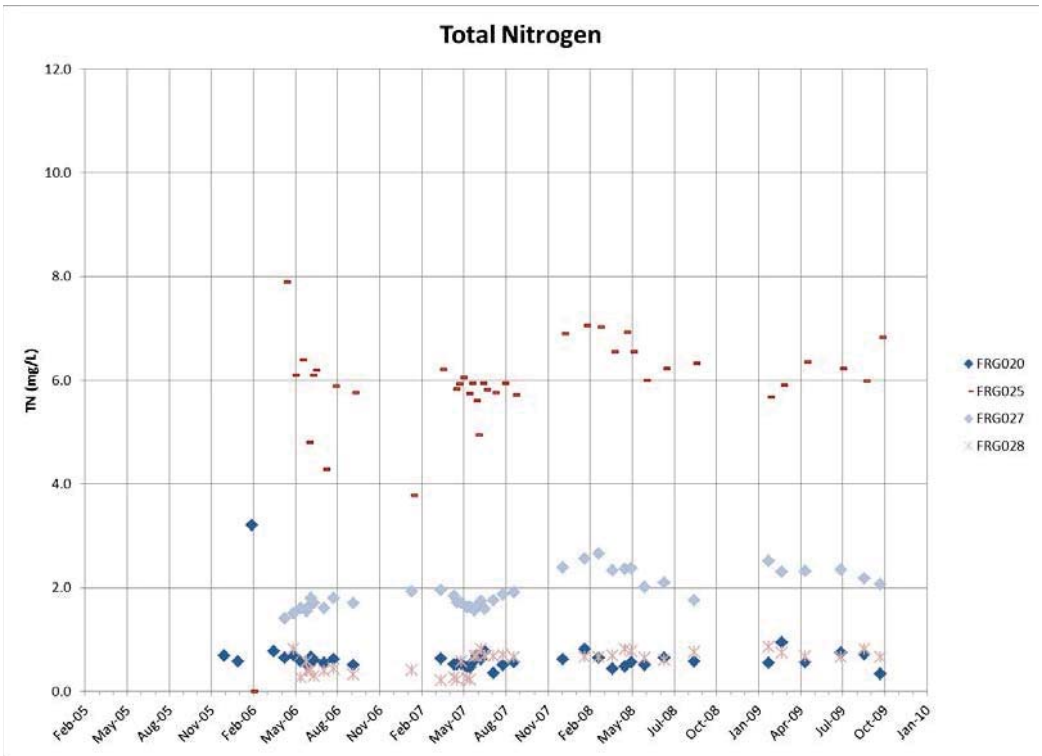


Figure 11-31. Duck Farm Discharge Nitrogen Time Series

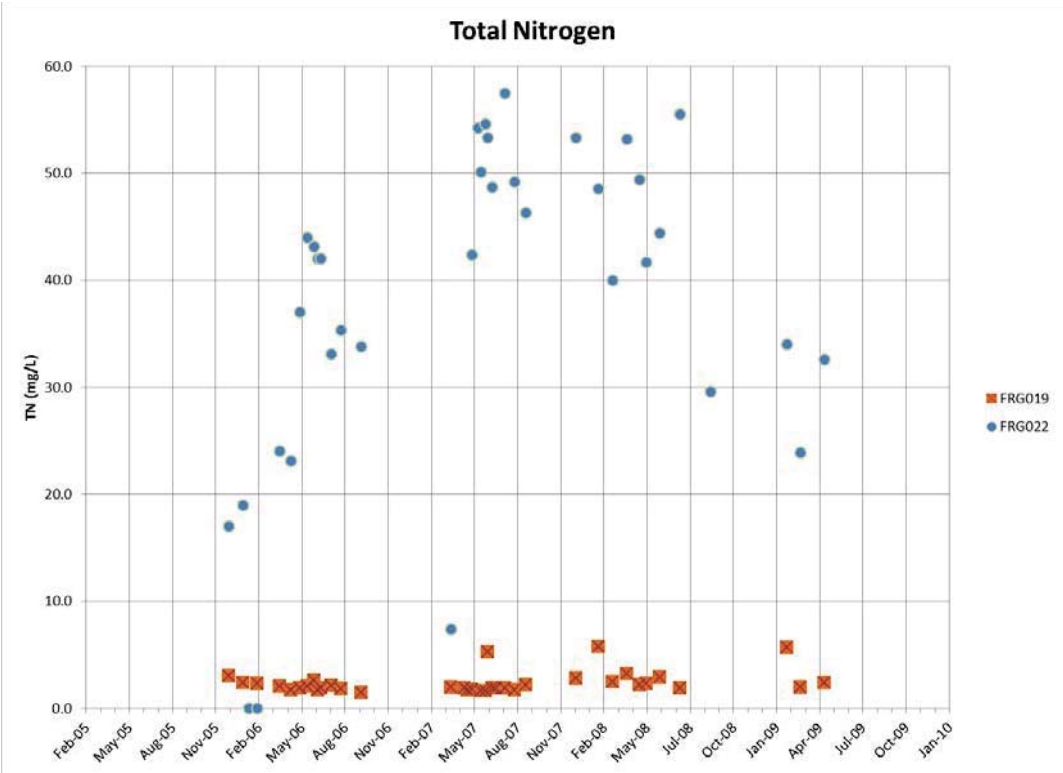


Figure 11-32. Nitrogen Time Series for Wills Creek

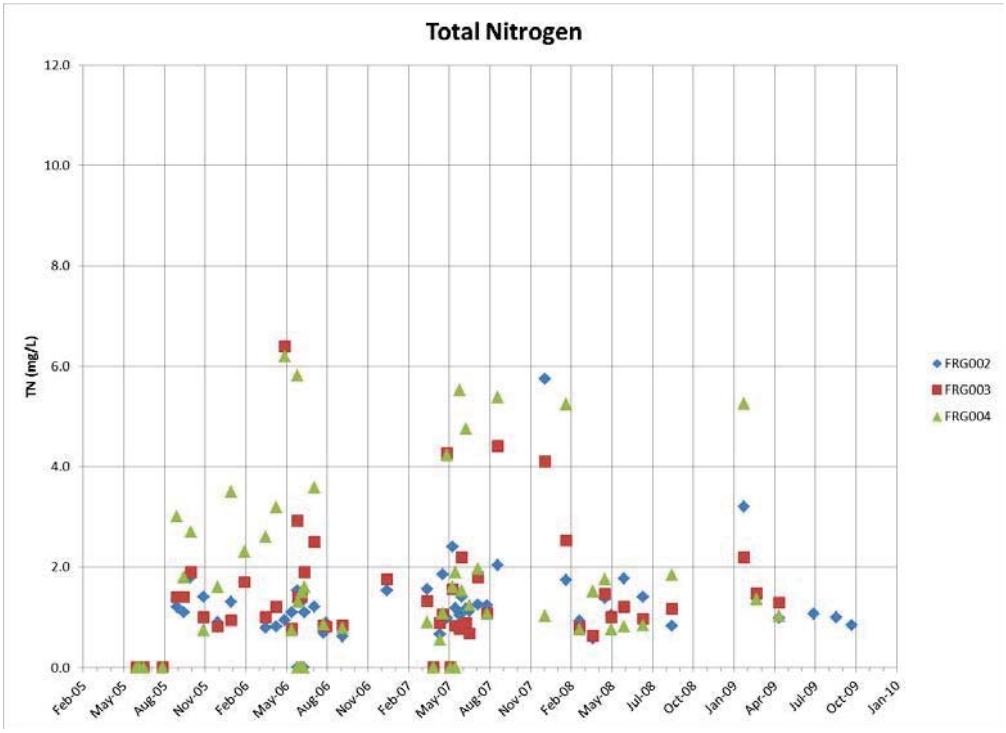


Figure 11-33. Nitrogen Time Series for Poospatuck Creek

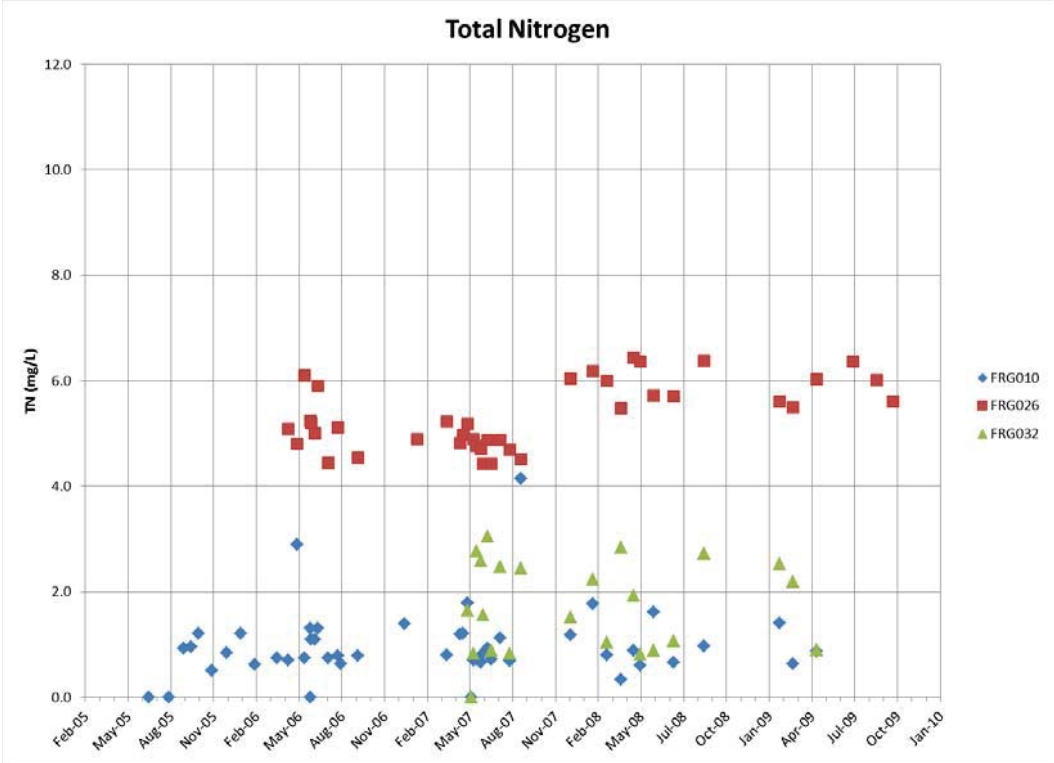


Figure 11-34. Nitrogen Time Series for the Middle Forge River

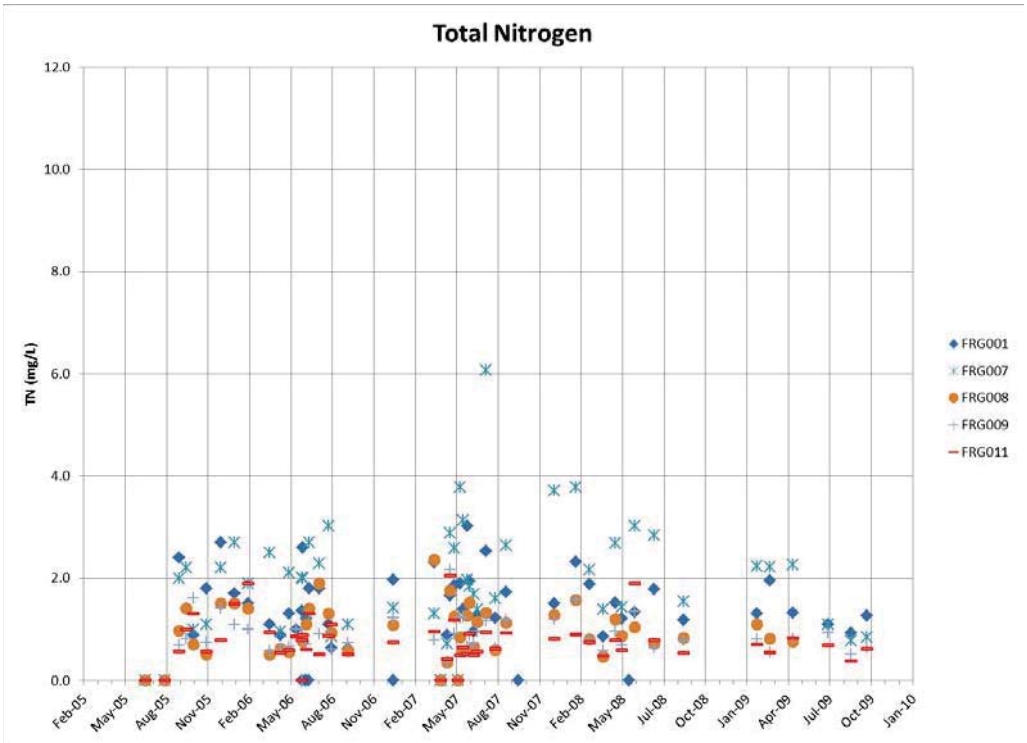


Figure 11-35. Nitrogen Time Series for the Lower Forge River

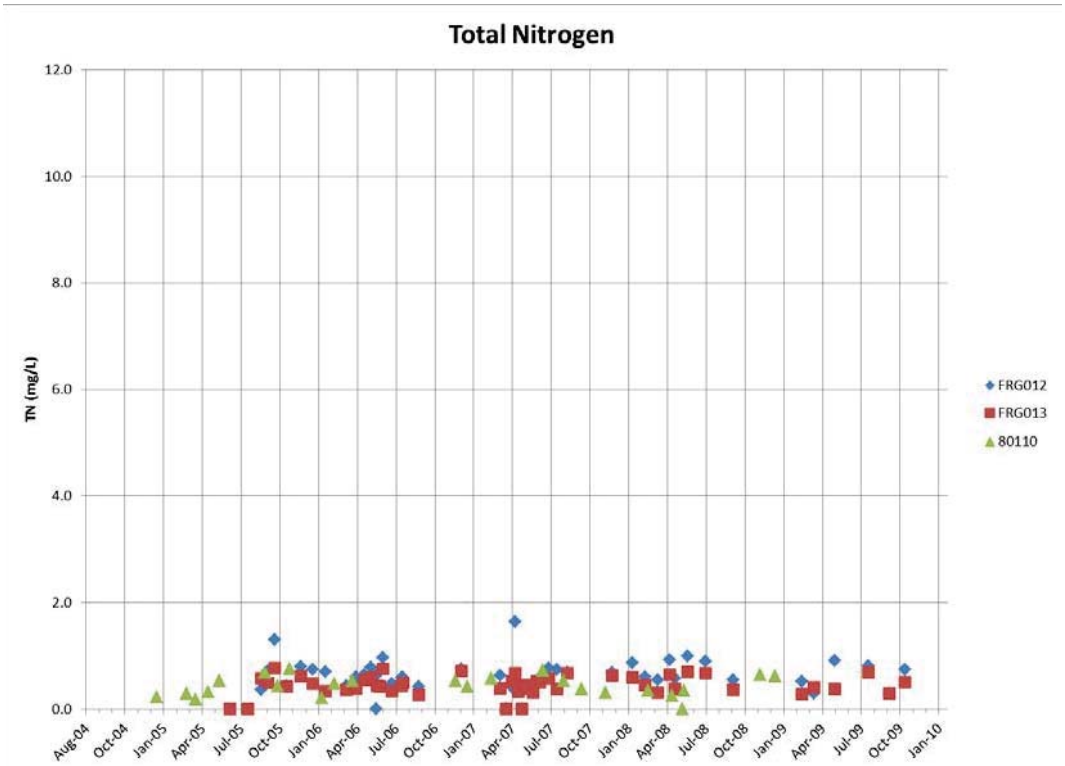
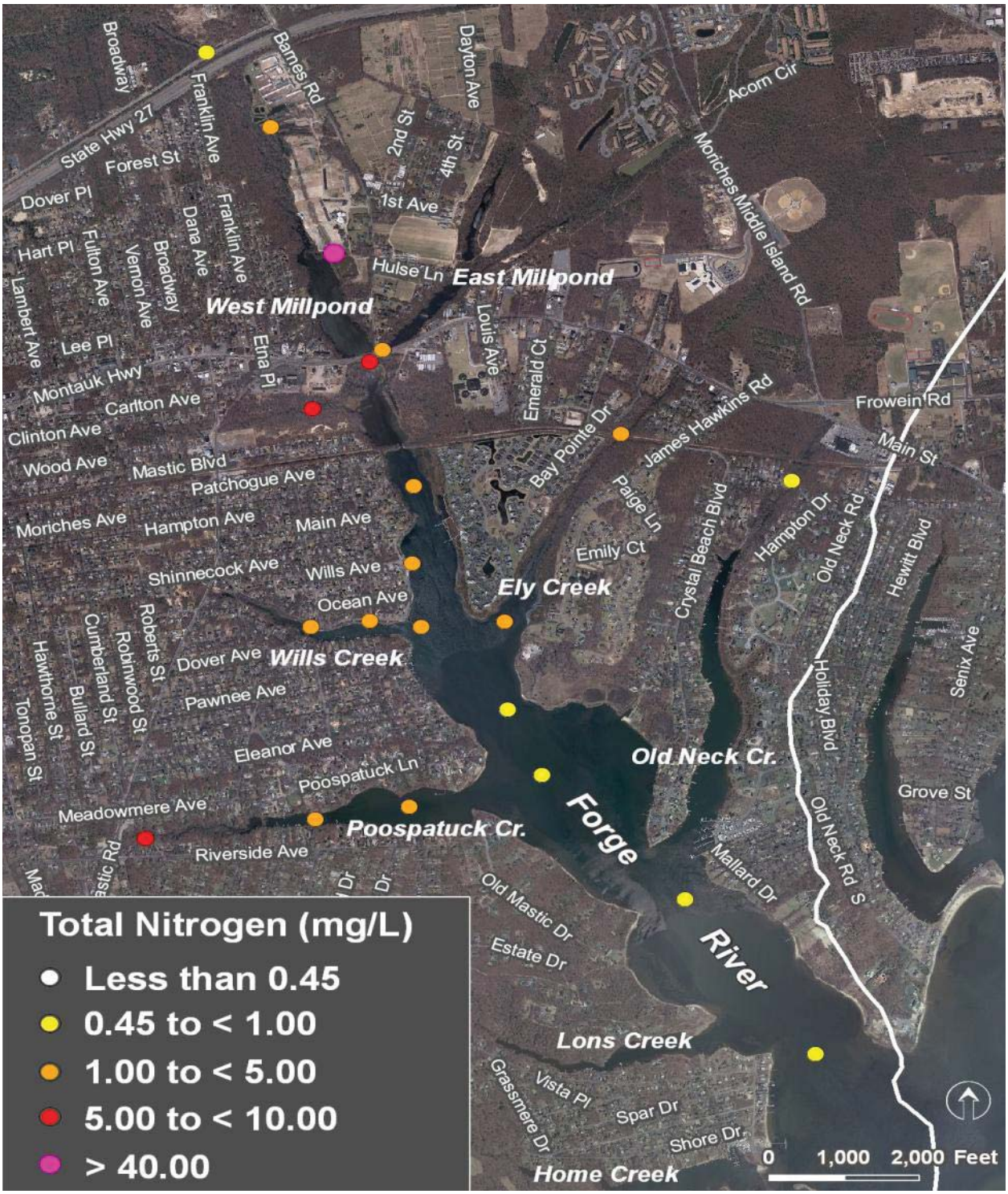


Figure 11-36. Average Nitrogen Concentrations in Forge River Surface Waters.



11.9.3 Nitrogen Budget – SoMAS of Stony Brook University

While flows from each of the nitrogen sources are not regularly measured, the School of Marine and Atmospheric Studies (SoMAS) of Stony Brook University estimated flow rates and loadings of nitrogen into the Forge River system (Swanson, O'Connell, Brownawell, Gobler, & Wilson, 2009). The distribution of nitrogen inputs by source is provided in Table 11-6.

Table 11-6. Relative Magnitude of Nitrogen Inputs to the Forge River System

Input	Percent of Input
Creeks	21.8
Atmospheric Deposition	2.6
Direct runoff	2.2
Groundwater	73.5

Source: SoMAS (Swanson *et.al.*, 2009)

These estimates demonstrate that the large majority of nitrogen entering the Forge River is from groundwater. The sources of groundwater nitrogen include releases from on-site wastewater treatment systems, leaching of nitrogen from lawn fertilizer, and leaching of nitrogen from the settling ponds associated with duck farm operations. Figure 11-37 shows groundwater nitrogen concentrations from monitoring wells located near the estuary. Nitrogen concentrations in two of the seven wells (north of Wills Creek) were 12.5-12.7 mg/L. These values are many times higher than average groundwater nitrogen. For example, the USGS reported a median concentration of total nitrogen in shallow groundwater (1946-1996) in Nassau County monitoring wells of 2.2 mg/L (Scorca & Monti, Jr., 2001).

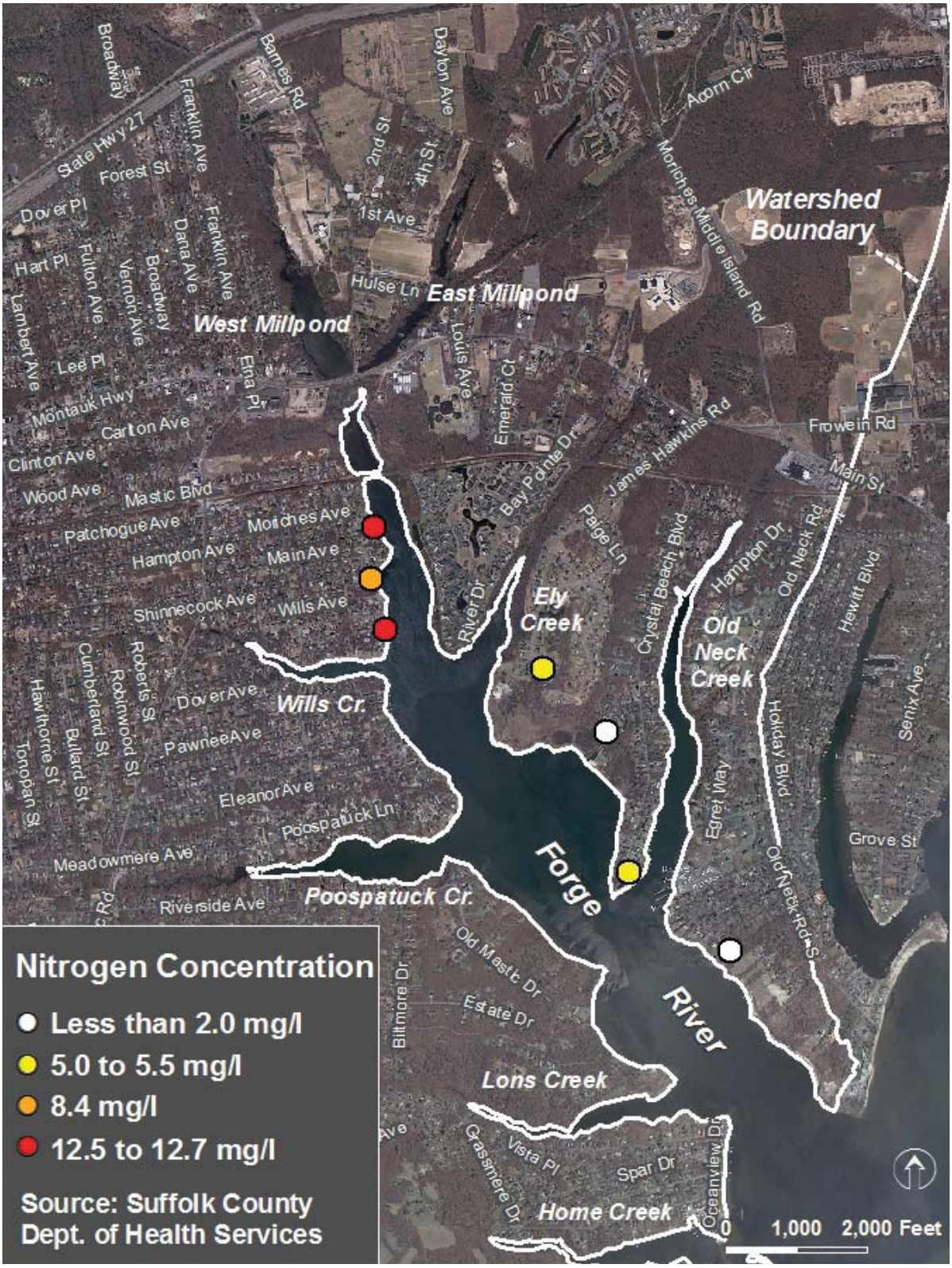
A mass balance of nitrogen for the Forge River system was developed by SoMAS and a summary of their results provided in Table 11-7. The authors estimated that approximately 30 to 50 percent of the nitrogen in the Forge River is derived from recycling of nitrogen from organic matter deposited in the sediments. Thus, according to the SOMAS study, sediment-derived nitrogen may account for one third to almost one half of all nitrogen inputs to the system. The majority of the rest of the nitrogen input is (as described above) from groundwater. Approximately 40 to 50 percent of the nitrogen in the system is removed annually due to exchange and flushing with Moriches Bay (Table 11-7).

Table 11-7. Nitrogen Balance in the Forge River System

Input	Estimated Annual Loading (kg/yr)	Lb/d
Inputs	273,000	1,649
Internal Recycling	122,640 – 245,000	740-1,480
Export	216,600	1,308

Source: SUNY Stony Brook

Figure 11-37. Groundwater nitrogen concentrations



11.9.4 Nitrogen Inputs – Background and Methodology

For the purposes of this watershed plan, a detailed nitrogen budget was prepared to evaluate the different upland sources of nitrogen released into the Forge River. Upland, or external, nitrogen sources are summarized for each subwatershed. This exercise will aid in the selection and prioritization of watershed management strategies that will be proposed as part of this watershed plan. The nitrogen budget also shows the relationship between point sources (*e.g.*, wastewater treatment plants that discharge to surface waters), non-point sources from groundwater underflow (*e.g.*, on-site wastewater treatment systems and wastewater treatment plants discharging to groundwater with long travel times) or surface runoff (*e.g.*, fertilizers and atmospheric deposition that result in immediate nitrogen contribution).

A nitrogen balance was performed to estimate the various nitrogen inputs to the Forge River for existing uses only. Future development (see Section 6.2, Build-out Analysis) was not factored into this exercise. The inputs that were evaluated included on-site wastewater treatment systems (OWTS), fertilizers, atmospheric deposition, wastewater treatment plants (STPs), and benthic flux.

Data from the Town of Brookhaven GIS database was used to identify the following land use categories for each parcel: Agricultural, Commercial/Industrial, Residential, and Vacant. The nitrogen sources were compiled on a per parcel basis with respect to these four land use classes. Table 11-8 shows which of the nitrogen sources were considered for each type of land use.

Table 11-8. Upland Nitrogen Inputs

	OWTS	Fertilizers	Atmospheric Deposition
Agricultural		√	√
Commercial/Industrial	√	√	√
Residential[1]	√	√	√
Vacant			√

[1]Residential parcels not connected to an STP contribute to all three categories. Those residential parcels that are connected to an STP only have a nitrogen contribution from fertilizers and atmospheric deposition.

As described in Section 4.3.2, only six percent of the land in the watershed contributes stormwater runoff into the Forge River; this runoff is discharged untreated (*e.g.*, without partial nitrogen removal through the soil column). Nitrogen inputs from the remainder of the watershed (*i.e.*, 94 percent) enter the Forge River via groundwater after passing through soils where some nitrogen removal occurs from root uptake and microbial action. Each of the nitrogen sources and Forge River loadings is described below including the methodologies used to derive the values.

11.9.5 Nitrogen Inputs- On-Site Wastewater Treatment Systems

Nitrogen contribution from on-site wastewater treatment systems (OWTS) are calculated based on assumptions and parameters derived from design standards and scientific literature. Considering depth to groundwater, a 40 or 50 percent nitrogen removal rate is applied based on literature reviewed (See Section 11.10.3). The lower value (*i.e.*, 40 percent) applies to systems whose depth to groundwater is less than nine feet. The higher value (*i.e.*, 50 percent) is for systems located nine feet or more from groundwater. The nine-foot depth follows from SCDHS regulations that require standard septic systems (*i.e.*, septic tank and leaching pools) to be installed in areas with a depth to groundwater greater than or equal to nine feet. The SCDHS requires installations where the depth to groundwater is less than nine feet to have an alternative design to mitigate the effects of high groundwater. Figure 11-38 reveals that most low-lying OWTS are located along the Wills, Poospatuck, Lons, and Home Creek subwatersheds of the Forge River; given the age of the residences, they are unlikely to support alternative designs and thus induce slightly greater nitrogen loads. Other assumptions for OWTS nitrogen are as follows:

- 3.5 persons per residential household (as per city-data for Mastic, NY)
- 10 lbs of nitrogen per person per year (Long Island Regional Planning Board, 1978)
- 44 gpd per person average water usage (*ibid.*)
- Industrial parcels do not produce process water (process water volumes and concentrations could not be estimated/verified as part of this project)

For the residential calculation, using the information from the first two assumptions, it was inferred that:

$$\frac{10\frac{lbsN}{yr}}{capita} = \frac{0.02740\frac{lbsN}{day}}{capita} X \frac{3.5capita}{household} = \frac{0.0959\frac{lbsN}{day}}{household}$$

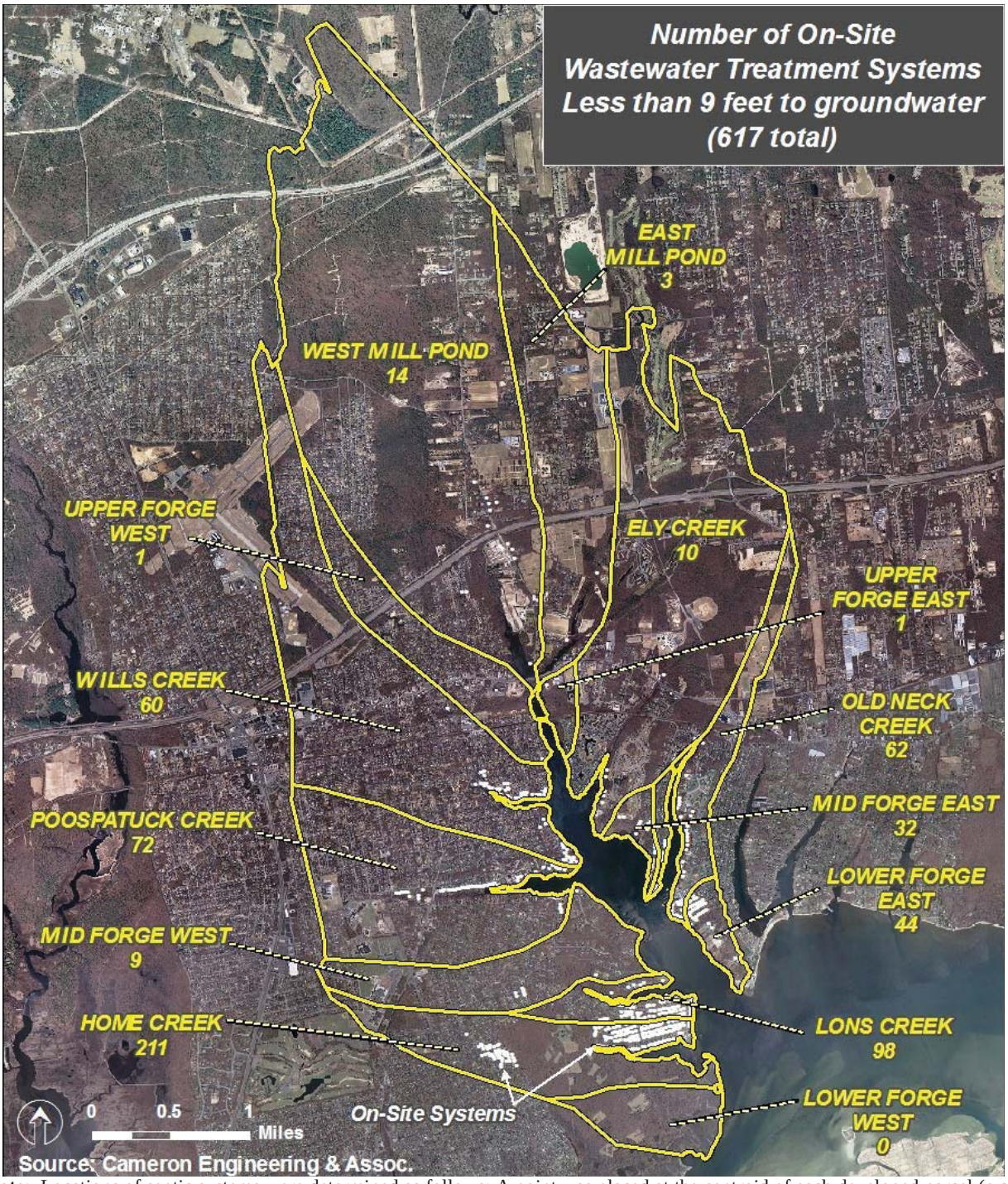
For the commercial/industrial calculation, using the information from the second two assumptions, it was inferred that:

$$\frac{10\frac{lbsN}{yr}}{capita} = \frac{0.02740\frac{lbsN}{day}}{capita} X \frac{day}{44gal} = \frac{0.0006227lbsN}{gal}$$

This rate was applied to the daily flow rate that was determined by using SCDHS design flow rates for each commercial/industrial establishment.

Using these rates, an assumed percentage of nitrogen removal from OWTS, and additional treatment from the soil column, the nitrogen contribution from all residential OWTS is estimated at approximately 430 lbs of nitrogen per day.

Figure 11-38. On-site Wastewater Systems Less Than Nine Feet from Groundwater



Note: Locations of septic systems were determined as follows: A point was placed at the centroid of each developed parcel (*e.g.*, residential, commercial, industrial, community facility) that uses a septic system (parcel layer provided by the Town of Brookhaven and included land use codes - these land use codes were checked and updated where necessary by the team). For the Poospatuck Reservation – which is not subdivided into lots – a point was created for each structure. Parcels that are connected to a sewage treatment plant, of course, were not included; these included the multi-family developments Waterways at Bay Pointe, Pine Hills South, and Villas at Pine Hills. Sewage flows were estimated for each of the parcels based on land use. The estimate of sewage flows from commercial and industrial uses considered specific uses within their respective land-use categories and building areas. Suffolk County Department of Health Services wastewater generation rates were employed to estimate flow.

11.9.6 Nitrogen Inputs - Wastewater Treatment Plants

Another significant nitrogen input to the Forge River is from the four sanitary wastewater treatment plants in the watershed. Three of the four treatment plants service high-density residential units. Although the wastewater from these residential units is conveyed to and treated at a private wastewater treatment plant, the plants - which discharge to groundwater - have nitrogen limits of 10 mg/L. Data available from the NYSDEC indicated that two of these STPs have, at times, exceeded their permitted nitrogen effluent limit of 10 mg/L (Table 11-9). Fines and consent orders can be imposed on the facilities if their nitrogen concentration exceeds this limit. Information on permitted flow rates and average effluent nitrogen concentrations are from the 2006 EPA Water Discharge Permit data for the residential treatment plants (Source: PCS Query). Duck farm permitted flow rates and average effluent nitrogen concentrations are from NYSDEC data and represent a 2010 average. Table 11-9 summarizes these data.

Table 11-9. Wastewater Treatment Plant Data

Wastewater Treatment Plant	Discharge Location	Permitted Flow (MGD)	Effluent Total Nitrogen as N concentration (mg/L)	Nitrogen- (lbs/day)	Nitrogen Contribution[1] (lbs/day)
Waterways at Bay Pointe	Sub-Surface	0.090	20.0	15.01	7.5
The Villas at Pine Hills	Sub-Surface	0.181	17.5	26.42	13.2
Pine Hills South	Sub-Surface	0.115	8.0	7.67	3.8
Jurgielewicz Duck Farm	Surface Water	0.578	40.5	195.00	195.0
				Total	**219.5 lbs/day**

[1] Assumes 50 percent additional nitrogen removal in soils for sub-surface discharges

Residential Wastewater Treatment Plants

There are three wastewater treatment plants that serve residential subdivision communities inside the contributing area for the Forge River; Waterways at Bay Pointe (0-2-year groundwater contributing area), Pine Hills South (2-5-year groundwater contributing area) and Villas at Pine Hills (10-25-year groundwater contributing area). Each of these plants discharges to groundwater either via leaching pools or recharge basins. Coincidently, all three plants are located inside the Ely Creek subwatershed. The nitrogen contribution from these plants represents approximately 35% of the total nitrogen inputs to the Ely Creek subwatershed. Ely Creek has one of the largest groundwater contributing areas of all of the creeks on the Forge River.

Duck Farm Wastewater Treatment

Two duck farms are located in the West Mill Pond subwatershed area. There is limited information on the Barnes Road Duck Farm, which has a zero discharge permit and four treatment lagoons. That duck farm was purchased by Jurgielewicz Duck Farm. The following discussion focuses on the Jurgielewicz Duck Farm. It has a SPDES permit with different nitrogen limits throughout the year. These limits range from 5 mg/L in the summer to 10 mg/L in the winter. Data from July 2009 through June 2010 are from the NYSDEC. Average flow for this data range is 0.578 million gallons per day (MGD) and the average effluent nitrogen concentration is 40.45 mg/L. Given these values, daily nitrogen generation is estimated at 195 lbs. The duck farm treatment plant's total *effluent* nitrogen concentration is similar to the *influent* concentration at a typical human wastewater treatment plant. A typical residential septic tank (*i.e.* assuming 50 percent nitrogen removal) contributes 0.04795 lbs N per day to groundwater and eventually to the Forge River. Thus, the Jurgielewicz Duck Farm contributes nitrogen to the estuary at a rate equivalent to 4,000 households with properly functioning OWTS. If the duck farm were meeting its effluent nitrogen concentration limit at their discharge limit of 0.6 MGD, it would represent 36.2 lbs N per day to the Forge River (Table 11-10). However, the Duck Farm is not meeting its regulatory limits.

Table 11-10. Jurgielewicz Duck Farm Nitrogen Limits

Months	Nitrogen Limit (mg/L)	Nitrogen Limit (lbs/day)
Jan. thru Feb.	10	50.04
March thru May	8	40.03
June thru Oct.	5	25.02
November	8	40.03
December	10	50.04
	Total	**13,215.56 lbs/year or 36.2 lbs/day**

The Jurgielewicz Duck Farm contribution to the Forge River is 195 lbs N/day.

11.9.7 Nitrogen Inputs - Fertilizer

Fertilizer is applied to agricultural, commercial/industrial and residential parcels. It was estimated from land use data and infrared aerial photography, that 25 percent of agricultural parcels (excluding livestock agriculture) use fertilizer. According to literature from the Center for Environmental Research at Cornell University (Hughes, Pike, & Porter, 1985), (Hughes & Porter, 1983) (Hughes, Porter, & Trautmann, 1983), a fertilization rate of 3.5 lbs N/year/1,000 sq.ft. was assumed for agricultural parcels, with 35 percent of the nitrogen in fertilizers reaching groundwater. Parcels that were not categorized agricultural, residential, or vacant fell into the commercial/industrial category. In a similar manner (based on infrared aerials), it was assumed that 25 percent of

commercial/industrial parcels apply fertilizer. According to New York State Guidelines for Urban Erosion and Sediment Control, turf accounts for an average of 15 percent of the area of a typical commercial or industrial parcel. Using the same Cornell University references as above, 35 percent of applied fertilizer reaches groundwater and the fertilization rate on turf grass is 2.4 lbs N/year/1000 sf. It was also estimated that 25 percent of residential parcels in the watershed apply fertilizer to their turf grass. New York Guidelines for Urban Erosion and Sediment Control assumes 70 percent of a residential parcel's area is turf grass, with 35 percent of applied fertilizer reaching groundwater. The assumed application rate is the same as commercial/industrial parcels at 2.4 lbs N/year/1000 sf.

The total fertilizer contribution to the Forge River is 76.42 lbs N/day.

11.9.8 Nitrogen Inputs - Atmospheric Deposition

The data for atmospheric contribution of nitrogen to the Forge River is from weather station NY96 located at Cedar Beach, Southold, NY. This station is the only one of its kind on Long Island. The sum of the NH_4 and NO_3 average concentrations equals 0.0234 lbs/acre/day (see Appendix B). A 65 percent removal rate (see Appendix B), or 0.0082 lbs/acre/day, due to plant uptake was applied to parcels that have a means of stormwater recharge (*e.g.*, infiltration or piping to recharge basins) prior to it reaching groundwater. This occurs for 8,860 acres of land. It was assumed that 100 percent of precipitation enters the Forge River from the 590 acres of land that does not recharge stormwater.

A total of 87.8 lbs N/day is contributed from atmospheric deposition to the Forge River.

11.9.9 Nitrogen Inputs - Benthic Contribution

The nitrogen contributions from benthic regions of the watershed are attributed to the internal recycling of sediments with enriched organic (decayed) matter that has accumulated in the Forge River and the adjacent creeks and ponds. Nitrogen contributions from benthic flux were estimated using information from several sources (Hughes, Porter, & Trautmann, 1983), (Aller, Brownawell, & Gobler, 2009), (Brownawell, Gobler, & Swanson, May 2009) as well as from conversations with some of the authors, *i.e.*, Dr. Bruce Brownawell and Dr. Robert Aller from Stony Brook University's School of Marine and Atmospheric Sciences (SOMAS). The researchers' measurements of net production rates were obtained in the summertime (22°C/71.6°F) and ranged from 33 to 64 mmol/m^2/day with an average of 45 mmol/m^2/day. The samples that represented extremes of 33 and 64 mmol/m^2/day were taken from the mouth of the Forge River and at Station 2 (located at the end of finger pier off the mouth of Wills Creek), respectively.

Since water-column oxygen content is variable and nitrogen flux is dependent on DO, the researchers suggested that there might be a 30 to 50 percent uncertainty inherent in the calculation of benthic flux annual averages and typical values. To be conservative, therefore, 20 mmol/m^2/day may be a realistic estimate for the year-round average benthic nitrogen flux for the Forge River and its creeks.

Further variability in benthic nitrogen flux (33-64 mmol/m^2/day) is related to location. A value of 10 mmol/m^2/day is appropriate in areas where flushing and mixing are greater (*i.e.* seaward of Old Neck Creek) and 30 mmol/m^2/day for river and areas upstream (*i.e.* Ely and Wills Creeks). This approach produces a fair distribution of the benthic flux across the entire estuary. The nitrogen contribution based on the internal recycling of benthic flux calculated using these boundary conditions is 1,543 lb/day of nitrogen.

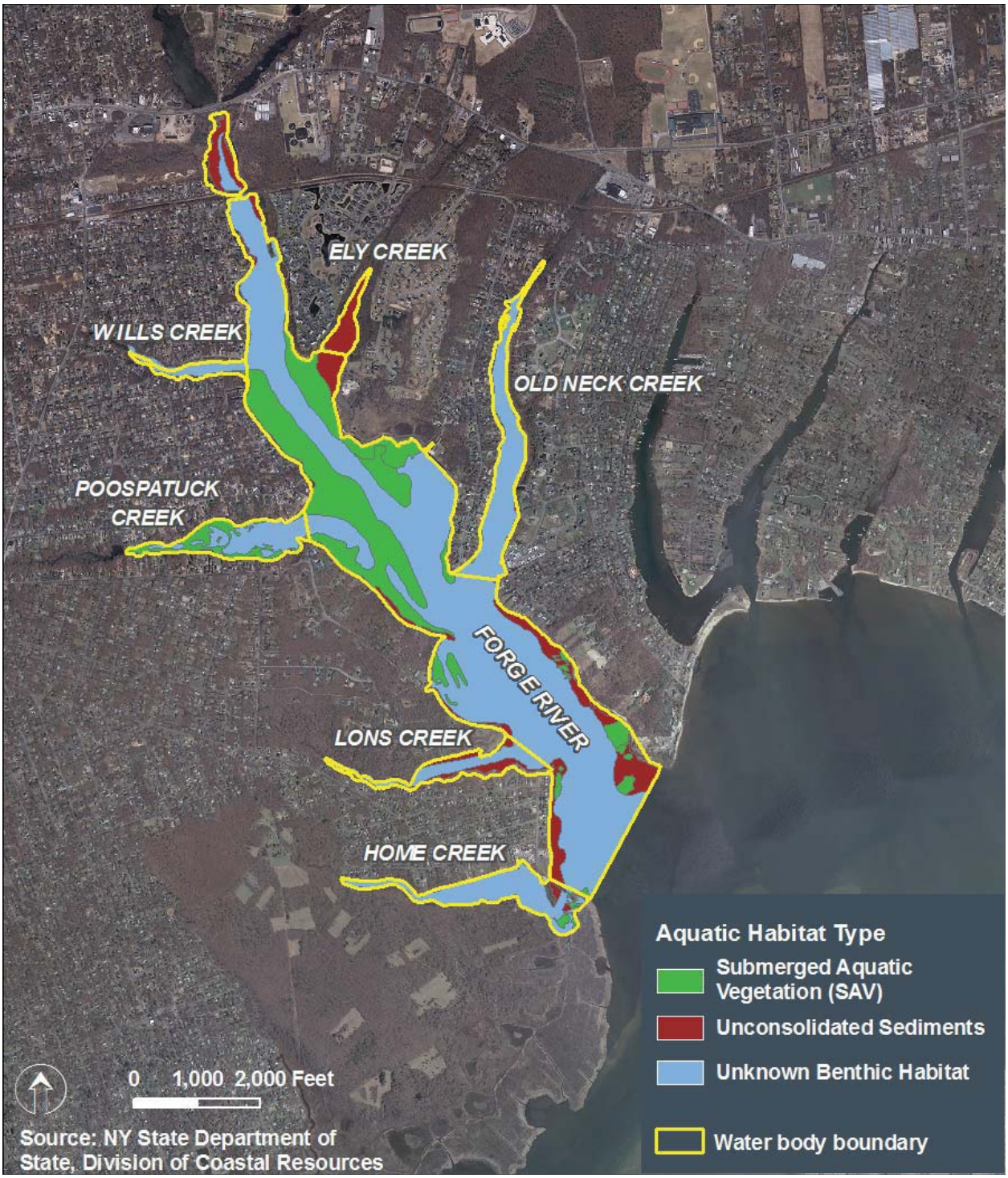
Additional information was available from the New York State Department of State, Office of Coastal, Local Government, and Community Sustainability. Information from this agency included a GIS dataset of polygons representing benthic habitat data; this data set was photogrametrically derived from conventional-color aerial photography of Long Island's south shore bays, acquired in May and June 2002. This dataset is available on the NYS GIS Clearinghouse website and is termed *Benthic Habitats Mapping of the South Shore Estuary of Long Island*. In the Forge River and its contributing creeks and ponds there are only three classifications represented, *Submerged Aquatic Vegetation* (447,167 m^2 or 110.5 acres), *Unconsolidated Sediments* (229,840 m^2 or 56.8 acres) and *Unknown Benthic Habitats* (1,503,634 m^2 or 371.6 acres). This information is mapped in Figure 11-39. Based on this information, the lower value of 10 mmol/m^2/day was applied to the *Submerged Aquatic Vegetation* and the higher value of 30 mmol/m^2/day to the *Unconsolidated Sediments* and *Unknown Benthic Habitats*. The nitrogen contribution based on the internal recycling of benthic flux calculated using these boundary conditions is 1,743 lb/day of nitrogen and is shown in Table 11-11, below.

Table 11-11. Benthic Nitrogen Contributions

	Benthic Contribution	
Waterbody	**lbs N/day**	**% of N in area**
Home Creek	**100.8**	**5.78%**
Lons Creek	63.1	3.62%
Poospatuck Creek	67.6	3.88%
Wills Creek	26.1	1.50%
Ely Creek	28.7	1.65%
Middle Forge East	0.0	0.00%
Old Neck Creek	**129.0**	**7.40%**
Forge River	**1327.8**	**76.17%**
Totals	1743.1	100.00%

A total of 1,743 lbs N/day is contributed from benthic flux to the Forge River.

Figure 11-39. Benthic Contributions



11.9.10 Nitrogen Inputs - Loading Model and Source Share

Each of the upland nitrogen contributions, on-site wastewater treatment systems (OWTS), wastewater treatment plant (WWTP) effluents, fertilizers and atmospheric deposition, were combined and a source share attributed to each subwatershed (Table 11-12). These derived values will support a prioritization of the subwatersheds for the development and implementation of watershed management strategies.

The nitrogen contributions from OWTS were most prevalent in the Wills Creek, Poospatuck, and West Mill Pond subwatersheds (Figure 11-40). This is attributed to the high density of homes and businesses in conjunction with high groundwater and a lack of additional treatment from sub-surface soils. Over half of the total nitrogen input from all of the OWTS in the watershed is produced by these three subwatersheds. The Jurgielewicz Duck Farm, located directly adjacent to West Mill Pond (Figure 11-40), represents the largest nitrogen point source, at 195 lbs N/day.

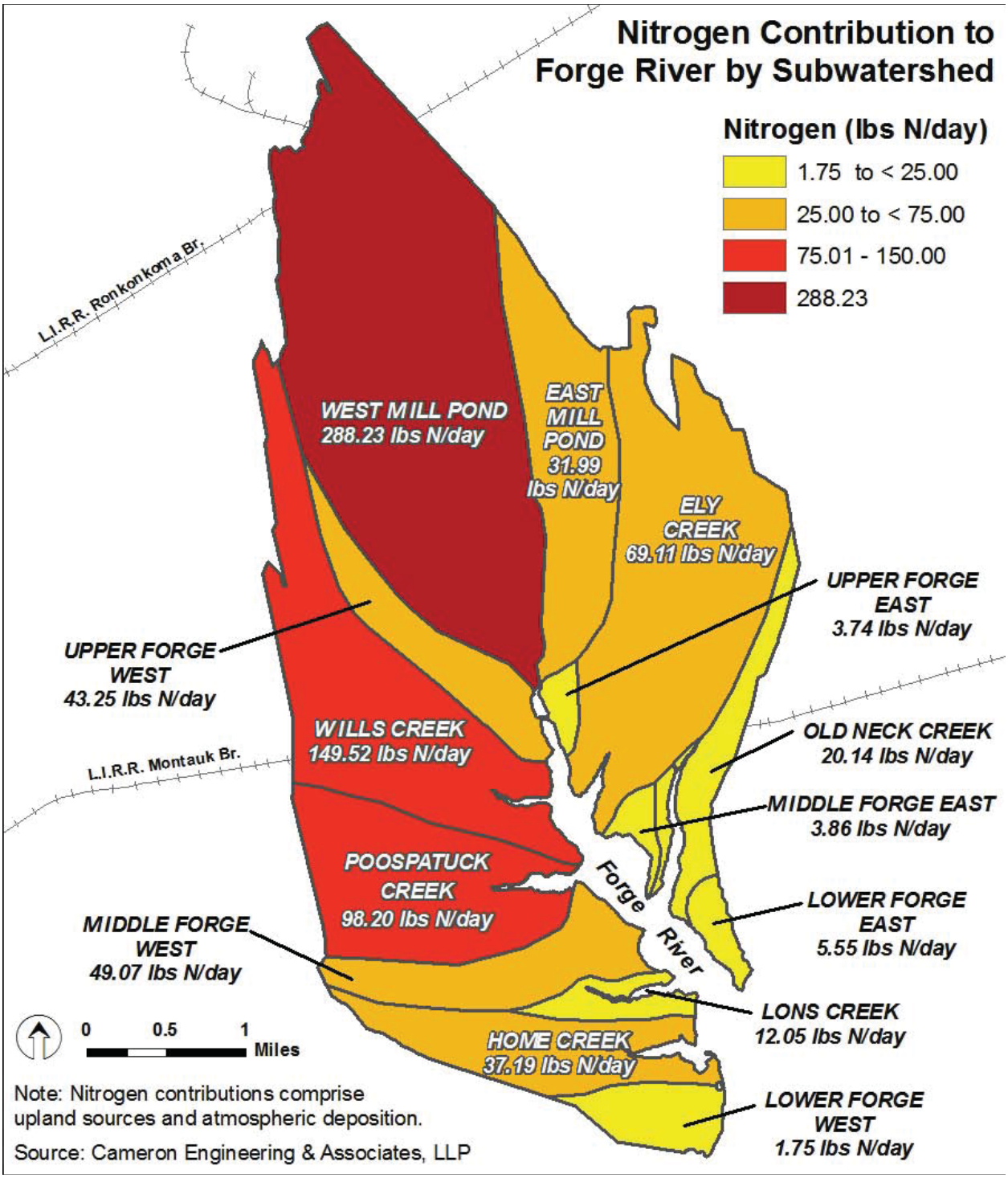
Ely Creek, although smaller than other creeks in the watershed, has the second largest groundwater drainage area. The three private WWTPs that service residential subdivisions are all located in the Ely Creek subwatershed.

Based on the assumptions discussed above, fertilizer usage is most common in the West Mill Pond, East Mill Pond, and Ely Creek subwatersheds, accounting for half of the fertilizer contribution of the entire watershed. The West and East Mill Pond subwatersheds have a large agricultural land use component with significant fertilizers input. The Ely Creek subwatershed also has land uses with high fertilizer requirements such as golf courses and school ball fields.

As atmospheric nitrogen inputs are directly related to subwatershed size, the three largest subwatersheds, West Mill Pond, Ely Creek, and Wills Creek, contribute the greatest quantity of atmospheric nitrogen.

Table 11-5 summarizes the nitrogen load by subwatershed and percent contribution to the entire watershed. A key finding of this nitrogen loading analysis is that 80 percent of all nitrogen from upland sources emanates from five subwatersheds: Mid Forge West, Poospatuck Creek, Wills Creek, West Mill Pond, and Ely Creek as shown in Figure 11-3.

Figure 11-40. Nitrogen Contributions by Subwatershed



Note: The Jurgielewicz Duck Farm ceased operations just prior to the publication of this report. Nitrogen loading will be re-calculated as part of the formulation of the TMDL without the input from the duck farm.

Table 11-12. Subwatershed Nitrogen Contributions
(Listed Highest to Lowest)

	Fertilizer		Atmospheric		On-Site Wastewater		WWTP Effluents		Totals	
Subwatershed	**lbs N/day**	**% of N in subwatershed**	**lbs N/day**	**% of N in subwatershed**	**lbs N/day**	**% of N in subwatershed**	**lbs N/day**	**% of N in subwatershed**	**lbs N/day**	**% of N in watershed**
West Mill Pond	14.73	5.11%	25.63	8.89%	52.86	18.34%	195.00	67.65%	288.23	35.42%
Wills Creek	10.04	6.72%	12.47	8.34%	127.01	84.95%	0	0%	149.52	18.38%
Poospatuck Creek	10.58	10.78%	8.42	8.58%	79.20	80.65%	0	0%	98.20	12.07%
Ely Creek	11.84	17.13%	13.09	18.94%	19.64	28.41%	24.55	35.52%	69.11	8.49%
Mid Forge West	5.48	11.17%	3.63	7.41%	39.95	81.42%	0	0%	49.07	6.03%
Upper Forge West	2.87	6.63%	4.45	10.28%	35.94	83.09%	0	0%	43.25	5.32%
Home Creek	2.87	7.71%	4.92	13.22%	29.40	79.07%	0	0%	37.19	4.57%
East Mill Pond	11.81	36.92%	6.86	21.44%	13.32	41.64%	0	0%	31.99	3.93%
Old Neck Creek	2.91	14.47%	3.40	16.88%	13.83	68.66%	0	0%	20.14	2.48%
Lons Creek	1.29	10.70%	1.35	11.23%	9.41	78.07%	0	0%	12.05	1.48%
Lower Forge East	0.90	16.26%	0.69	12.47%	3.95	71.28%	0	0%	5.55	0.68%
Middle Forge East	0.64	16.59%	0.56	14.62%	2.66	68.79%	0	0%	3.86	0.47%
Upper Forge East	0.46	12.27%	0.57	15.25%	2.71	72.48%	0	0%	3.74	0.46%
Lower Forge West	0.00	0.00%	1.75	100.00%	0.00	0.00%	0	0%	1.75	0.21%
Totals	**76.42**	**9.39%**	**87.79**	**10.79%**	**429.88**	**52.83%**	**219.55**	**26.98%**	**813.64**	**100.00%**

11.10 Water Quality Discussion

11.10.1 Relationship between Nitrogen, Chlorophyll-a, and Dissolved Oxygen

In estuarine conditions, nitrogen is typically the limiting nutrient for algal growth. As nitrogen concentrations increase, algal populations bloom. Chlorophyll-a is a measure of algal growth and is directly related to nitrogen inputs. Chlorophyll-a peaks correspond to peaks in phytoplankton populations. Different phytoplankton species bloom at different times and often sequentially, but as Figure 11-10 through Figure 11-13 show, chlorophyll-a concentrations are highest in the warm months of the spring through summer and early fall. High algal concentrations give rise to wide swings in dissolved oxygen, supersaturating the water column during the day as photosynthesis releases oxygen into the water and depleting oxygen at night as the algae respire. Oxygen monitoring results confirm that DO swings from anoxic conditions (zero DO) to supersaturated conditions (DO approaching 20 mg/L).

As phytoplankton and *Ulva* (sea lettuce) blooms peak and then die (*i.e.*, due to nitrogen and light limitations), organic matter from the dead algal cells accumulates on the bottom. Although phytoplankton contributions to Forge River eutrophication have been well understood for some time, the role of *Ulva* in the nutrient cycle has only recently been investigated. Research was conducted on *Ulva* and nutrient cycling in the Forge River from May 2006 through 2007 (Swanson, O'Connell, Brownawell, Gobler, & Wilson, 2009). The researchers found that *Ulva* populations, like phytoplankton, display distinct patterns of growth and decay that are influenced by nutrients, light, and temperature. Experimental incubations demonstrated that decaying *Ulva* both released nutrients and consumed oxygen. The seasonal decline in *Ulva* likely also supplies regenerated nitrogen to pelagic algal blooms and may contribute to the hypoxic conditions in the Forge River, thereby exacerbating the symptoms of eutrophication during summer.

As the algal blooms decline, more oxygen becomes available to sediment bacteria. These bacteria then degrade the organic matter, utilizing oxygen for respiration and releasing inorganic nitrogen back into the water column. Such microbial activity can bring dissolved oxygen concentrations well below the water quality standard of 4.8 mg/L needed to sustain most aquatic organisms as specified for SA, SC, and C classified waters.

Intense bacterial activity eventually depresses oxygen levels, which slows bacterial processes thereby restoring oxygen levels. Once dissolved oxygen concentrations rise, algal growth and reproduction accelerates and is stimulated by the nitrogen released from the bacteria and the cycle begins again. This cycle is enhanced in the Forge River by large inputs of nitrogen from groundwater. The shallow waters and poor circulation keep

temperatures high and limit dilution from Bay waters, which further enhances the cycle. This cycle has been in place at least since the early 1950s and probably longer according to Stony Brook University SoMAS report, *What History Reveals about Forge River Pollution*, (Swanson, Brownawell, Wilson, & O'Connell, 2010). The majority of nitrogen that gives rise to this cycle is primarily from two sources: groundwater and sediment flux. These and other contributions are discussed below.

11.10.2 Nitrogen Sources and Algal Blooms

According to the same SoMAS report, duck farming was extensive in the 1940s and peaked in the 1960, leaving a legacy of duck waste in the form of highly enriched sediments. As duck farming decreased, residential development increased with a nearly six-fold increase in population between 1960 and 2005. Most of the development until the 1980s relied on cesspools and septic systems which leach nitrogen into the groundwater and ultimately into the Forge River. These on-site wastewater treatment systems have been identified as a major source of nitrogen loading to the Forge River (Munster, Hansen, & Bokuniewicz, 2004) (Swanson, O'Connell, Brownawell, Gobler, & Wilson, 2009).

Most freshwater flow to the Forge River is from groundwater seepage. Because groundwater travels slowly to the estuary, nitrogen entering the Forge River through groundwater today may have been released many years or even decades ago. Conversely, nitrogen loading from groundwater near the shoreline has a more immediate impact. Groundwater contributions represent the largest nitrogen input to the Forge River.

Most of the remainder of the nitrogen that enters the Forge River water column comes from the sediments. There is a large pool of nitrogen that resides in the sediments of the Forge River and its tributary creeks. The sediments are high in nitrogen primarily from decades of organic deposition from dense algal bloom crashes, leaf fall, and duck farm waste. Bacterial degradation of this sediment nitrogen releases it back into the water column.

Dense algal blooms will likely recur annually as long as groundwater and sediment nitrogen sources are unchanged. The blooms will continue to drive significant fluctuations in Forge River dissolved oxygen concentrations, supersaturating them during the daylight hours and lowering them to dangerous levels during nighttime algal respiration periods. As long as the hypoxic and anoxic conditions persist, the Forge River will be inhospitable to most marine organisms.

11.10.3 Nitrogen Inputs to Groundwater from Cesspools and Septic Systems

Cesspools and septic systems (OWTS) have a central collection point, which is either a cesspit or a septic tank that removes solids from the effluent. For cesspools, the liquid fraction of the effluent flows directly into the surrounding soil. Septic systems route the liquid fraction to a leaching field for dispersal over a large area where it percolates through the soil, ultimately reaching groundwater. Nitrogen from OWTS effluent that enters groundwater travels primarily horizontally toward sea level and the surface waters of the Forge River. A smaller fraction travels vertically percolating into deeper aquifers.

The nitrogen from on-site systems is almost exclusively ammonia, which either volatilizes, or is converted into nitrate by soil bacteria. Limited reductions in nitrogen loads may occur if the on-site wastewater treatment systems are close to the water table or have a limited flow distance to adjacent surface waters. Figure 11-41 shows the dense distribution of on-site wastewater systems in the Forge River watershed.

Estimates of nitrogen removal for cesspools and septic systems range greatly. A number of factors contribute to the effectiveness of these systems including; condition of the system, depth to groundwater, soil type, soil organic matter content, and temperature. Nitrogen losses from cesspools are primarily due to the loss in the cesspit and in the area immediately surrounding it (Smith & Myott, 1975). Septic systems achieve a greater removal due to the use of a separate settling tank followed by leaching pools or fields. The leach field distributes the liquid fraction over a wide area, which provides contact time with biofilms (*i.e.*, bacterial films) that form in the soils. The leach field also distributes the effluent over a larger area, providing more opportunity for degradation by soil bacterial and nitrogen uptake in the root zone.

Researchers (Valiela, et al., 1997) compiled removal estimates from numerous studies to attempt to quantify nitrogen loading to Waquiot Bay, Massachusetts; they reported that the nitrogen loss in a cesspit or a septic tank was approximately six percent. Earlier work (Porter, 1980) also compiled information on nitrogen removal for septic systems to estimate loadings to groundwater on Long Island and reported a range from 11 to 19 percent. Additional and more significant removal occurs in the vadose zone (*i.e.*, the portion of the soil profile from the ground surface to the water table) through volatilization and uptake by plant roots. Valiela estimated this to be approximately 39 percent. Valiela also estimated an additional 34 percent loss might result between the root zone and aquifer.

Porter estimated the total loss through the septic tank, leach field, and root zone to be approximately 50 percent. Most studies attributed little or no removal of nitrogen below the root zone, as organic matter concentrations are low, temperatures are below optimal for

bacterial processes, and oxygen levels may be reduced (WSDH, 2002). Porter, however, suggested that losses in the vadose zone between the root zone and aquifer could result in an additional 10 percent reduction.

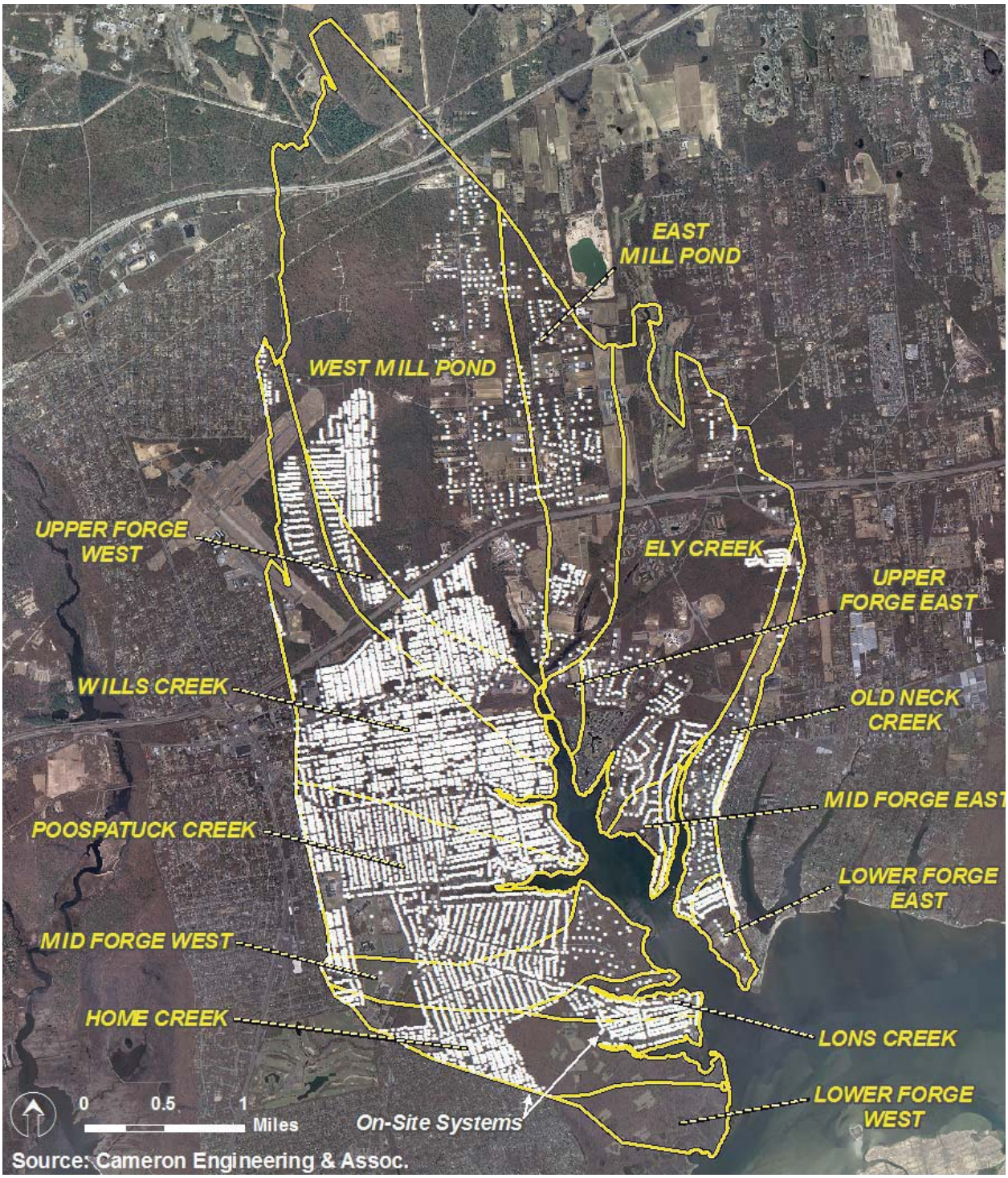
The Porter study reports levels that are more consistent with other estimates for nitrogen removal. While removal is highly dependent on location, the conditions in Waquiot Bay and Long Island do not suggest that high levels of removal should be expected. Soils are sandy with limited organic matter to bind ammonia or support denitrification by bacteria. Valiela notes that some of the removal estimates are based on rough estimates. This is unsurprising since a review of a number of other septic system removal studies frequently commented on the difficulty of establishing an accurate estimate of removal and of separating out the impacts factors such as dilution.

Based on a case study in a fine sand soil, the US EPA's Onsite Wastewater Treatment Systems Manual estimates that approximately 99 percent of the nitrogen from a septic system is in the form of ammonia (USEPA, 2002). About 49 percent of this is lost to volatilization, bound to sediment, taken up by roots, or converted to nitrate within the first 0.6 meters. Thus, there is good support for the 50-percent value as the total nitrogen removal from septic systems. The SoMAS Forge River research used a uniform reduction from septic systems of 50 percent. A smaller reduction would apply to households with cesspools since these do not include the leach field and the significant reductions associated with it. Thus, about half (or more) of the nitrogen from unsewered residences inside the Forge River watershed travels to the estuary in the slow-moving groundwater.

Distance from the estuary affects nitrogen loading in two ways. Effluent from on-site systems that are farther inland travels further vertically than systems closer to the estuary. In those locations, some of the effluent nitrogen is lost to deeper aquifers rather than travelling in shallow groundwater to the estuary. Secondly, many homes close to the estuary are at elevations so low that there is little unsaturated soil between the on-site system and groundwater. Here there is no opportunity for soil bacteria or roots to act on the nitrogen prior to its release to groundwater and then the estuary. Several hundred homes are less than nine feet above groundwater, the minimum currently required by the County for on-site wastewater treatment systems (Figure 11-38). These low-lying homes are clustered primarily in four areas:

- Along the northern side of Wills Creek
- Along the northern side of Poospatuck Creek and
- Most of the homes between Lons Creek and Home Creek
- Along both sides of the southern end of Old Neck Creek

Figure 11-41. Distribution of Septic Systems in the Watershed



11.10.4 Surface Water Nitrogen Inputs

Surface water contributions to eutrophication, whether from streams or stormwater runoff, are small relative to groundwater and sediment contributions. The sandy soils in the area allow for rapid infiltration and connection to groundwater. Runoff primarily acts as a transport pathway from surface sources to groundwater. Surface sources include agricultural and residential use of fertilizer for crops, lawns, and golf courses.

One significant source of surface water nitrogen is the duck farm that discharges via West Mill Pond into the Forge River. The discharge occurs via leaching to groundwater from the duck farm's wastewater lagoons. The lagoons, however, are so close to West Mill Pond, that they are effectively a surface water discharge. West Mill Pond itself is a surface water discharge to the Forge River.

11.11 Total Nitrogen Inputs

An understanding of the relative quantities of nitrogen inputs is critical to the development and prioritization of management strategies to improve water quality in the estuary. It is clear from Table 11-13 that benthic flux is responsible for the majority (68 percent) of nitrogen entering the Forge River water column. The benthic flux contribution is an estimate by SoMAS researchers (see earlier section) that they suggest has a 30 to 50 percent uncertainty inherent in the value. Even so, it would comprise the largest source of nitrogen to the estuary. The discharge from on-site wastewater treatment systems is the second highest source of nitrogen (17 percent) and the Jurgielewicz Duck Farm is third (8 percent).

Table 11-13. Estimate of Total Nitrogen Inputs

Input	Lbs N/day	% of total N Input
Fertilizer	76.4	3.0%
Atmospheric deposition	87.8	3.4%
Onsite wastewater systems	429.9	16.8%
Sewage treatment plants	24.6	1.0%
Jurgielewicz duck farm	195.0	7.6%
Benthic flux*	1743.1	68.2%
Total Nitrogen Inputs	**2556.8**	**100.0%**

11.12 Water Quality Summary

Water quality classifications in the Forge River include C, SA, and SC waters, which support fish, shellfish, and wildlife and primary and secondary contact recreation. The Forge River has a long history of water quality impairments including chronic hypoxia and fish kills. The Upper Forge River is included in the 303(d) list and is impaired by high concentrations of

pathogens and nitrogen, and high dissolved oxygen demand. The Lower Forge River and Cove is considered impaired due to pathogens.

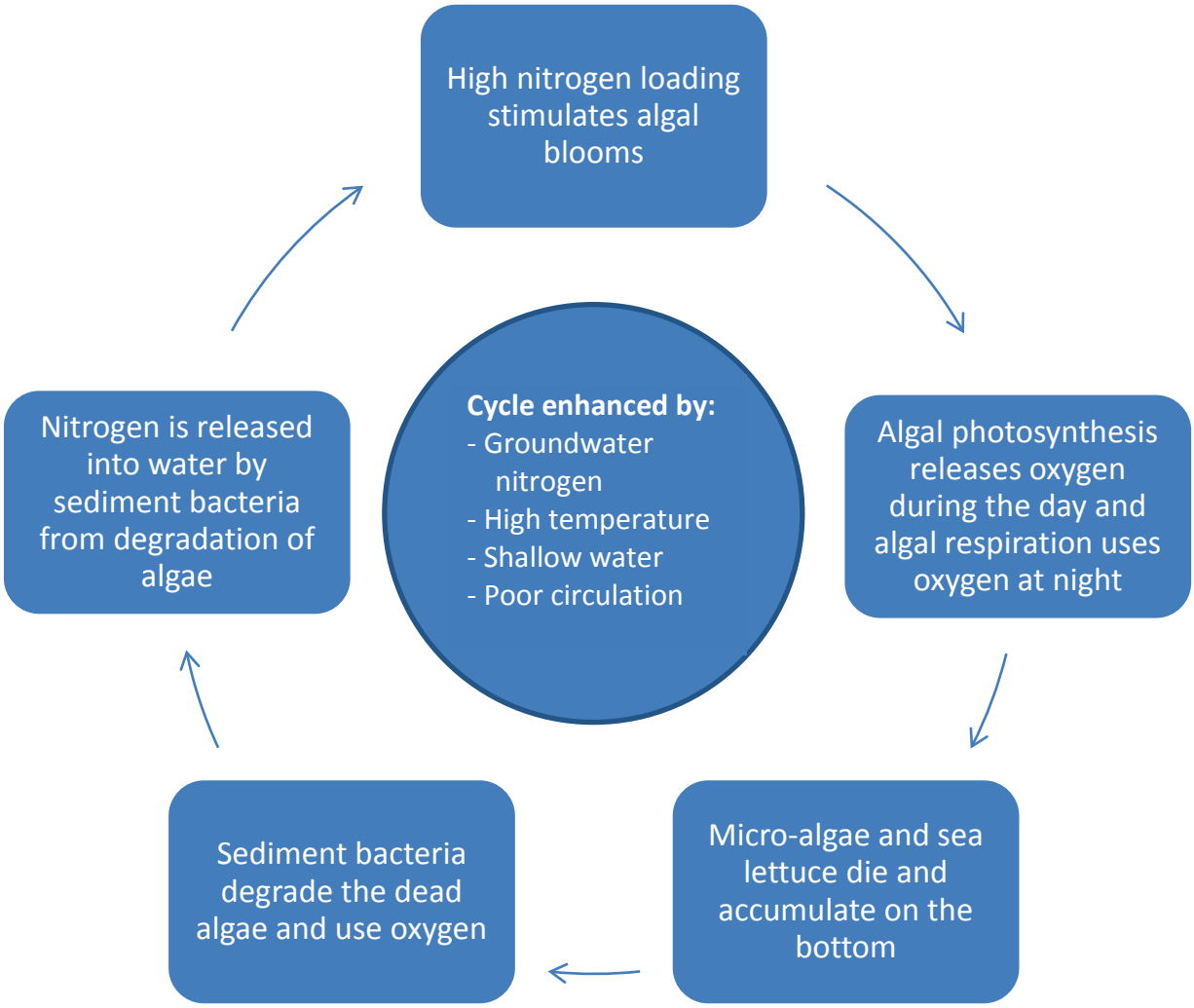
Extensive data have been collected by SCDHS, SoMAS, and others throughout the Forge River system for many years. Statistical and graphical evaluation of the data supports the conclusion that the system has suffered from elevated nutrients, low dissolved oxygen levels, and high pathogen loadings.

Long-term nitrogen loadings have stimulated lengthy and frequent blooms of *Ulva* and phytoplankton that eventually become nitrogen and light limited and die, falling to the bottom. This organic deposition along with leaf fall has allowed a pool of nitrogen to accumulate in the sediments of the Forge River estuary providing an ongoing source to the water column that perpetuates the cycle (Figure 11-42). The cycle will continue indefinitely until sediment and groundwater nitrogen sources are significantly reduced and circulation within the estuary and between the estuary and Moriches Bay is restored to natural conditions including a stable inlet. Dissolved oxygen concentrations vary widely over the course of the day and season as algae blooms and decays. Photosynthetic activity during blooms supersaturates the water during the daylight hours. Algal respiration and sediment bacterial activity at night bring DO to low and even zero concentrations.

It is estimated that the largest nitrogen input to the Forge River is from nitrogen released from microbial degradation of sediment organic matter. The majority of the organic matter is from degraded algal (*Ulva* and phytoplankton) blooms that have settled to the bottom. The second largest source of nitrogen is on-site wastewater treatment systems that release nitrogen to groundwater that then flows into the Forge River where it stimulates algal blooms.

If groundwater nitrogen were significantly reduced, algal blooms would be less frequent and less intense. Less intense and fewer algal blooms would reduce the deposition of organic matter to the sediments. Activity by aerobic sediment bacteria would slow, releasing less nitrogen back to the water table. Anaerobic bacteria located deeper in the sediment where oxygen is depleted, would denitrify remaining organic material and release nitrogen to the atmosphere. Reducing groundwater nitrogen inputs to the estuary is one of the most effective ways to improve water quality in the Forge River.

Figure 11-42. Sediment-water column nitrogen cycle



12 Regulatory Background

The policies and programs of federal, state, and local government and agencies affect stormwater management and wetland, stream corridor and habitat protection and restoration efforts. Various levels of government share jurisdiction over the watershed. Although the Town of Brookhaven controls most land-use decisions in the watershed, a number of federal, state, county, and local entities also have responsibilities over the management and use of land, water, and infrastructure in the watershed.

12.1 The Village of Mastic Beach

Mastic Beach became a village in August 2010 by a vote of its residents. The new Village has not yet established a Village code or a final Village boundary map. The proposed boundaries, delineated in Figure 12-1, show that some of the lowest elevation areas of the watershed are inside the Village as are a portion of Poospatuck Creek and all of Lons Creek.

The Village will have authority over land use, zoning, and some of the infrastructure inside its borders. As such, it will have the capacity to regulate future development and redevelopment, stormwater management, and certain aspects of wastewater collection and treatment.

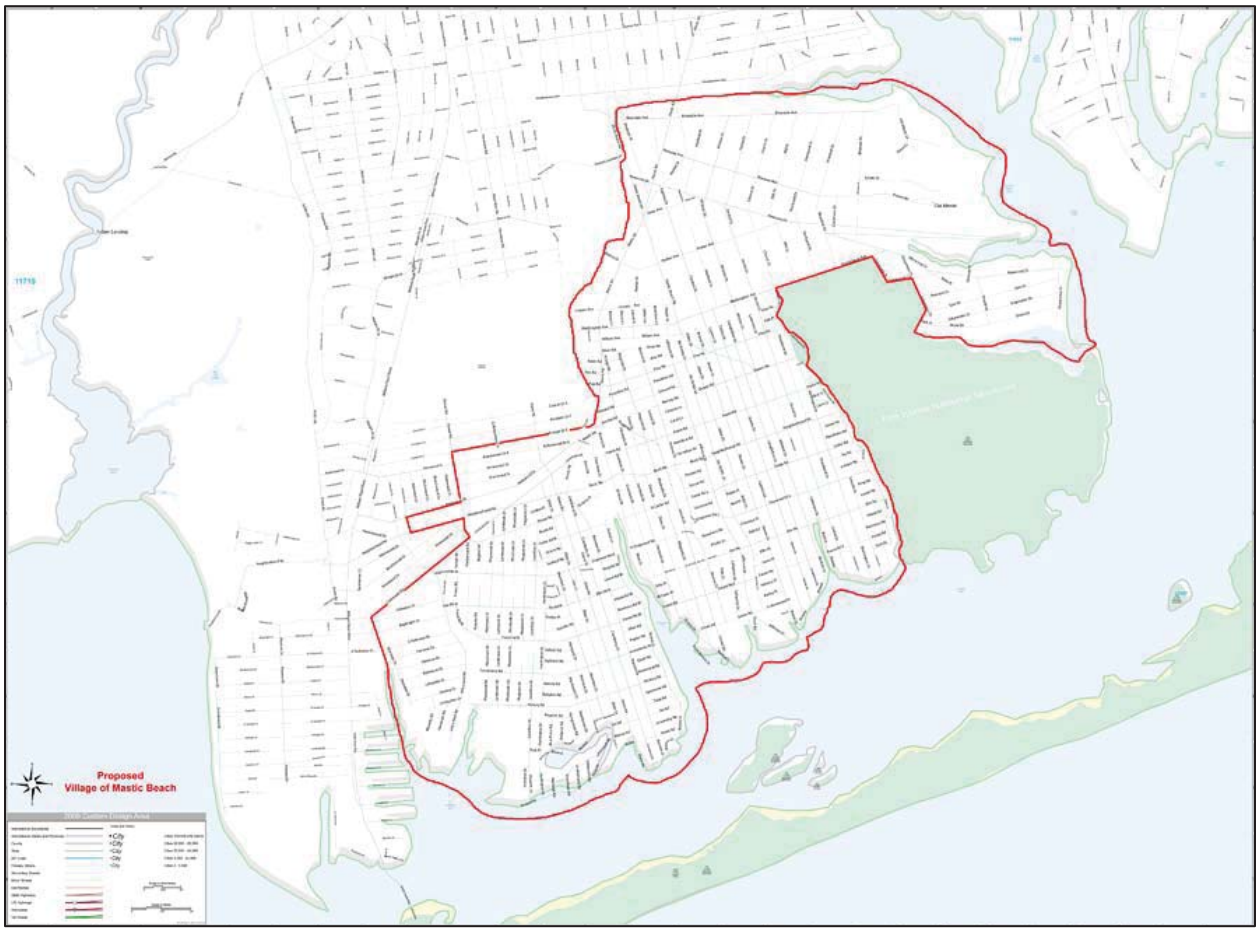
12.2 The Town of Brookhaven

The Forge River watershed is located entirely inside the Town of Brookhaven. The following analysis summarizes local laws, ordinances, programs, and practices that affect point and nonpoint source pollution management and watershed ecology in the Forge River watershed.

12.2.1 Land Use and Zoning

The Town of Brookhaven regulates land use activities in its unincorporated communities, which comprise most of the Forge River watershed. It also regulates use of underwater lands including the bottomlands of the Forge River and the management of stormwater. The Town has also developed a Wetlands and Waterways ordinance that places lands defined as wetlands or waterways under the protection of the Town Board (see Section 10.2.2 below). Land use regulation by the Town has the greatest potential to influence the future of the Forge River watershed.

Figure 12-1. Village of Mastic Beach Draft Boundary Map



12.2.2 Wetlands and Waterways Law

Adopted by the Town Board in January 1993, the Wetlands and Waterways Law is codified within Chapter 81 of the Town Code for Brookhaven. Since wetlands and waterways are important resources, the purpose of the law, as stated in *§ 81-1 Legislative intent* of the Town Code, is to "protect and preserve these natural resources and the valuable attributes and functions they possess." The law applies to all lands that meet the definition of wetlands and waterways, in particular, surface waters, lands underwater and wetlands. Because of this law, the Town of Brookhaven regulates a variety of activities including construction, dredging, dumping, and pollution discharge, all of which require a permit from the Town.

The law establishes two review categories - Categories A and B. For the regulation of land development or related alterations, the categories are distinguished by the dimensional envelope of such activities as follows:

- Category A: Includes "subdivisions, land divisions, site plans, new residential and commercial buildings and associated activities which propose to or cause the erection of a building within 50 feet of wetlands and/or cause activities in association with construction of a new building such as removal of natural vegetation, filling, grading, the installation of roads, parking areas, drainage areas and the like which cause a disturbance to the soils or vegetation within 25 feet of wetlands." (See *§ 81-3 Definitions* of the Town Code).
- Category B: Applies to development activities that fall outside the envelope of Category A projects and "include subdivisions, land divisions, site plans, new residential and commercial buildings and associated activities which propose to or cause the erection of a building within 120 feet of wetlands but outside of 50 feet of wetlands and/or cause activities in association with construction of the structure such as removal of natural vegetation, filling, grading, the installation of roads, parking areas, drainage areas and the like which cause no disturbance to the soils or vegetation within 25 feet of wetlands". (See *§ 81-3 Definitions* of the Town Code).

Category B projects also include dredging, placement of mooring piles and construction for residential docks and other activities that may affect a wetland or waterway. In addition, Category A projects include commercial docks and residential docks that exceed standards set forth in *§ 81-10 Category B permits* of the Wetlands and Waterways Law.

The law also establishes standards for the installation of commercial and residential docks, defines the application process for permits, and sets penalties for violations. Activities such as hunting and fishing, particular activities of the Town departments (*e.g.*, protecting the public health, maintenance of public works and highways) and specific types of lawn maintenance are exceptions and thus are not regulated.

In its review and decision on whether to grant, deny, or limit the permit, the Town Board is required to consider a range of factors including wetland and surface water functions, the effect of the proposed activity on public welfare, navigation, public access, impact to adjacent properties, fishing and shellfishing, storm dangers and water quality. The Town Board is also allowed, via the law, to give preference to "water-dependent activities that must have a shoreline, wetland or waterway location in order to function, and that will have as little impact as possible upon surface waters, the wetland, and adjacent area." (See § 81-11 and § 81-12 of the Town Code for language addressing the granting, denying or limiting of Category A and B projects.)

12.2.3 Stormwater Management

Amendments to the 1972 Clean Water Act required municipalities with populations greater than 100,000 to plan programs and practices to reduce non-point sources of pollution as of 1990 ('Phase I'). Phase II of the program began in 2003, which required all municipalities, including the Town of Brookhaven, to implement the plans developed in Phase I. The Phase II program requires the Town of Brookhaven to operate according to a permit, which it must secure from the DEC to discharge stormwater runoff into its surface waters. The DEC grants a SPDES (State Pollutant Discharge Elimination System) permit only if the Town develops and implements a comprehensive stormwater management program that includes the following six categories of programs and practices:

- Public education and outreach on stormwater impacts
- Public involvement / participation
- Illicit discharge detection and elimination
- Construction site stormwater runoff control
- Post-construction stormwater management in new development and redevelopment
- Pollution prevention / good housekeeping for municipal operations

The Town has complied with the conditions of its DEC permit by adopting Chapter 86 of the Town Code: *Stormwater Management and Erosion Control* and Chapter 86A: Prohibition of Illicit Discharges and Connections to the Town of Brookhaven Municipal Separate Storm Sewer System. The Town is also developing Management Plans for the watersheds inside the Town and is mapping its stormwater infrastructure, including outfalls to surface water and catch basins. Its Highway Department installed and continues to install catch basins throughout the Town to intercept stormwater and reduce discharges to surface waters. The Town also offers public education programs on non-point source pollution and information on its website.

12.2.4 Floodplain Management

Chapter 33 of the Town code sets flood zone construction standards in relation to the standards set by the Federal Emergency Management Agency (FEMA). The Town bases its standards on FEMA flood elevations for the different hazard zones mapped by the agency. The agency recently completed new flood maps for most of the country that in many cases place more coastal areas inside flood hazard zones. Town development regulations are based on FEMA requirements and require a permit for any new or substantially improved structure to be located in Zone A1-A30, AE or AH, or Zone A if base flood elevation data are available. The Town code is designed to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

- *Regulate uses which are dangerous to health, safety and property due to water or erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities;*
- *Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;*
- *Control the alteration of natural floodplains, stream channels, and natural protective barriers which are involved in the accommodation of floodwaters;*
- *Control filling, grading, dredging and other development which may increase erosion or flood damages;*
- *Regulate the construction of flood barriers which will unnaturally divert floodwaters or which may increase flood hazards to other lands; and*
- *Qualify for and maintain participation in the National Flood Insurance Program.*

Many of the Forge River riparian areas are at low elevations that place them inside one of the flood hazard zones. New construction or substantial reconstruction or additions inside these zones must conform to the Town's flood control regulations. A map of FEMA flood zones is provided in Figure 5-5, in Section 5.4.

12.3 County Involvement in the Watershed

12.3.1 Suffolk County Department of Health Services

The County's Department of Health Services, Division of Environmental Quality supervises a number of programs that potentially impact the Forge River watershed. They include 1) groundwater and drinking water protection, 2) wastewater management, 3) toxic and hazardous materials pollution control, 3) monitoring and laboratory analyses, 4) enforcement of regulations, and 5) environmental management studies and programs for groundwater and surface waters, including related ecological issues.

The County manages these programs through the division's five offices: *Water Resources, Pollution Control, Wastewater Management, Ecology, and the Public and Environmental Health Laboratory*.

Water Resources monitors groundwater quality. *Pollution Control* may be involved in the event of spills or hazardous material storage inside the watershed. *Wastewater Management* is responsible for onsite wastewater disposal systems. The *Office of Ecology* has many responsibilities inside the watershed. They include groundwater and surface water environmental management studies, bathing beach monitoring, environmental quality review for development, and marine, surface (freshwater) and point source water sampling.

12.3.2 Suffolk County Department of Environment and Energy

Suffolk County's Department of Environment and Energy (DOEE) has a Division of Water Quality Improvement that supervises administers, and implements ¼ percent sales

tax funded Water Quality Protection and Restoration Program and Land Stewardship projects. The agency coordinates the activities of other County agencies such as the Department of Public Works (SCDPW) and the County Department of Parks, Recreation, and Conservation for ¼ percent sales funded projects.

12.3.3 Suffolk County Planning Department

The Suffolk County Planning Department's Council on Environmental Quality (CEQ) advises the County Executive and Legislature on major issues related to the environment. The CEQ determines what County activities may have a significant impact on the environment. They recommend properties for addition to the County Nature Preserve. They brief the Legislature and Executive on developments with environmental significance and review the environmental impact of projects requested by the Executive or Legislature. The CEQ also reviews environmental impact statements for County agencies. The CEQ would likely review the recommendations of the Forge River Management Plan.

12.3.4 Suffolk County Department of Public Works

The County Department of Public Works, Division of Highways, Structures, Waterways, Engineering maintains bridges, culverts, structures such as tide gates, and 300 waterways. This Division would be involved in the dredging of the Forge River.

The Division of Sanitation and Sewerage Facilities is responsible for the permitting, construction, and operation of private and public wastewater treatment facilities. This Division would be consulted for any projects inside the watershed pertaining to new or existing treatment plants and developments requiring them.

The Division of Vector Control is responsible for mosquito control in the Suffolk County. The mosquito ditches of the Forge River's tidal wetlands are under the management of this agency.

12.4 State Involvement in the Watershed

12.4.1 New York State Department of Environmental Conservation

The New York State Department of Environmental Conservation (DEC) manages the State's recreational and commercial fisheries, tidal and freshwater wetlands, and other natural resources of the coastal and inland environments. The DEC is responsible for surface and ground water quality protection, particularly through the State Pollution Discharge Elimination System (SPDES) permit program. The discharges from the wastewater treatment plants are regulated by the DEC. The SPDES (Phase II) covers

municipal stormwater systems, construction sites greater than one acre, and oversight of spill remediation.

The DEC reviews and permits activities within or adjacent to freshwater and tidal wetlands. The agency is responsible for various natural resource protection programs and enforces the State's environmental laws.

The DEC certifies coastal waters for shellfishing and sets and administers fisheries regulations. The Director of the DEC's Region I office has chaired the Forge River Task Force since its inception.

12.4.2 New York State Department of Transportation

The State's Department of Transportation (DOT) is responsible for the design and maintenance of State roads and their drainage infrastructure. A number of the roadways, particularly NYS Route 27 and 27A (Sunrise Highway and Montauk Highway), are under DOT jurisdiction. Drainage from Montauk Highway enters the Forge River system by the East and West Mill Ponds. The DOT is a regulated small Municipal Separate Storm Sewer System (MS4). As a designated MS4, the State is required to address the stormwater discharges from their systems and will need to coordinate with the Forge River Task Force and the Town to improve water quality from road runoff in this system.

12.5 Federal Involvement in the Watershed

12.5.1 United States Army Corps of Engineers

The US Army Corps of Engineers (USACE or the Corps) provides planning, design, construction, and operating services for a variety of water resource and other civil works projects that typically include navigation and dredging, flood control, environmental protection, and disaster response. The Corps also issues permits for projects in navigable waterways.

The USACE completed a Forge River Watershed Reconnaissance Study in the fall of 2008 that assessed past and current watershed activities and trends and identified watershed management opportunities. The reconnaissance study found a 'federal interest' in continuing the study into the feasibility phase.

In 2009, the USACE issued a 'Project Management Plan' (PMP) that describes the details of the feasibility study the Corps would undertake with the Town as local sponsor and with the participation of other partners and participants. The feasibility study will result in a management plan for the Forge River that compliments this study. The USACE study will

include models to address hydrologic, hydraulic, and sediment transport conditions and environmental surveys to map the remaining riparian habitats along the stream corridors.

The Corps plans to conduct preliminary-level studies of potential water quality improvements (such as constructed wetlands) that could help meet TMDL objectives. The USACE will then prepare an Environmental Impact Statement (EIS) based on the information and alternatives identified in the feasibility study. The Corps divided the study into two phases and identified the following tasks in each:

PHASE I

a) A comprehensive update of hydrologic, hydraulic, and sediment (yield and transport) models for a range of flow rates for existing conditions and future conditions within the Forge River watershed.

b) Identification of the environmental resources (key species and habitat types) that should be restored, enhanced or sustained to insure a well-functioning watershed supporting a wide diversity of plants and animal species and improving water quality.

c) Investigation of large and small scale conceptual, site-specific environmental restoration, sediment control, and erosion control opportunities within the Forge River watershed. Prioritize alternatives in the event that funding is not fully available.

d) Evaluation of ground water and surface water interactions and identification of the relationship between environmental conditions in the Forge River and Moriches Bay and Moriches Inlet. Hydrodynamic and water quality conditions within the Forge River will be modeled for the evaluation of hydrodynamic modification as an alternative.

e) Identification of actions and programs that can be implemented by federal, state, and local agencies that can help fund or implement solutions to water quality problems based on existing and future development in the watershed.

PHASE II

a) Develop watershed management alternatives that integrate ecosystem restoration with flood control, groundwater recharge, polishing of wastewater effluent, and recreation. Prepare supporting engineering and environmental documentation of without project conditions and with-project conditions for each alternative evaluated in the feasibility phase.

b) Design, and assess costs, benefits, and environmental outputs of each alternative. Costs will include construction costs, land acquisition, and operation and maintenance.

c) Formulate for appropriate scale and location of alternative using the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) or other defensible scientific method.

d) Prepare a comprehensive environmental document to assist in future watershed management, complete public information process, and prepare Record of Decision.

Most of the Phase I tasks listed above will be completed as part of this Watershed Management Plan and during the preparation of the TMDL. The USACE will investigate specific restoration alternatives during the development of the Corps' Management Plan. The Plan will include preliminary restoration alternatives in Phase I and more definitive recommendations in Phase II. Significantly, the Plan will make recommendations for federal involvement in *implementable* projects at specific sites. A separate feasibility study for those projects would be included in Phase II.

12.5.2 United States Environmental Protection Agency

The US Environmental Protection Agency (USEPA) will review the findings and recommendations that come from this project and the work of the USACE (after DEC review) to establish the final nitrogen TMDL for the Forge River.

12.5.3 Federal Emergency Management Agency

The Federal Emergency Management Agency (FEMA) established various flood hazard zones based on elevation above sea level and potential exposure to inundation and wave action for various frequency flooding events (*i.e.,* 50-, 100-, 500-year storms). Municipalities like the Town of Brookhaven and the newly incorporated Village of Mastic Beach base their building and zoning codes on property location relative to FEMA flood zones (see Section 12.2.4 above).

12.5.4 United States Fish and Wildlife Agency

The US Fish and Wildlife Agency (USFWS) manages a number of preserves on Long Island, including the Wertheim Preserve, which is located on the Great South Bay. The agency has no property under its purview in the Forge River watershed. The agency's Coastal Program does get involved in 'priority coastal ecosystems' to: *1) identify the most important natural resource problems and solutions; 2) influence the planning and decision-making processes of other agencies and organizations with the Service's living resource capabilities; 3) implement solutions on-the-ground in partnership with others; and 4) instill a stewardship ethic, and catalyze the public to help solve problems, change behaviors, and promote ecologically sound decisions.*

The USFWS's Coastal Program will provide incentives to municipalities for protection of threatened, endangered and other species on private and public lands. The program will also fund the protection and restoration of coastal habitat for fish and wildlife in cooperation with public and private partners.

12.5.5 Regulatory Summary

The policies and programs of federal, state, and local governments and agencies affect stormwater management and wetland, stream corridor, and habitat protection and restoration efforts. Various levels of government share jurisdiction over the watershed. Although the Town of Brookhaven controls most land use decisions in the watershed, a number of Federal, State, County, and local entities also have responsibilities over the management and use of land, water, and infrastructure in the watershed. These entities and their coordinated efforts will be critical in restoring the quality of the Forge River.

13 Summary of Forge River Impairments

- High nitrogen inputs to the water column
  - Groundwater is the largest external source
  - Remineralization from sediment microbial activity may be as high as groundwater
  - Groundwater nitrogen is primarily from on-site wastewater systems
  - The largest surface water nitrogen input is from the duck farm on West Mill Pond
- Existing groundwater nitrogen pool is large
  - Nitrogen entered the groundwater contributing to the Forge River over many decades
  - The volume of groundwater entering the Forge River is large
  - Groundwater travel time is slow, so even if current inputs cease, a large reservoir of nitrogen will continue to flow into the Forge River
- Existing sediment nitrogen pool is large
  - Large quantities of nitrogen have accumulated in Forge River sediments
  - Sediment nitrogen will continue to be remineralized by microbial activity
  - Remineralized nitrogen will be released into the water column as long as organic rich sediments remain on the bottom.
- The duck farm is the largest single point source of nitrogen to the Forge River
- High nitrogen inputs are the primary cause of dense algal blooms
  - Various species of phytoplankton and the macroalga, *Ulva*, bloom in high densities
  - Blooms last for long periods during the warm months of the year
  - When nitrogen and light become limiting, blooms die and sink to the bottom
  - Microbial release of nitrogen back to the water column stimulates additional algal growth
  - Algal bloom biomass may be the largest contributor to sediment volume
- Nitrogen from cesspools and septic systems changes little in groundwater
  - Once nitrogen reaches groundwater it travels unchanged into the estuary
  - Proximity to the estuary has little impact on residential nitrogen contributions
- Onsite wastewater systems operate poorly in low-lying areas
  - Homes constructed less than nine feet from groundwater may contribute more nitrogen to groundwater (and the estuary) than those perched at higher elevations
  - Cesspools are less effective at removing nitrogen than septic systems
- The estuary provides little suitable habitat for aquatic organisms
  - Unconsolidated anoxic sediments are not suitable for most benthic species
  - Pelagic species are driven from the estuary by persistent hypoxia and anoxia
  - *Spartina* wetlands provide important aquatic habitat and are primary in southern areas
  - *Phragmites* has invaded primarily the brackish head of the Forge River and Ely Creek

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15 Governmental Roles in Watershed Management

This chapter describes and evaluates the roles and responsibilities of governmental and non-governmental groups for the Forge River Watershed. The first section identifies, describes, and evaluates the existing roles, responsibilities, and effectiveness of agencies as they affect watershed management. The second section describes their roles and responsibilities for Total Maximum Daily Load (TMDL) development and implementation. The final section describes programs and policies affecting watershed management with descriptions of local ordinances, potential amendments, and changes to them that would enhance management actions, and information on sewer district formation.

This section identifies, describes, and evaluates the existing roles, responsibilities, and effectiveness of federal, state, county, and local agencies as they affect point and non-point sources of pollution including stormwater management, wetland, stream corridor and habitat protection and restoration, watershed hydrology, and dredging.

15.1 Federal Agencies

The federal agencies that have roles in watershed management are the U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), and the U.S. Fish and Wildlife Service (USFWS). The following briefly describes their roles and responsibilities.

15.1.1 U.S. Environmental Protection Agency

The USEPA has authority over several regulatory and permitting mechanisms which can be used to implement watershed management plans. Section 305(b) of the Federal Clean Water Act (CWA) requires each State to monitor, assess and report on the quality of its waters relative to designated uses established in accordance with its water quality standards. Section 303(d) of the CWA requires each State to list waters not meeting water quality standards and prioritize those waters for Total Maximum Daily Load (TMDL) development or other management. Ultimately, the USEPA will have to approve a TMDL and monitor its implementation progress through the State of New York's programs as a delegated permitting authority.

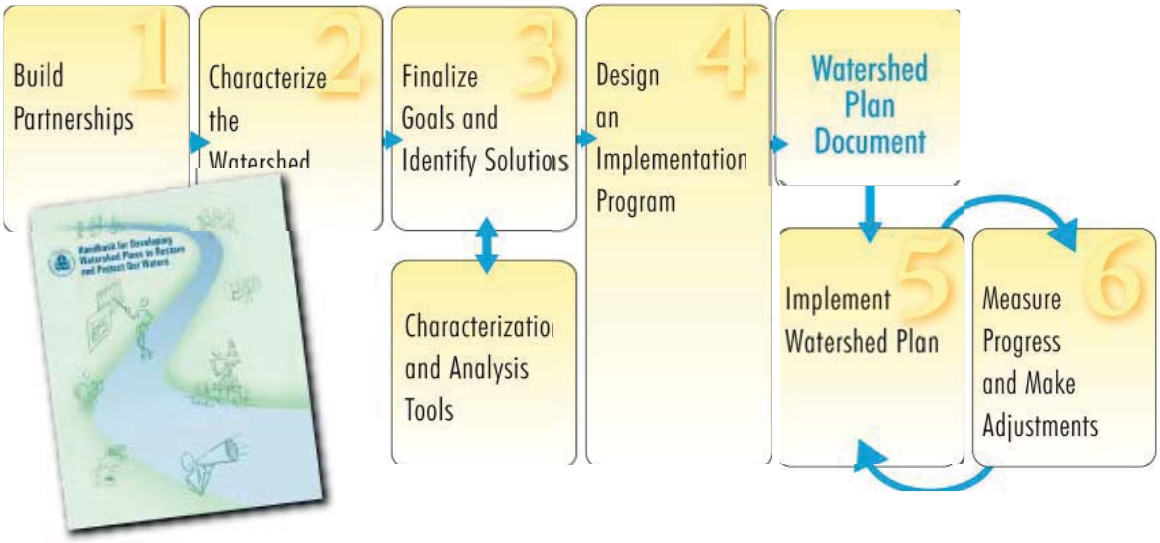
The USEPA permitting authority includes national Pollution Discharge Elimination System (NPDES) permitting for wastewater treatment facilities and stormwater facilities, confined animal operations permitting, and 401 water quality certifications which ensure that water quality standards will be met whenever activities occur within surface waters or wetlands. These programs are effective at addressing point source activities through the

State of New York as a delegated state, but do not impact non-regulated nonpoint source activities.

- Polluted stormwater runoff from Municipal Separate Storm Sewer Systems (MS4s) is regulated by the USEPA. Phase I, issued in 1990, requires medium and large cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges. Phase II, issued in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the permitting authority, to obtain NPDES permit coverage for their stormwater discharges. MS4 permitting is conducted by the NYSDEC as the delegated authority.
- The 1987 amendments to the Clean Water Act (CWA) established the Section 319 Nonpoint Source Management Program. Under Section 319, states, territories, and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects. Projects funded by the grants have to include nine essential elements of watershed planning, which align to actions being taken for the Forge River watershed. The nine elements are:
- Identify causes and sources of pollution that need to be controlled.
- Determine load reductions needed.
- Develop management measures to achieve goals.
- Develop implementation schedule
- Develop interim milestones to track implementation of management measures.
- Develop criteria to measure progress toward meeting watershed goals.
- Develop monitoring component.
- Develop information/education component.
- Identify technical and financial assistance needed to implement plan.

The USEPA has written guidance on developing watershed management plans and provides grant funding for developing local watershed plans and monitoring and modeling programs to support watershed management. Its *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA, 2008) provides detailed guidance for developing and implementing watershed plans in a collaborative framework. Figure 15-1 provides an overview of the steps of the watershed plan development and implementation process described in detail by the handbook. Funding for non-point source controls can be sought for the Forge River through the 319 grant program if the nine elements listed above are implemented.

Figure 15-1. Steps in the Watershed Planning and Implementation Process



15.1.2 U.S. Army Corps of Engineers

The USACE is responsible for permitting activites in wetlands and streams through Section 404 of the Clean Water Act. The 404 permitting process is effective for protecting jurisdictional streams and wetlands, but is not effective at protecting smaller streams and wetlands. The USACE would oversee any dredging activity in the Forge River watershed.

The USACE can also obtain federal funds to develop and implement water quality plans. Typically, the USACE will initially receive $100,000 in federal funds to evaluate whether a water quality initiative within a given watershed is feasible. Additional funds are later obtained. The USACE has obtained $3 million for studies within the Forge River watershed.

15.1.3 U.S. Geological Survey

The USGS has no permitting authority. The USGS sets up and supports stream gages throughout the United States. Often, gages are cost-shared with state or local governments. The USGS also does some water quality monitoring; this could occur at selected gages or as part of special studies undertaken by the agency. The flow and water quality monitoring data that is collected help support watershed studies including modeling activities. The USGS has also developed watershed models in certain regions of the United States to evaluate pollutant fate and transport.

15.1.4 U.S. Fish and Wildlife Service

The USFWS is responsible for protecting regionally significant habitat areas and federally threatened and endangered species. These programs are effective at addressing federal species, but do not address federal species of concern or local species of interest.

15.2 State Agencies

The New York State agencies that have roles in watershed management are the Departments of Environmental Conservation (NYSDEC), State (NYSDOS), and Transportation (NYSDOT). The following briefly describes their roles and responsibilities.

15.2.1 New York State Department of Environmental Conservation

The NYSDEC is responsible for enforcing New York State's environmental resources laws. They are the agency that has been authorized by USEPA to issue State Pollutant Discharge Elimination System (SPDES) permits for wastewater and stormwater discharges and 401 water quality certifications. Wastewater treatment plants are regulated and effluent limits are set via SPDES permits.

There are three SPDES general permits required for activities associated with stormwater discharges administered by the NYSDEC. The Multi- Sector General Permit for Stormwater Discharges Associated with Industrial Activities (MSGP) addresses stormwater runoff from certain industrial activities. This permit requires facilities to develop Stormwater Pollution Prevention Plans (SWPPPs) and report the results of industry-specific monitoring to the NYSDEC on an annual basis. Stormwater Phase II requires permits for stormwater discharges from MS4s in urbanized areas. Permittees are required to develop Stormwater Management Program (SWMP) and submit annual reports to the NYSDEC. Construction activities disturbing one or more acres of soil must be authorized under the General Permit for Stormwater Discharges from Construction Activities. Permittees are required to develop a SWPPP to prevent discharges of construction-related pollutants to surface waters. NYSDEC provides guidance for local officials on complying with state and federal stormwater management requirements with its Stormwater Management Guidance Manual for Local officials (NYSDEC, 2004). The guide includes a sample local law for stormwater management and erosion and sediment control. The NYSDEC has also published numerous stormwater design manuals to support its stormwater programs.

The NYSDEC Bureau of Water Assessment Management monitors the waters of the state, reviews data and information to evaluate these waters, and reports on the quality and the ability of these waters to support uses. Routine statewide monitoring determines the

overall quality of waters, trends in water quality, and identification of water quality problems and issues. Water quality assessments and reporting evaluates monitoring results and reports on water quality. Reports include the Waterbody Inventory/Priority Waterbodies List, New York State Water Quality Report (Section 305b) Report, and Section (303d) List of Impaired Waters. The Water Quality Management Program establishes water quality based permit limits, participation in watershed-specific management groups and activities, and coordination of Total Maximum Daily Load (TMDL) development and other appropriate strategies to address impaired waters. Load and wasteload allocations resulting from TMDL calculations are implemented via the SPDES program.

15.2.2 New York State Department of State

The NYSDOS Division of Coastal Resources works in partnership with community groups, non-profit organizations, state and federal agencies, and local governments. The Division implements the Federal Coastal Zone Management Act in New York State through the New York State Coastal Management Program, implements the State's Waterfront Revitalization of Coastal Areas and Inland Waterways Act that provides funding for a broad range of projects through the Environmental Protection Fund Local Waterfront Revitalization Program, and develops Local Waterfront Revitalization Programs and Harbor Management Plans. The agency also participates in regional planning for the areas surrounding the Long Island Sound and the South Shore Estuary Reserve, protects water quality through intermunicipal watershed planning, develops and applies remote sensing and Geographic Information Systems (GIS) technology, plans for the prevention and mitigation of coastal hazards, protects and restores coastal habitats, and implements New York's coastal policies through Consistency Review.

The NYSDOS assists in the development and implementation of watershed management plans. Each watershed plan is guided by an intermunicipal organization, facilitated by the NYSDOS, which shares resources and cooperates on projects to reduce water pollution. The NYSDOS grants awards from the Environmental Protection Fund Local Waterfront Revitalization Program. Forge River watershed management planning is being funded by the NYSDOS.

The NYSDOS published its Guidebook *Watershed Plans: Protecting and Restoring Water Quality*" (NYSDOS, 2007) that discusses stakeholder processes, watershed characterization, watershed goals, developing watershed management plans, and implementing the plans.

15.2.3 New York State Department of Transportation

The NYSDOT has implemented an environmental initiative to ensure that its projects minimize impacts on the environment. The NYSDOT is regulated as a small MS4 stormwater facility, and as such has developed measurable goals. One of these goals is to maintain involvement with local and regional watershed associations including the South Shore Estuary Reserve program.

15.3 Suffolk County

The Suffolk County agencies that have roles in watershed management are the Department of Health Services, Department of Environment and Energy, Planning Department, and the Department of Public Works. The following briefly describes their roles and responsibilities.

15.3.1 Department of Health Services

The Department of Health Services (SCDHS) is responsible for onsite wastewater systems and issues permits for new septic systems. While this program is effective at managing new onsite systems, it does not address older onsite systems which could be a major pollutant source.

15.3.2 Department of Environment and Energy

The SCDEE administers a ¼-percent sale tax, which funds water quality protection and land stewardship programs. These funds could be used to protect and restore wetlands and riparian habitats that may fall outside the jurisdiction of the USEPA, USACE, and NYSDEC.

15.3.3 Planning Department

The Planning Department's Council on Environmental Quality reviews environmental documents that could be developed as part of a watershed management process or as part of an infrastructure project. These reviews help ensure that impacts from new projects to the human and natural environments are minimized.

15.3.4 Department of Public Works

The Department of Public Works is responsible for permitting, construction, and operation of private and public wastewater treatment facilities. These facilities must also meet federal and state SPDES requirements. The Department of Public Works' involvement ensures local needs are met. The Department is also currently taking a lead on efforts to dredge the Forge River for navigation purposes. This provides an opportunity to coordinate specific navigational dredging actions with restoration activities.

15.4 Town of Brookhaven

The Town of Brookhaven has jurisdiction over the majority of land within the Forge River watershed. The Town reviews all new site plans to ensure they comply with local ordinances and policies. The Town's ordinances, programs and policies can be developed and applied to protect resources that do not fall under federal and state jurisdiction.

15.5 Village of Mastic Beach

The Village of Mastic Beach was incorporated in 2010. The Village has not yet developed land use ordinances, but any future development policies and ordinances could impact the quality of the Forge River.

16 Roles & Responsibilities for TMDL Development & Implementation

This section identifies the government roles that would enable the voluntary completion of a nitrogen TMDL for the Forge River. It is organized by processes and includes monitoring and assessment, identification of impairments, TMDL development, implementation, and enforcement. Table 16-1 summarizes the existing and potential roles of various government entities as well as other stakeholders in the Forge River watershed processes. The agencies with specific regulatory authority for developing, approving, implementing, and enforcing a TMDL are described.

Table 16-1. Roles of Selected Stakeholders in Management of Forge River Watershed

	Monitoring and Assessment		Develop TMDL/Management Strategies			Implementation
Entity	**Collect Data**	**Assess Watershed**	**Develop Models**	**Identify Targets**	**Develop Strategies/Plan**	**Implement Strategies**
Federal						
EPA	○	○	○	○	○	○
USACE	■	■	■		■	■
USGS	■	■	■			
State						
DEC	■	■	■	■	○	
Dept. of Health	■	■				
Cooperative Extension	■				■	■
Local						
Suffolk County	■	■			■	■
Town of Brookhaven			■	■	■	■
Village of Mastic Beach					■	■
Poospatuck Indian Nation					■	■
Other						
Forge River Task Force	■	■	■	■	■	■
Universities	■	■	■			
Other Interest Groups	■	■			■	

○ Oversight Role
■ Current or Potential Future Role

16.1 Monitoring and Assessment

Monitoring is an ongoing task within the watershed planning process. Monitoring data are used to evaluate whether a given waterbody is meeting its designated uses. Monitoring occurs over time to determine whether waters which meet their uses continue to do so and whether impaired waters improve as management strategies are implemented. Monitoring can also help identify potential sources of pollution. Several entities have performed

extensive monitoring within the Forge River watershed as described in earlier chapters of this plan.

The amount of data collected in the past has been effective for evaluating the overall health of the watershed and river and for identifying the major sources of pollution to the Forge River. Continuous monitoring will be required to evaluate whether watershed management and particular TMDL strategies are working to improve water quality in the Forge River. Specific monitoring recommendations will be included in the Watershed Management Plan. Recommendations on changes, if any, to the parameters, location, and frequency of Suffolk County's data collection program in the Forge River will be included in the Watershed Management Plan to ensure that monitoring resources are spent most effectively for future watershed management needs. Some long term stations should be maintained to evaluate trends over time, but other stations or parameters could change to evaluate the performance metrics of specific objectives in the Watershed Management Plan.

16.2 Identification of Impairments

Section 305(b) of the Clean Water Act requires states to assess and periodically report on the quality of all the waters of their state. The NYSDEC Division of Water developed the Consolidated Assessment and Listing Methodology (CALM), which outlines the process the Department follows in monitoring and assessing the quality of New York State waters. The process has three stages: monitoring, assessment, and listing. The Methodology consists of three separate parts documented in its *Monitoring Strategy* describing the water quality monitoring program; the Assessment Methodology describing the evaluation of monitoring data and information to determine levels of water quality and use support; and the Listing Methodology describing the identification and prioritization of waters that do not meet water quality standards or support designated uses. All documents can be found on the NYSDEC website (www.dec.ny.gov/chemical/31296.html).

The NYSDEC Statewide Ambient Water Quality Monitoring program (SWMP), which includes monitoring of surface waters and groundwater, uses a rotating strategy in which all major drainage basins in the state are monitored over a five year period. This data is then processed following the CALM to identify if impairments exist and if so, implement restoration and protection efforts that may include TMDL development.

16.3 TMDL Development

A TMDL is an estimate of the amount of pollutant that a given waterbody can assimilate and maintain its designated uses and standards. The Clean Water Act requires that a TMDL be developed for impaired waterbodies. The TMDL must also allocate the allowable load

between point and nonpoint sources; the analysis must also include a margin-of-safety to account for any uncertainty. The margin-of-safety can either be an explicit allocation of the allowable load or be incorporated through conservative modeling assumptions.

The Forge River is listed by the State of New York for impairments to aquatic life and recreational uses based on low dissolved oxygen and high coliform bacteria observations, respectively. This watershed management effort is focused on management strategies to address the aquatic life impairment only. Monitoring data and analyses performed and documented in the watershed characterization indicates that excessive nutrients in the Forge River from several sources are the cause of low dissolved oxygen.

NYSDEC is responsible for developing TMDLs in New York State, and the United States Environmental Protection Agency (USEPA) must ultimately approve or disapprove all TMDLs. Third parties can also develop TMDLs and there are benefits to this approach:

- Third parties are familiar with their watershed and can provide valuable data and insight to causes and sources of impairment and potential strategies
- Third parties often provide a level of funding to support better monitoring and modeling for analyses
- Third party TMDLs often have a higher level of public involvement which can provide educational opportunities for the public and elected officials

There are also potential downfalls of third party TMDLs:

- Third parties must understand that certain criteria must be included in the TMDL in order to obtain NYSDEC and USEPA approval
- Third party TMDLs often take longer to complete than a TMDL completed in the more traditional approach
- The third party can be viewed by others as biased or serving the interests of a subset of stakeholders

The Town of Brookhaven is pursuing a third party TMDL and plans to hire a contractor to complete the modeling work. In addition, the Forge River Task Force has been formed which is chaired by NYSDEC and has members representing the Town of Brookhaven, Suffolk County, Poospatuck Indian Nation, and public interest groups. This group has been meeting monthly since 2005. Given the variety of membership and the inclusion of NYSDEC, the group should be able to complete a third party TMDL successfully, provided there is adequate funding for the project. Potential roles in developing the TMDL include:

- USEPA provides oversight of TMDL development and must approve it.
- NYSDEC ensures that the TMDL includes all items necessary for approval; provides guidance to the Forge River Task Force and Town of Brookhaven.

- NYSDOS, Division of Coastal Resources has provided funding for the watershed studies and TMDL.
- Town of Brookhaven is providing funding for consulting services to complete the modeling and TMDL report.
- Suffolk County can continue its monitoring program to support TMDL model development.
- The USACE is collaborating with the Town of Brookhaven on watershed management strategy development through its watershed planning project. The USACE project includes: updating hydrologic, hydraulic, and sediment models for existing and future conditions; identifying species and habitats that should be restored; investigating and prioritizing environmental restoration and sediment control opportunities in the watershed; evaluating link between groundwater and surface water; identifying actions and programs that can be implemented by federal, state, and local programs. Many of these tasks will be completed concurrently and integrated with TMDL development.
- The Forge River Task Force and public interest groups including Save the Forge River, Peconic Baykeeper, Ducks Unlimited, and Waterways Homeowners Association monitors TMDL development to ensure watershed goals are met.

16.4 TMDL Implementation and Enforcement

The final step in the process is to implement the TMDL and other watershed management strategies. If the TMDL and strategies are not implemented, the ultimate goal of restoring the Forge River will not be met. Point and nonpoint sources will implement practices to reduce their nutrient loadings to the watershed that may be permitted and enforced via SPDES permits. Some practices may also result in aquatic and terrestrial habitat protection and restoration or wetland protection and restoration. Other strategies may include dredging. Several management practices could require environmental permits.

For instance, the NYSDEC may modify and implement any load allocations (LA) and wasteload allocations (WLA) to implement TMDL allocations if necessary through the SPDES program. Suffolk County can monitor the effectiveness of the TMDL and other watershed management strategies upon implementation. The County may also work with homeowners on programs to ensure onsite wastewater systems are properly operating and to provide centralized treatment in areas where there are concentrations of failing systems. The Town of Brookhaven may modify land use ordinances as a result of the TMDL or develop new approval requirements for Stormwater Pollution Prevention Plans (SWPPP) for new development. The Town may also evaluate opportunities for stormwater retrofit within its jurisdiction and pursue funding. Similarly, the Village of Mastic Beach and Poospatuck Indian Nation could implement elements of the TMDL. More information on town programs is provided in Section 3.1. The roles of various federal, state, and local agencies are provided in Table 16-2 and Table 16-3.

Table 16-2. Roles of Federal and State Agencies in TMDL Implementation

Entity	TMDL Implementation Role	Permitting Authority	Effectiveness of Authority
USEPA	• Review TMDL for reasonable assurance that TMDL will be implemented	• NPDES, 401 (water quality certification that standards will be maintained for activities occurring in surface waters and wetlands)	• NPDES - effective at controlling point sources; no impact on nonpoint sources • 401 - helps protect streams and wetlands; not effective for protecting non-jurisdictional streams and wetlands
USACE	• Protect wetlands (including streams and coastal areas) • $3 million allocated to USACE for Forge River watershed studies as described in Section 2.2	• 404 - requires avoidance; if avoidance of streams and wetlands is not practicable, impacts must be minimized and mitigated	• 404 process effective for jurisdictional waters and wetlands; not effective for smaller, non-jurisdictional areas - these would require local government protection.
United States Fish and Wildlife Service (USFWS)	• Ensure strategies protect regionally significant habitat areas of Moriches Bay and striped bass spawning habitat on Forge River • Oversight of any strategies which could impact endangered species habitat	• Section 7 consultations for compliance with Endangered Species Act	• Helps protect federal listed threatened and endangered species; no permitting authority over other rare species.
NYSDEC	• Assure TMDL is implementable prior to submittal to USEPA for approval • Enforce State's environmental resource laws	• SPDES including MS4 permits, construction permits for sites over 1 acre, and spill remediation • Requires new stormwater permit applicants to include approved SWPPP from Town of Brookhaven • 401 Water Quality Certifications	• Effective for point sources • Coordination with Town of Brookhaven ensures that local knowledge is included in the permitting process
NYSDOS	• Providing funds under Title 11 of Environmental Protection Fund	• Ensure coastal projects are consistent with State's Coastal Zone Management Plan	• Helps protect coastal areas

Table 16-3. Roles of County Agencies, the Town, and Village in TMDL Implementation

Suffolk County Department of Health Services (SCDHS)	• Office of Waste Management - responsible for onsite wastewater systems • Office of Pollution Control - could be involved with spills or hazardous materials storage • TMDL implementation monitoring of groundwater, surface water, and beaches	• Septic system permits	• Permitting program does not address older systems that could be impacting watershed
Suffolk County Department of Environment and Energy (SCDEE)	• Administers a 1/4% sales tax, which funds Water Quality Protection and Restoration Program and Land Stewardship projects. Funds could be used to protect and restore wetlands and riparian areas in watershed.	N/A	• SCDEE should use these funds to match federal grants and other sources to maximize funds available where practicable
Suffolk County Planning Department	• Council of Environmental Quality reviews environmental documents and would likely review TMDL and Forge River Management Plan	N/A	• Evaluates and minimizes impacts on human and natural environment from projects it reviews
Suffolk County Department of Public Works (SCDPW)	• Responsible for permitting, construction, and operation of private and public wastewater treatment facilities • Dredging	• Wastewater treatment facilities permits; must meet SPDES	• Ensures local needs are met
Town of Brookhaven	• Jurisdiction over majority of land in watershed; review site plans for consistency with local ordinances	• Local ordinances	• Information provided in Section 3.1
Village of Mastic Beach	• Incorporated in 2010	• None currently	• Information provided in Section 3.1

Various management strategies will be implemented by different agencies, permit holders, and stakeholders. Agencies that could be involved with potential management strategies are described below:

- NYSDEC – The TMDL could include wasteload allocations for SPDES facilities. The NYSDEC has authority over SPDES permits and compliance associated with the permits. If any new wastewater facilities were constructed, NYSDEC would have oversight of the permitting of the treatment and conveyance systems. NYSDEC would also be involved in wetland creation and restoration strategies.

- USACE – Prior discharges from duck farms and other sources have resulted in a large flux of nutrients from the sediments in the Forge River. Dredging might help alleviate the impacts of these historical loads. The USACE would have lead authority over any dredging operations. The USACE would also have a role with stream or wetland restoration strategies implemented to reduce nutrient loading and provide other benefits such as habitat, recreation, and educational opportunities. The USACE would be involved in any strategies implemented within stream and wetland areas.
- SCDHS - Since failing onsite systems are one of the potential causes of the impairment, addressing this issue will be important to restoring the Forge River. The SCDHS is responsible for onsite systems in the County.
- The Town of Brookhaven and Village of Mastic Beach – Any land use planning strategies such as special zoning districts and ordinances would be implemented by the local governments. The local governments could also be involved in any recommended dredging projects or strategies to address failing septic systems and cesspools.

17 Programs and Policies Affecting Watershed Management

This section presents the programs and practices affecting the watershed, including those focusing on point and non-point source pollution management and watershed ecology.

17.1 Local Laws and Ordinances

This section summarizes local laws, ordinances, programs, and practices that affect point and non-point source pollution management and watershed ecology in the Forge River watershed and assesses their adequacy and utility. The strengths and weaknesses of local laws, programs, and practices as they relate to the management of point and nonpoint source pollution and protection of water quality and ecology are identified. The Town of Brookhaven can use the laws and ordinances listed below to regulate activities that are inconsistent with watershed management plan strategies designed to improve water quality.

17.1.1 Town of Brookhaven – Wetlands and Waterways Ordinance

Adopted by the Town Board in January, 1993, the Wetlands and Waterways Law is codified within Chapter 81 of the Town Code for Brookhaven. Since wetlands and waterways are important resources, the purpose of the law, as stated in §81-1 of the Town Code, is to "protect and preserve these natural resources and the valuable attributes and functions they possess." The law applies to all lands which meet the definition of wetlands and waterways, in particular, surface waters, lands underwater and wetlands. As a consequence of this law, the Town of Brookhaven regulates a variety of activities including construction, dredging, dumping and pollution discharge; all of the regulated activities require a permit from the Town. A more detailed description of the ordinance is provided in the Characterization chapter.

17.1.2 Town of Brookhaven – Land Use and Zoning

Land use planning and zoning helps protect and restore water quality. Local governments planning departments guide development away from environmentally sensitive areas into areas where there will be less impact on the environment. In addition, local governments' site review process can help protect important environmental features including those that help maintain a watershed's functions including wetlands, riparian buffers and floodplains. Riparian areas and floodplains help protect watersheds through several processes including: shading streams to help prevent algal blooms by limiting light, providing habitat, filtering pollutants including nutrients, and maintaining hydrology.

The Town of Brookhaven reviews site plans to determine how close to wetlands and waterways a proposed building is. Site plans that propose buildings within 50 feet of a

waterway are classified as Category A. When the Town reviews Category A developments, its wetlands and waterways ordinance requires it to consider the protection of environmentally sensitive areas, maintenance of natural vegetation to the extent feasible, and setbacks from waterways when determining whether to grant or deny a permit. This ordinance language allows the Town to consider site-specific features and constraints while giving them the authority to protect the environment. Depending on how the Town implements this ordinance, it could use it to protect important watershed areas including floodplains, wetlands, and riparian areas while giving them the flexibility to work with the developer and individual site issues.

17.1.3 Town of Brookhaven – Stormwater Management and Erosion Control

Controlling stormwater runoff is important to maintaining the health of a watershed. Proper stormwater management helps ensure that natural hydrology is protected as development occurs. Without management, as impervious surfaces increase, more rainfall runs off directly into streams, rivers, and coastal waters and less soaks into the landscape. This increase in runoff volume can result in channel erosion and impact aquatic habitat. Proper erosion and sediment control practices help prevent sediment from construction sites from reaching streams. This sediment impacts aquatic habitat, the ability of wetlands to remove pollutants, and carries pollutants with it.

The Town of Brookhaven has a strong stormwater management ordinance. New development must compare post-development stormwater with predevelopment conditions and New York's Stormwater Management Design Manual includes flows that include both peak and runoff volume. To effectively protect stream channels, it is important to manage runoff volume. The Town requires stormwater pollution prevention plans to include a maintenance schedule for any BMPs and easements to ensure maintenance access to BMPs.

To minimize the time of soil exposure during construction, phasing plans must be included in a Stormwater Pollution Prevention Plan (SWPPP). No more than five acres can be disturbed at any one time unless approved in the SWPPP.

17.2 Potential Amendments and Changes

This section identifies specific amendments to local laws and needed changes to municipal practices and programs to better protect and restore the watershed and water-related resources in the Town of Brookhaven and the Village of Mastic Beach. The Mastic Beach discussion focuses on which ordinances will be important to the Forge River, as they do not have ordinances in place yet.

17.2.1 Town of Brookhaven

The Town of Brookhaven might consider developing a Forge River zoning overlay district. Additional restrictions on new development would be imposed within such an overlay district. These might include:

- More stringent requirements for onsite wastewater treatment systems.
- Additional development limits to help protect riparian and wetland areas.
- Limits on nitrogen concentrations leaving the site.

The Town might incentivize property owners inside the overlay district to practice the kind of environmental stewardship that could improve Forge River water quality by:

- Providing rebates for retrofitting bathroom fixtures with low water use models.
- Providing tax credit for granting the Town a conservation easement in riparian areas.
- Providing credit for replacing a cesspool or failing septic system.

The Town might also consider providing incentives or 'development credits' to developers that include the following in their site plans:

- Low impact site design – There are a number of site planning strategies that can reduce runoff through non-structural means including narrower streets, grassed swales for drainage, and porous pavements. New York State's Stormwater Management Design Manual includes a chapter on low impact design and the USEPA has a Green Streets program.
- Nutrient loading limits for new development – New development might be required to meet a designated level of TN and TP loading from their site as calculated from a site development model. Developers not able to meet those loading limits could purchase credits. Those funds might then be used for wetland and stream restoration projects elsewhere in the watershed. North Carolina has implemented this approach in several of its nutrient impaired watersheds.

The Town does not have a riparian buffer ordinance and its floodplain ordinance mirrors FEMA requirements and does allow development in the floodplain. The Town's Wetlands and Waterways Ordinance does give the Town flexibility to protect environmentally sensitive areas.

17.2.2 Village of Mastic Beach

The Village of Mastic Beach was incorporated in August 2010 and does not yet have zoning and ordinances. The Village should consider the following:

- Stormwater – The Village should adopt a stormwater ordinance that requires new development to control runoff volume to mirror pre-development runoff. Controlling runoff volume will protect Forge River water quality.

- Erosion and Sediment Control – The Village should consider adopting an ordinance to require erosion and sediment control for new development.
- Site Plan Review – The Village should consider requiring riparian buffer and floodplain protection for new development. If flexibility in reviewing plans is desired, a site development review process similar to what Brookhaven requires for Category A developments should be considered.
- Wastewater Management – The Village should develop a strategy that leads to replacement of cesspools and failing septic systems.

17.3 Sewer District Formation

This section provides a full discussion on the legal and procedural issues and regulatory requirements regarding the formation of a sewer district in the Forge River watershed. An example of sewering costs is provided from a recent study by Suffolk County.

17.3.1 Legal and Procedural Issues

Suffolk County (County) or the Town of Brookhaven (Town) may form a sewer district. County law Article 5-A, Sections 253, 254 and 256A County regulates the formation of a County sewer district. A Town can form a sewer district in two different manners. A Town sewer district may be formed by the submission of a valid petition under Town Law Article 12, Sections 190, 193 and 194 or through a Town Board motion under Town Law Article 12-A, Section 209.

Figure 17-1 and Figure 17-2 summarize the legal and procedural steps for establishing a County and a Town sewer district, respectively. The formation process for both County and Town sewer districts comprises the following basic steps:

- Petition or motion to form a sewer district
- Map and plan
- Public hearing
- State comptroller review
- Vote on district formation
- Potential permissive referendum
- Potential review of aggrieved party cases (certiorari)

Proper notice of the public hearing is required under either formation process. The notice must follow the strict guidelines detailed in the relevant County or Town law. Key information is required in the notice, including boundary description, proposed improvement description, project cost and costs borne by a typical property owner, the proposed financing method, benefit assessment, and an explanation of costs.

The majority of procedural steps to establish a County or Town sewer district are similar. The major difference is a more extensive coordination process for the Town Sewer District formation. For example, the County Clerk receives filings from the Town Clerk to form a Town sewer district. Under Section 190, a public hearing is held earlier in the formation of a Town district than for that of a County district. Pretreatment codes may vary with a Town sewer district.

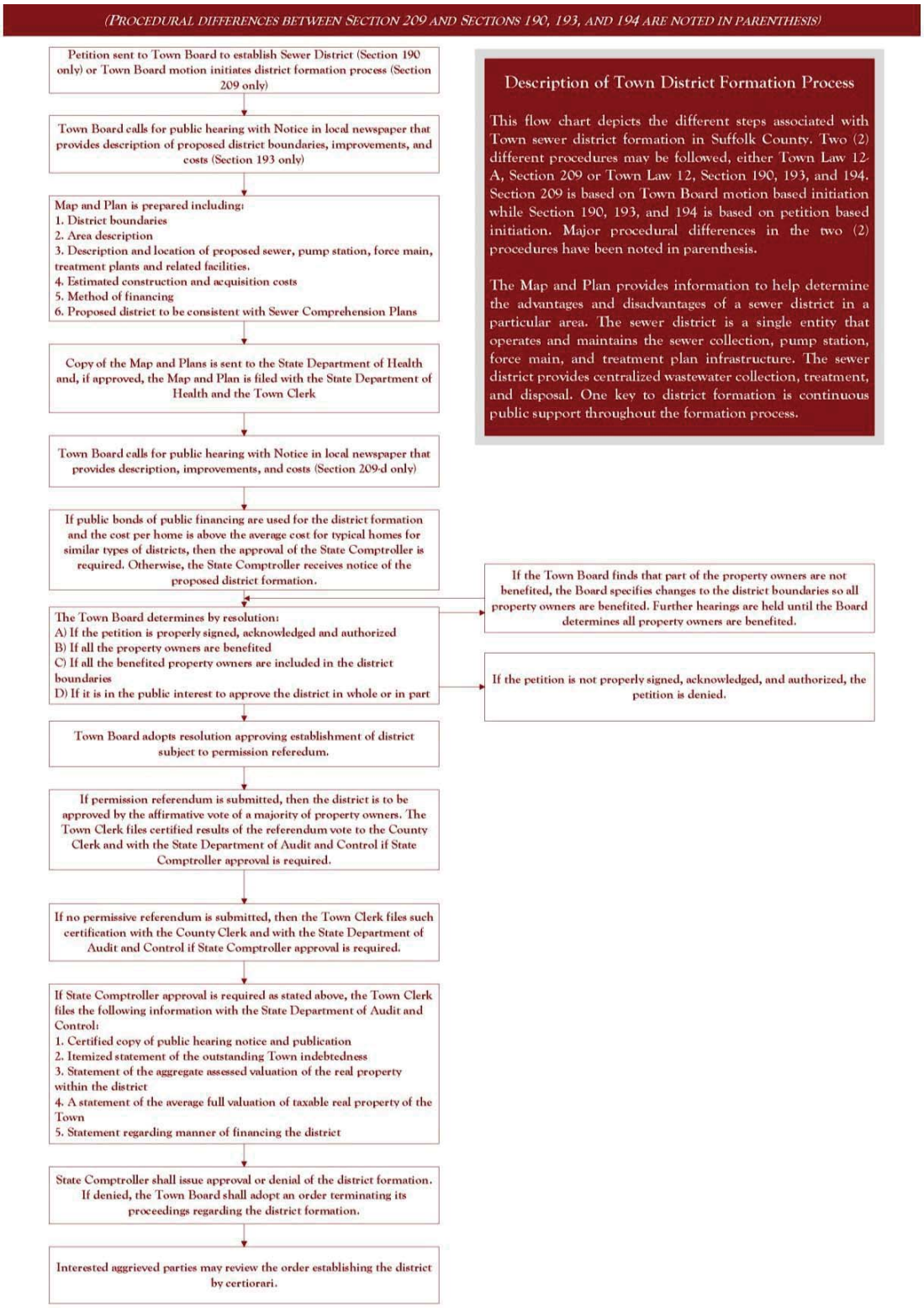
The advantages and disadvantages of a particular sewer district location are evaluated through a Map and Plan, which typically includes the following sections:

- Background
- Service area
- Design considerations
- Proposed collection system
- Project costs
- Project financing
- Recommendations and conclusions

The project costs section typically includes capital costs, operation and maintenance costs, connection fees, land acquisition costs, debt service, and cost to a typical property owner. After approval of the Map and Plan and satisfaction of other regulatory requirements, Contract Documents are completed that include detailed infrastructure design for wastewater collection and treatment and discharge of treated effluent.

Figure 17-1. Legal Steps to Form a County Sewer District

Figure 17-2. Legal Steps to Form a Town Sewer District



17.3.2 Regulatory Requirements

Sewering of the Forge River Watershed (or a portion thereof) would require a number of approvals and permits. A State Environmental Quality Review (SEQR) would be required (see following section). The NYSDEC would require an effluent discharge permit under the SPDES program (see following section).

There are multiple areas that have high groundwater conditions in the Forge River watershed. In these areas, the depth to groundwater would be taken into consideration when designing the sewage collection system and the wastewater treatment plant. Dewatering permits would likely be required for portions of the collection system and wastewater treatment plant construction. The extent of dewatering could be limited using a combination of alternative collection systems (*i.e.* low-pressure and vacuum system collection mains).

If wetlands were located on or adjacent to potential wastewater treatment facility locations, then a wetland permit application would be required from the NYSDEC. A Coastal Consistency approval would be required from the NYSDOS if the wetland was within the Coastal Zone. The NYSDOS reviews the consistency of federal actions, either direct actions, permits, or funding, within New York's coastal zone. If the permit in question is a tidal wetland permit, a related Army Corps of Engineers permit would be involved, and that federal action would be reviewed by the NYSDOS for consistency.

As required with most large construction projects, a Stormwater Pollution Prevention Plan (SWPPP) and Notice of Intent (NOI) would be needed from the NYSDEC. Stormwater Phase II requirements pertain to construction activities that disturb one or more acres. Construction stormwater flows are regulated by the NYSDEC through the SWPPP and NOI. A SWPPP is a plan for controlling runoff and pollutants from a site during and after construction activities. A Notice of Intent is typically filed before beginning construction to describe the site, identify nearby waterbodies, and provide a description of stormwater control measures.

Suffolk County Department of Health Services (SCDHS), Suffolk County Department of Public Works (SCDPW), and Ten State Standards would govern the design of the sewers, pump stations, force mains, and treatment processes.

Approval from the State Comptroller would be required where public financing is provided and the cost per home is above the average for typical homes for similar types of districts.

Since portions of the proposed conceptual collection system are located in a state roadway (NY27), approval by the NYSDOT would be required. Land may need to be acquired for

the proposed treatment plant site and the zoning of the site may need to be changed depending on its current classification. Legal easements may need to be obtained depending on sewer and force main routes. Various Town and local permits may be needed depending on the location and design of the final project.

SPDES (Part 750) Permit

Because the Forge River empties into Moriches Bay, it may be technically feasible to discharge the effluent from a wastewater treatment plant directly to surface water via a point source discharge. Since the Forge River is an impaired surface water (*i.e.*, on the NYSDEC 303d list) and may ultimately be subject to a Total Maximum Daily Load (TMDL) for nitrogen, a new point source discharge to the Forge River would likely have more strict effluent restrictions than that for a non-impaired surface water.

Groundwater discharges within Suffolk County are regulated by the Suffolk County Department of Health Services (SCDHS). Applications are made to the Office of Wastewater Management. The approval process includes authorization for construction and a final project approval following a field inspection of the completed project. The requirements for water and sewage disposal must conform to state public health codes and Article 4, Article 6, Article 7 and Article 12 of the Suffolk County Sanitary Code. See Table 3-1 for typical effluent limits. If a sewage treatment plant that discharges to groundwater is located within the Forge River's groundwater contributing area, it will be a non-point source discharge to the River and may require a higher quality effluent than the typical groundwater effluent limits (Table 17-1).

Table 17-1. Typical Effluent Limits for Groundwater Discharge

Parameter	Effluent Concentration
BOD5	<30 mg/L
Total Suspended Solids	<30 mg/L
Total Nitrogen	<10 mg/L
PH	6.5 - 7.5
Alkalinity	50-100 mg/L
Total Dissolved Solids	1,000 mg/L

Source: NYSDEC

State Environmental Quality Review

In New York State, most projects or activities proposed by a state agency or unit of local government (*e.g.*, Suffolk County) require an environmental impact assessment as described by the State Environmental Quality Review Act (SEQRA) under New York State Environmental Conservation Law (ECL) and regulations under NYCRR § 617 (Part 617). Specifically, "No agency involved in an action may undertake, fund or approve the

action until it has complied with the provisions of SEQRA. A project sponsor may not commence any physical alteration related to an [agency] action until the provisions of SEQRA have been compiled with."

There are three categories of actions, Type 1, Type II, and Unlisted. A Type I action is likely to have a significant negative impact on the environment and would likely require preparation of an Environmental Impact Statement (EIS). A Type II action is not likely to have a significant impact on the environment and would be exempt from environmental review. An Unlisted action does not meet the Type I threshold but would be subject to review by the lead agency to determine whether it might cause significant adverse environmental impacts. Sewering of the Forge River Study Area would likely be considered a Type I action.

As part of SEQRA, the County must consider social and economic factors along with environmental impacts when deciding to approve or undertake an "Action." Sewering of the Forge River Study Area may include commercial, industrial and residential development; work on roads, formation of districts and land use plans, local zoning and planning, and public health regulations. SEQRA establishes procedures for considering environmental impacts, including those the public wants considered. If the procedures are not adhered to, the public may challenge the agency's decision in court, generally seeking to have the decision annulled and the environmental review process started over.

The County would likely be required to complete a "Long Form" Environmental Assessment Form (EAF) to determine the environmental impacts. The EAF is a checklist identifying areas of significant environmental impacts. A properly completed EAF must contain enough information to describe the proposed action, its location, purpose, and potential impacts to the environment. The completed EAF also identifies the project action. The lead agency (*i.e.*, Suffolk County Legislature, which is represented by the Suffolk County Council on Environmental Quality [CEQ]) and all involved agencies (*i.e.*, Suffolk County Department of Health Services, Town of Brookhaven, Pine Barrens Commission, NYSDEC, etc.) would review the completed EAF and would likely make a "positive declaration" that the proposed action would have significant adverse impacts on the environment and an Environmental Impact Statement (EIS) would be required. A "positive declaration" must be declared in writing.

Following a positive declaration, the CEQ would define the scope of issues to be addressed in a draft EIS, including content and level of detail of analysis, range of alternatives and any required mitigation measures. The scope would also identify issues that do not need to be addressed in the EIS. Scoping provides for early participation by involved agencies and

the public in review of the Project. The EIS provides the means to systematically consider significant adverse environmental impacts, alternatives, and mitigation strategies. The EIS facilitates weighing of social, economic, and environmental factors in the planning and decision-making processes. The draft EIS is the initial document prepared and circulated for review and comment before a final EIS is prepared. The first draft EIS may be determined incomplete and require additional information and details.

The EIS must identify all significant adverse environmental impacts that would occur from the Action including potential development following the sewering of the watershed. The "ECL §8-0109(2) specifically requires that all potential environmental impacts of a project subject to an EIS be considered, including the long-term and short-term effects of the project." The SEQRA process prohibits segmentation (*i.e.*, dividing the environmental review into various individual and unrelated activities or stages requiring individual determinations of significance).

Once a draft EIS is accepted as complete, notice would be provided requesting public comments on the draft EIS during a minimum 30-day comment period. The comment period may be extended a minimum of ten days following the public hearing.

All public and involved agencies' comments and responses by the Lead Agency are incorporated into the final EIS along with the earlier draft EIS and all changes and additions to the draft EIS. After the final EIS is completed and made available to the public, a written Findings Statement is prepared consistent with the final decision reached regarding the project. Project approval can be granted if the Findings Statement concludes that all significant adverse environmental impacts are adequately mitigated. NYS law provides for a period of up to four months to challenge the final decision as defined under Article 78 of New York's Civil Practice Law & Rules.

17.3.3 Implementation Steps and Timetable

The time required to form a sewer district and construct its components depends in large part on the effort expended for the legal, administrative, and financial components. It is likely that several public informational meetings would be held as preliminary district boundaries were formulated. A detailed survey (metes and bounds) would be completed prior to finalization of the district boundaries. The Suffolk County Sewer Agency and the Town of Brookhaven would convene meetings to evaluate requirements and costs. Sewering of the Forge River watershed could take approximately six years from district formation through construction and startup testing, assuming that the multiple construction components occur simultaneously. An estimated project timetable is provided in Table 17-2.

Table 17-2. Estimated Project Timetable

DESCRIPTION	MONTHS																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
District Formation, DEIS, Map & Plan	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																		
SEQRA									■	■	■	■	■	■	■	■	■	■	■	■																
Public Hearings			■			■										■			■																	
Engineering Design RFP																			■	■	■															
Engineering Design																						■	■	■	■	■	■	■	■	■	■	■	■			
SPDES Permit Application																														■						
Financing																															■	■	■	■	■	■
State Comptroller Approval																																			■	■

DESCRIPTION	MONTHS																															
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
Bid Process and Construction	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Start-up																														■	■	■

17.3.4 Cost Estimates

The public hearing notice must include boundary description, proposed improvement description, project cost and costs borne by a typical property owner, the proposed financing method, benefit assessment, and an explanation of the costs. Once the sewer district boundaries are finalized, a more detailed cost estimate is developed. Cost components for designing, constructing, and operating a sewer district (collection system and sewage treatment plant) include:

Capital Costs – sewer collection piping, pump stations, force mains, property procurement and wastewater treatment plant

Operating Costs – annual operation and maintenance of collection system, pump stations, force mains and treatment plant

Connection Fees – costs for each property to connect to the sewer collection system

Abandonment Costs – costs to properly abandon existing on-site treatment and disposal systems (septics, cesspools, and leach fields)

Debt Service – annual debt service associated with financing of capital costs and soft costs (will use current interest rate and reduced SRF subsidized interest rate)

Soft Costs – legal, financial and engineering costs (map & plan, survey, engineering report, contract documents, and construction inspection).

The Suffolk County Sewering Agency, which is part of the Suffolk County Department of Public Works, completed the "*Mastic - Mastic Beach - Shirley Sewering Feasibility Study* (Sewering Feasibility Study)" in January 2009. It compared three sewering alternatives for communities west of the Forge River, but within parts of its watershed. The costs cited below do not include abandonment costs for existing on-site wastewater treatment systems (*i.e.*, cesspools and septic systems) and plumbing costs for extending property owners' waste pipe to the collection systems. Based on estimates from previous studies conducted by Cameron Engineering & Associates, LLP, these fees typically range from $5,000 to $10,000 depending on the collection system to which the parcel owner would connect. The costs also do not include connection fees that the parcel owner may incur. The County's Sewering Feasibility Study considered several alternatives which are summarized below. These alternatives do not represent recommendations for Forge River sewering. Rather they offer a recent and related example of typical costs for consideration by the Town.

Mastic - Mastic Beach - Shirley Alternative #1

Sewered Area: The business district on Montauk Highway from the Forge River to William Floyd Parkway, all parcels east of William Floyd Parkway to the Forge River and north of Neighborhood Road (including those parcels on Neighborhood Road). This alternative includes both commercial and residential parcels.

Estimated cost per parcel: $7,500

Mastic - Mastic Beach - Shirley Alternative #2

Sewered Area: All parcels along Montauk Highway from the Forge River to William Floyd Parkway, parcels on William Floyd Parkway from the Montauk Highway to Neighborhood Road and parcels on Neighborhood Road from William Floyd Parkway to the Forge River. This alternative focuses on commercial parcels; some residential parcels fall within the commercial areas intended for sewering.

Estimated cost per parcel: $30,000

Mastic - Mastic Beach - Shirley Alternative #3

Sewered Area: The business district on Montauk Highway from the Forge River to William Floyd Parkway. This alternative focuses on commercial parcels; some residential parcels fall within the commercial areas intended for sewering.

Estimated cost per parcel: $28,000

The alternatives considered by the County's Mastic - Mastic Beach - Shirley Sewering Feasibility Study comprised a mix of different collection systems (*e.g.*, vacuum and low-pressure sewers) and a conventional gravity collection system with pump stations. The costs included the purchase of land for pump stations. It was assumed that sewage treatment plants could be located either on Town-owned land or on land donated by a private developer. For their estimates, the County assumed that the sewage treatment plant's effluent would be discharged to subsurface leaching pools and would therefore be a non-point source discharge through groundwater to the Forge River.

Alternative #1 of the County study comprises a significant portion of the most heavily developed and unsewered portions of the Forge River watershed. As such, it offers a reasonable approximation of the actual cost to sewer the developed areas of the watershed that contribute the greatest amounts of nitrogen to the Forge River from on-site wastewater treatment systems. The boundary for Alternative #1 (*i.e.*, the Mastic-Shirley Boundary) and for the currently unsewered areas within the western part of the watershed (the Forge River Potential Sewering Boundary) are depicted in Figure 17-3.

Figure 17-3. Map of Mastic-Shirley and Potential Forge River Sewering Areas

Table 17-3 demonstrates that the two potential sewering areas are roughly equivalent. The Forge River and Mastic-Shirley potential sewering areas comprise 9,000 and 8,517 parcels respectively, a difference of only five percent. The Mastic-Shirley area (3,660 acres) is approximately 14 percent larger than the Forge River area (3,220 acres), though the distribution of land uses is very similar. It is reasonable to assume therefore, that the per parcel costs to sewer Mastic-Shirley (Alternative #1) would be comparable to that for the Forge River potential sewering area. Applying the $7,500 cost per parcel to the 9,000 parcels within the Forge River potential sewering area yields a total sewering cost of $67,500,000 plus connection piping and fees.

Table 17-3. Comparison of Sewering Areas

	Forge River Potential Sewering Area	**Mastic-Shirley Alternative #1 Area**
No. of Parcels	9,000	8,517
Length of Roads (miles)	108	107
No. of Acres	3,220	3,660
Land Use Description	% of area	% of area
Agricultural	0.0%	0.0%
Residential	79.4%	78.5%
Vacant	15.9%	16.1%
Commercial	1.8%	2.7%
Recreation and Entertainment	0.1%	0.1%
Community Services	0.3%	0.4%
Industrial	0.0%	0.0%
Public Service	0.9%	0.7%
Wild, Forested etc…	0.1%	0.1%
Non-coded	1.6%	1.4%

18 Works Cited

NYSDEC, 2004. *Stormwater Management Guidance Manual for Local Officials*. Prepared by the New York State Department of Environmental Conservation and New York State Department of State in cooperation with the New York State Association of Regional Councils. September 2004.

NYSDOS, 2007. *Guidebook, Watershed Plans, Protecting and Restoring Water Quality*. New York State Department of State, Division of Coastal Resources, Albany, NY. 2007.

USEPA, 2008. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.* U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch, Washington, DC. EPA 841-B-08-002, March 2008.

19 Subwatershed Prioritization Introduction

The subwatershed prioritization (Table 1-1, Figure 1-1, and Figure 1-2) evaluates the relative severity of threats to the Forge River's water quality and habitat. The threats and impairments include point and nonpoint sources of nutrients and contaminants that have reached or could reach the estuary via stormwater runoff and groundwater. Other impairments include those associated with shorelines and riparian vegetation.

Differences in subwatershed contributions derive from variations in land use, impervious surface area, density of on-site wastewater treatment systems, future development, and other considerations. The goal of the prioritization exercise is to determine the relative contribution of each subwatershed to the degradation of the Forge River's water quality and habitats. Mitigation efforts would then be focused first on those subwatersheds that are most impaired and their specific impairments.

The prioritization effort focuses on four watershed analysis categories: land use/land cover, stormwater, nitrogen, and creek ecology/hydrology (See Table 19-1, Table 19-2, and Table 19-3 for the Forge River Prioritization Matrix). A number of subcategories are included in each of the analysis categories. The NYS Department of State, Division of Coastal Resources, (NYSDOS) which provided funding for this study, suggested a number of subwatershed characteristics in the project request for proposals. All of the characteristics that are relevant to the Forge River are included in this prioritization, but some have been re-classified into different categories. For example, under the NYSDOS Land Use category, 'proximity to estuary' is classified here instead as 'groundwater travel time to estuary.' This better reflects the actual contributing factor. See Section 20.2 for details.

Although actual data was used to calculate the prioritization characteristics, a more subjective 'weighting' factor was then applied to each characteristic based on research into the causes of Forge River degradation. Those characteristics that have a greater impact on Forge River water quality were assigned a greater weighting. An interpretation of the results of the prioritization follows an explanation of the derivation and significance of each of the characteristics used in its development.

Table 19-1. Prioritization Scores by Subwatershed

Characteristic	Unit	Range (higher = more impaired)					Weighting	Lower Forge West			Home Creek			Lons Creek			Middle Forge West			Poospatuck Creek		
		1	2	3	4	5	1-5	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#
Land Use/ Land Cover																						
Forest cover	% of total acres	40% - 32%	32% - 24%	24% - 16%	16% - 8%	8% - 0%	1	105	2%	5	316	6%	5	72	1%	5	233	5%	5	120	2%	5
Turf cover	% of total acres	>0% - 4%	4% - 8%	8% - 12%	12% - 16%	16% - 20%	2	0	0%	0	36	8%	4	14	3%	2	54	11%	6	76	16%	10
Industrial land	% of total acres	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	1	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0
Agricultural land	% of total acres	>0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%	2	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0
Acreage Preserved/No Development Potential	% of total acres	25% - 20%	20% - 15%	15% - 10%	10% - 5%	5% - 0%	1	213	3%	5	513	7%	4	127	2%	5	414	6%	4	839	12%	3
Acreage with development potential	% of total acres	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	2	0	0%	0	17	1%	2	12	1%	2	30	1%	2	13	1%	2
Subtotal										**10**			**15**			**14**			**17**			**20**
Stormwater																						
No-recharge areas	% of total acres	>0% - 6%	6% - 12%	12% - 18%	19% - 24%	25% - 30%	2	0	0.0%	0	0	0.0%	0	79	5.0%	2	47	3.0%	2	101	5.9%	2
Impervious cover (roads, parking lots, etc)	% of total acres	>0% - 5%	5% - 10%	10% - 15%	15% - 20%	20% - 25%	2	0	0%	0	290	16%	8	22	1%	2	86	5%	2	254	14%	6
Development adjacent to (<75') shoreline	% of total acres ≤ 75ft of shore	>0% - 5%	5% - 10%	10% - 15%	15% - 20%	20% - 25%	2	2	2%	2	3	4%	2	14	17%	8	9	11%	6	10	13%	6
Subtotal										**2**			**10**			**12**			**10**			**14**
Nitrogen																						
Nitrogen contribution to estuary from upland sources and atmospheric deposition (not including STP discharges)	pounds N/day	>0 - 30	30 - 60	60 - 90	90 - 120	120 - 150	5	2		5	38		10	13		5	49		10	98		20
OWTS density	number/total acres of each subwatershed (land only)	>0 - 0.40	0.40 - 0.81	0.81 - 1.21	1.21 - 1.62	1.62 - 2.02	5	0	0.0	0	621	1.17	15	202	1.45	20	543	1.23	20	1593	1.87	25
Number OWTS where the depth from surface to groundwater <10'	number	1 - 60	60 - 120	120 - 180	180 - 240	240 - 300	5	0		0	270		25	136		15	16		5	84		10
Estimated Wastewater Flow (gpd) from OWTS within 10 yr groundwater travel time	gallons per day	1 - 101,000	101,000 - 202,000	202,000 - 303,000	303,000 - 404,000	404,000 - 505,000	4	0		0	59,550		4	52,050		4	110,850		8	395,331		16
Number of Homes built prior to 1970	number of homes	>0 - 200	200 - 400	400 - 600	600 - 800	800 - 1000	3	0		0	354		6	103		3	235		6	598		9
Groundwater travel time to estuary	% of total acres within the less-than-10-year groundwater travel-time boundary	0% - 2%	2% - 4%	4% - 6%	6% - 8%	8% - 10%	4	208	2.2%	8	311	3.4%	8	137	1.5%	4	295	3.2%	8	607	6.6%	16
STP discharges	pounds of N/day	>0 - 40	40 - 80	80 - 120	120 - 160	160 - 200	5	0		0	0		0	0		0	0		0	0		0
Subtotal										**13**			**68**			**51**			**57**			**96**
Creek Ecology/Hydrology																						
Spartina	acres	75% - 60%	60% - 45%	45% - 30%	30% - 15%	15% - 0%	2	64	62%	2	18	17%	8	4	4%	10	4	4%	10	1	1%	10
Phragmites	acres	>0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%	2	23	44%	10	5	9%	2	1	1%	2	0	0%	0	1	2%	2
Hardened shoreline	% of shoreline linear feet	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	2	0	0%	0	0	0%	0	1602	14%	4	678	6%	2	471	4%	2
Basin Depression Depth	feet	>0% - 0.99	1 - 1.99	2 - 2.99	3 - 3.99	4 - 4.99	1	0		0	2		3	4		5	0		0	3.5		4
Subtotal										**12**			**13**			**21**			**12**			**18**
TOTAL	**none**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**			**37**			**106**			**98**			**96**			**148**

Table 19-2. Prioritization Scores by Subwatershed (continued)

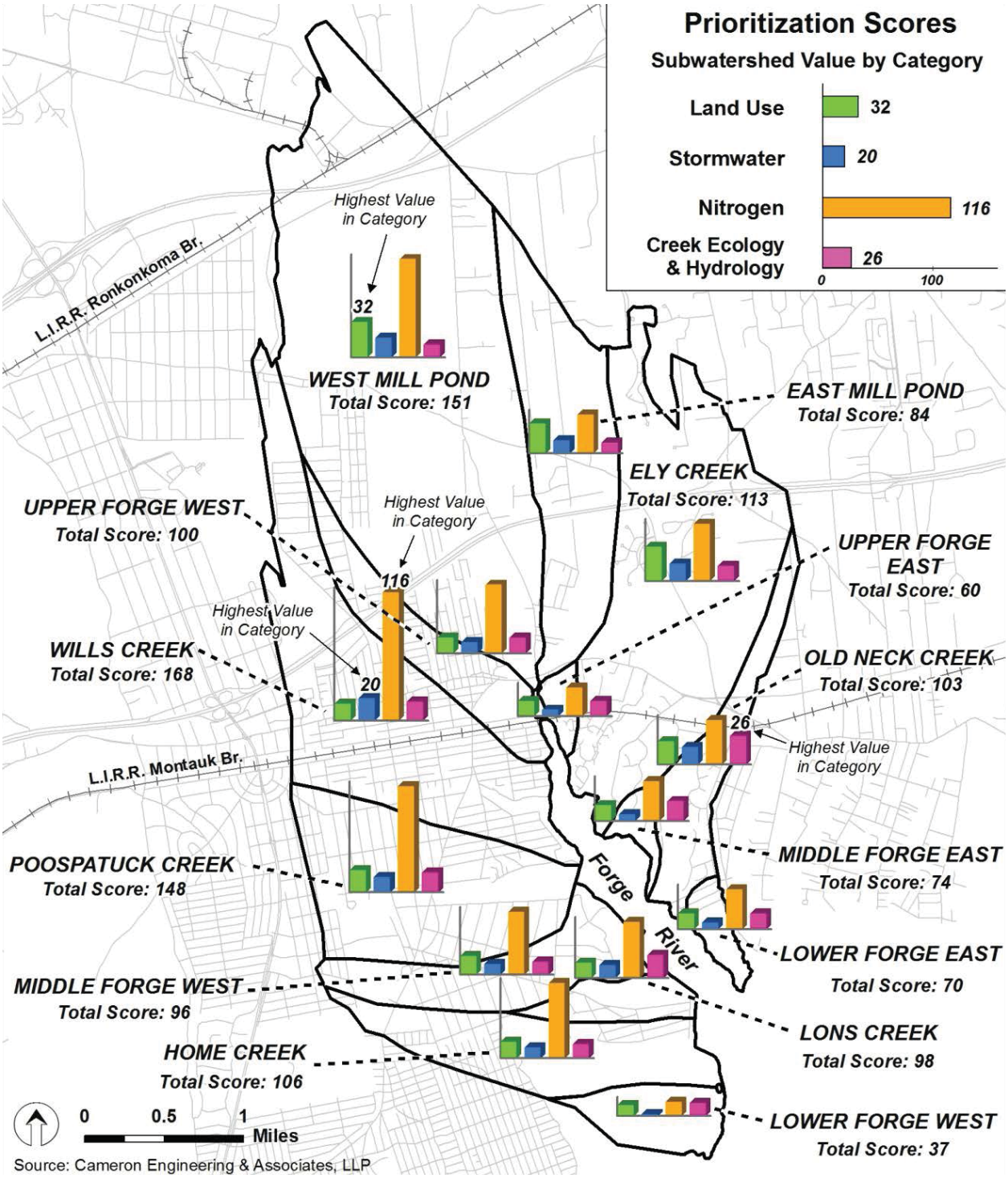
Characteristic	Unit	Range (higher = more impaired)					Weighting	Wills Creek			Upper Forge West			West Mill Pond			East Mill Pond			Upper Forge East		
		1	2	3	4	5	1-5	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#
Land Use/ Land Cover																						
Forest cover	% of total acres	40% - 32%	32% - 24%	24% - 16%	16% - 8%	8% - 0%	1	487	10%	4	165	3%	5	1908	39%	1	369	8%	5	28	1%	5
Turf cover	% of total acres	>0% - 4%	4% - 8%	8% - 12%	12% - 16%	16% - 20%	2	51	11%	6	12	3%	2	57	12%	6	23	5%	4	5	1%	2
Industrial land	% of total acres	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	1	1	5%	1	0	0%	0	5	35%	4	0	0%	0	0	0%	0
Agricultural land	% of total acres	>0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%	2	0	0%	0	0	0%	0	182	46%	10	172	43%	10	0	0.00%	0
Acreage Preserved/No Development Potential	% of total acres	25% - 20%	20% - 15%	15% - 10%	10% - 5%	5% - 0%	1	1215	17%	2	328	5%	5	1627	22%	1	508	7%	4	59	1%	5
Acreage with development potential	% of total acres	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	2	24	1%	2	52	2%	2	1188	54%	10	271	12%	4	0.1	0.003%	2
Subtotal										**15**			**14**			**32**			**27**			**14**
Stormwater																						
No-recharge areas	% of total acres	>0% - 6%	6% - 12%	12% - 18%	19% - 24%	25% - 30%	2	162	9.0%	4	141	8.0%	4	460	27.0%	10	224	13.0%	6	38	2.0%	2
Impervious cover (roads, parking lots, etc)	% of total acres	>0% - 5%	5% - 10%	10% - 15%	15% - 20%	20% - 25%	2	410	22%	10	120	6%	4	255	14%	6	102	5%	4	11	1%	2
Development adjacent to (<75') shoreline	% of total acres ≤75ft of shore	>0% - 5%	5% - 10%	10% - 15%	15% - 20%	20% - 25%	2	10	13%	6	1	2%	2	0	0%	2	2	2%	2	2	3%	2
Subtotal										**20**			**10**			**18**			**12**			**6**
Nitrogen																						
Nitrogen contribution to estuary from upland sources and atmospheric deposition (not including STP discharges)	pounds N/day	>0 - 30	30 - 60	60 - 90	90 - 120	120 - 150	5	148		25	42		10	91		20	32		10	4		5
OWTS density	number/total acres of each subwatershed (land only)	>0 - 0.40	0.40 - 0.81	0.81 - 1.21	1.21 - 1.62	1.62 - 2.02	5	2499	2.02	25	752	1.97	25	1090	0.39	5	265	0.34	5	4	0.07	5
Number OWTS where the depth from surface to groundwater <10'	number	1 - 60	60 - 120	120 - 180	180 - 240	240 - 300	5	150		15	1		5	19		5	3		5	1		5
Estimated Wastewater Flow (gpd) from OWTS within 10 yr groundwater travel time	gallons per day	1 - 101,000	101,000 - 202,000	202,000 - 303,000	303,000 - 404,000	404,000 - 505,000	4	502,850		20	141,002		8	162,400		8	38,855		4	1,500		4
Number of Homes built prior to 1970	number of homes	>0 - 200	200 - 400	400 - 600	600 - 800	800 - 1000	3	862		15	234		6	252		6	53		3	1		3
Groundwater travel time to estuary	% of total acres within the less-than-10-year groundwater travel-time boundary	0% - 2%	2% - 4%	4% - 6%	6% - 8%	8% - 10%	4	598	6.5%	16	203	2.2%	8	912	9.9%	20	324	3.5%	8	45	0.5%	4
STP discharges	pounds of N/day	>0 - 40	40 - 80	80 - 120	120 - 160	160 - 200	5	0		0	0		0	195		25	0		0	0		0
Subtotal										**116**			**62**			**89**			**35**			**26**
Creek Ecology/Hydrology																						
Spartina	acres	75% - 60%	60% - 45%	45% - 30%	30% - 15%	15% - 0%	2	1	0%	10	0	0%	10	0	0%	10	0	0%	10	0	0%	10
Phragmites	acres	>0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%	2	1	1%	2	1	2%	2	0	1%	2	0	0%	0	3	6%	2
Hardened shoreline	% of shoreline linear feet	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	2	1045	9%	2	107	1%	2	0	0%	0	0	0%	0	78	1%	2
Basin Depression Depth	feet	>0% - 0.99	1 - 1.99	2 - 2.99	3 - 3.99	4 - 4.99	1	2		3	0		0	0		0	0		0	0		0
Subtotal										**17**			**14**			**12**			**10**			**14**
TOTAL	none	n/a	n/a	n/a	n/a	n/a	n/a			**168**			**100**			**151**			**84**			**60**

Table 19-3. Prioritization Scores by Subwatershed (continued)

Characteristic	Unit	Range (higher = more impaired)					Weighting	Ely Creek			Middle Forge East			Old Neck Creek			Lower Forge East		
		1	2	3	4	5	1-5	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#	#	% or ratio	W#
Land Use/ Land Cover																			
Forest cover	% of total acres	40% - 32%	32% - 24%	24% - 16%	16% - 8%	8% - 0%	1	895	18%	3	22	0.5%	5	114	2%	5	46	1%	5
Turf cover	% of total acres	>0% - 4%	4% - 8%	8% - 12%	12% - 16%	16% - 20%	2	86	18%	10	5	1%	2	47	10%	6	9	2%	2
Industrial land	% of total acres	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	1	8	53%	5	0	0%	0	1	7%	1	0	0%	0
Agricultural land	% of total acres	>0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%	2	43	10.72%	4	0	0.00%	0	0.1	0.03%	2	0	0.00%	0
Acreage Preserved/No Development Potential	% of total acres	25% - 20%	20% - 15%	15% - 10%	10% - 5%	5% - 0%	1	1016	14%	3	61	1%	5	259	4%	5	60	1%	5
Acreage with development potential	% of total acres	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	2	533	24%	6	3	0.1%	2	52	2%	2	25	1%	2
Subtotal										**31**			**14**			**21**			**14**
Stormwater																			
No-recharge areas	% of total acres	>0% - 6%	6% - 12%	12% - 18%	19% - 24%	25% - 30%	2	216	13.0%	6	47	3.0%	2	110	6.4%	4	84	5.0%	2
Impervious cover (roads, parking lots, etc)	% of total acres	>0% - 5%	5% - 10%	10% - 15%	15% - 20%	20% - 25%	2	231	12%	6	10	1%	2	70	4%	2	12	1%	2
Development adjacent to (<75') shoreline	% of total acres ≤ 75ft of shore	>0% - 5%	5% - 10%	10% - 15%	15% - 20%	20% - 25%	2	6	7%	4	3	4%	2	16	20%	10	2	2%	2
Subtotal										**16**			**6**			**16**			**6**
Nitrogen																			
Nitrogen contribution to estuary from upland sources and atmospheric deposition (not including STP discharges)	pounds N/day	>0 - 30	30 - 60	60 - 90	90 - 120	120 - 150	5	45		10	4		5	22		5	6		5
OWTS density	number/total acres of each subwatershed (land only)	>0 - 0.40	0.40 - 0.81	0.81 - 1.21	1.21 - 1.62	1.62 - 2.02	5	353	0.23	5	59	0.93	15	249	0.80	10	85	1.01	15
Number OWTS where the depth from surface to groundwater <10'	number	1 - 60	60 - 120	120 - 180	180 - 240	240 - 300	5	12		5	33		5	69		10	48		5
Estimated Wastewater Flow (gpd) from OWTS within 10 yr groundwater travel time	gallons per day	1 - 101,000	101,000 - 202,000	202,000 - 303,000	303,000 - 404,000	404,000 - 505,000	4	79,064		4	17,550		4	71,145		4	25,500		4
Number of Homes built prior to 1970	number of homes	>0 - 200	200 - 400	400 - 600	600 - 800	800 - 1000	3	22		3	7		3	87		3	62		3
Groundwater travel time to estuary	% of total acres within the less-than-10-year groundwater travel-time boundary	0% - 2%	2% - 4%	4% - 6%	6% - 8%	8% - 10%	4	946.5	10%	20	61	0.7%	4	228	2.5%	8	82	0.9%	4
STP discharges	pounds of N/day	>0 - 40	40 - 80	80 - 120	120 - 160	160 - 200	5	24.5		5	0		0	0		0	0		0
Subtotal										**52**			**36**			**40**			**36**
Creek Ecology/Hydrology																			
Spartina	acres	75% - 60%	60% - 45%	45% - 30%	30% - 15%	15% - 0%	2	2	2%	10	8	8%	10	1	1%	10	0	0%	10
Phragmites	acres	>0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%	2	6	11%	4	6	12%	4	5	9%	2	1	1%	2
Hardened shoreline	% of shoreline linear feet	>0% - 11%	11% - 22%	22% - 33%	33% - 44%	44% - 55%	2	0	0%	0	1354	12%	4	5904	52%	10	103	1%	2
Basin Depression Depth	feet	>0% - 0.99	1 - 1.99	2 - 2.99	3 - 3.99	4 - 4.99	1	0		0	0		0	3.5		4	0		0
Subtotal										**14**			**18**			**26**			**14**
TOTAL	**none**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**			**113**			**74**			**103**			**70**

Figure 19-1. Map of Prioritization Scores by Subwatershed

Figure 19-2. Subwatershed Prioritization by Category



20 Subwatershed Prioritization Methodology

20.1 Subwatershed Delineations

The subwatershed boundaries were delineated in the characterization phase of the project and are shown in Figure 4-1. The overall watershed boundary is approximately equivalent to the groundwater contributing area for the Forge River. The characterization phase provided the contributions of flow and nitrogen from each subwatershed to the estuary.

20.2 Classifications

Four major watershed classifications were utilized for Forge River estuary impairments: land use/land cover, stormwater, nitrogen, and creek ecology/hydrology. Subcategories were included within each of the major classifications.

The NYSDOS suggested a number of subwatershed characteristics in the project scope. All of the characteristics from that list that are relevant to the Forge River are included in this prioritization. Some have been re-classified as shown in Table 20-1. Six of the NYSDOS-suggested characteristics are not addressed because they are either not pertinent to the watershed or because they are covered in a related discussion: other nutrient loads, percent within recharge area, percent within designated growth area, number of road crossings, violations of water quality standards, and connection with downstream waters. As nitrogen is the nutrient with the most effect on the estuary, 'other nutrient loads' are not addressed. The study area includes the groundwater contributing area as well as the stormwater recharge area - there is no 'designated growth area.' The number of road crossings is not relevant. Violations of water quality standards and creek connections to the main branch of the Forge River are discussed in the Characterization Report.

20.3 Prioritization Values

A range of prioritization values (or scores) was calculated for each of the subwatersheds. Each range of values was divided into five sub-ranges and assigned a number from 1 to 5, with the number 5 representing the most impaired condition. A factor with values from 1-5 was then applied to each subwatershed characteristic to weight the characteristic according to its relative importance with respect to other factors.

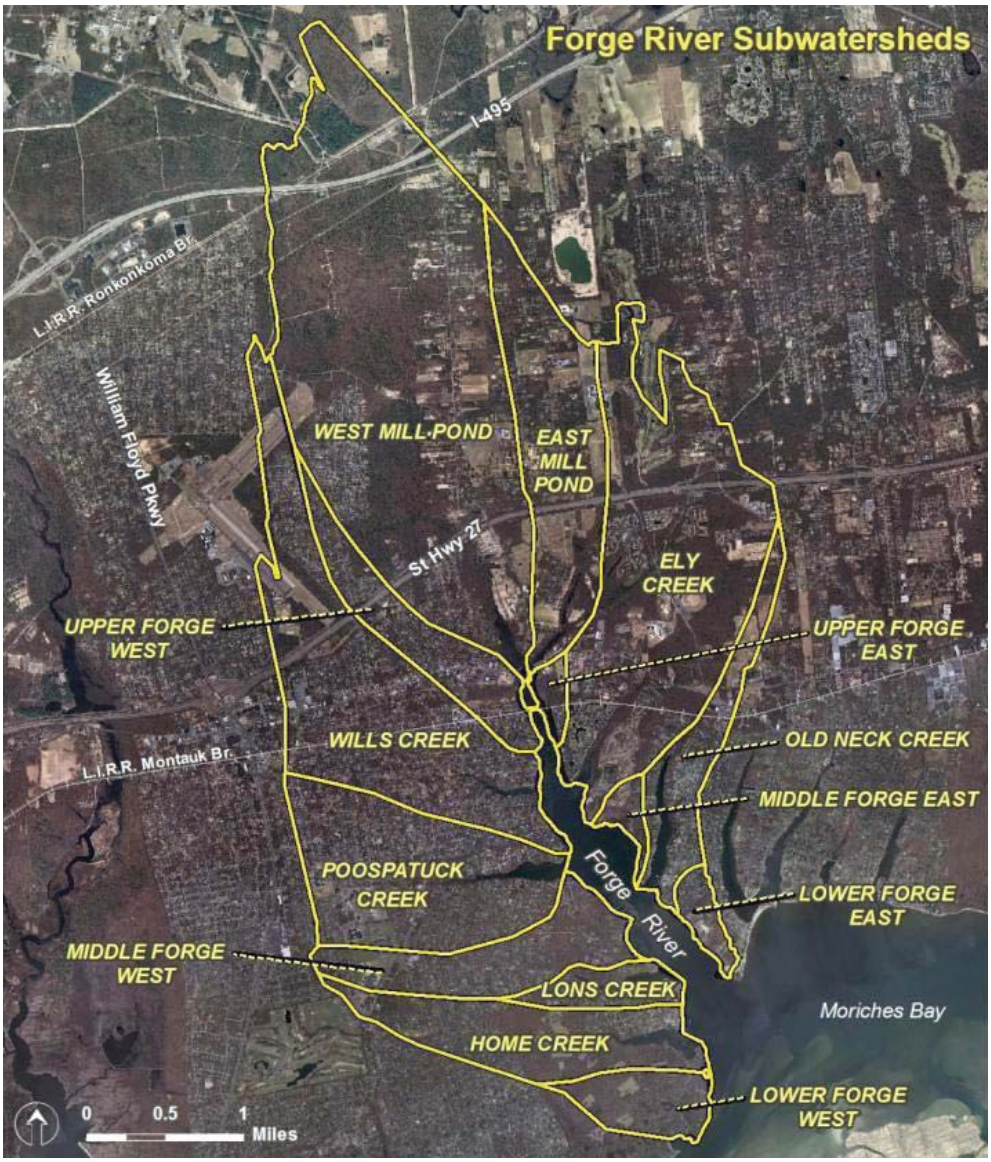
All characteristics are evaluated based on their value relative to the entire watershed. This makes possible a comparison of each subwatershed relative to the entire watershed. For example, the matrix value for forested area in a particular subwatershed is its percentage of the forested area within the entire watershed.

Table 20-1. Report and NYSDOS Classifications

Classification in Report	**NYSDOS Classification**
Forest cover	% Forest Cover
Turf cover	% Turf Cover
Industrial land	"Hotspot" Density, Industrial land
Agricultural land	
Acreage Preserved/No Development Potential	Public Ownership; # Large parcels/willing owners
Acreage with development potential	Development potential
Stormwater	
No-recharge areas	Stormwater outfall density
Impervious cover (*i.e.*, buildings, roads)	% Impervious Cover
Development adjacent to (<75') shoreline	
Nitrogen	
Nitrogen contribution - upland and atmospheric	Nitrogen loading
OWTS density	
Number OWTS where the depth from surface to groundwater <10'	Sewer system condition
Estimated Wastewater Flow from OWTS within 10 yr. groundwater travel time	Sewer system condition
Number of Homes built prior to 1970	Sewer system condition
Groundwater travel time to estuary	
STP discharges	Sewer system condition
Creek Ecology/Hydrology	
Spartina	% Riparian Cover; Habitat and biota scores
Phragmites	% Riparian Cover; Habitat and biota scores
Hardened shoreline	
Basin Depression Depth	

Thus, forest cover for each subwatershed is assigned the following values according to the respective ranges for its percentage of forest cover within the entire watershed: 1 (32-40%), 2 (24-32%), 3 (16-24%), 4 (8-16%) and 5 (>0-8%). A subwatershed with an assigned value '5' would have little forest cover, and therefore greater acreage in land uses with more potentially adverse impacts on the estuary, such as developed and agricultural areas. A weighting of 1 for forest cover is appropriate as this characteristic has little direct adverse impact on Forge River water quality. In contrast, the agricultural land for each subwatershed is assigned the following values according to their respective ranges for percent of total agricultural land within the entire watershed: 1 (>0-10%), 2 (10-20%), 3 (20-30%), 4 (30-40%) and 5 (40-50%). Subwatersheds with greater acreage under cultivation will be subjected to higher fertilizer and pesticide usage and increased erosion. Agricultural land has a weighting factor of 2, reflecting its greater potential impact on water quality than forested land cover.

Figure 20-1. The Forge River watershed and subwatersheds



Values of the constituent characteristics (Table 1-1) are totaled for each of the four categories (*i.e.*, land use, stormwater, nitrogen, and creek ecology/hydrology) by subwatershed to create category scores. This allows a comparison of the severity of each impact category across the subwatersheds. Finally, the four category scores are tallied for each subwatershed to generate an overall score. This overall, or final, score permits a comparison of the combined impacts at the subwatershed level.

21 Subwatershed Prioritization Classifications

21.1 Land Cover and Land Use

Land use is probably the most important upland contributor to water quality in the Forge River estuary. Land use determines, in large part, the quality and quantity of stormwater and the quality of groundwater reaching the Forge River. Land use also affects creek ecology through changes to the riparian zone. The Prioritization Matrix (Table 19-1, Table 19-2, and Table 19-3) includes the Land Use characteristics described below.

Forest Cover – The acreage in a subwatershed that is forested contributes little nitrogen or other contaminants to groundwater. Decomposition of fallen leaves and branches does generate nitrogen, but that nitrogen is also taken up by the trees of the forest as well as the understory plants. Consequently, far less nitrogen reaches groundwater in forested areas than in developed areas or those with managed landscapes. As forest cover has little negative impact on the Forge River, it was assigned a weighting of 1. Forest cover within each subwatershed ranges from 0 to 40 percent of total forested area in the entire watershed.

Turf Cover – Turf cover, or turfgrass, is typically grown with inputs of fertilizer and pesticide. This is typically the case for turfgrass in residential, institutional, commercial, and office park land uses. When applied, a significant fraction (estimated at 35 percent) of fertilizer nitrogen reaches groundwater, where it then travels to the Forge River. Another fraction of turf fertilizer reaches the Forge River directly via stormwater runoff. Thus, subwatersheds with greater turf cover potentially contribute more nitrogen to the Forge River. Turf cover can affect the Forge River through the release of nitrogen, which can have a direct effect on water quality. Turf cover is assigned a weighting of 2. Turf cover within each subwatershed ranges from 0-20 percent of the total turf coverage within the entire watershed.

Industrial Land – Industrial land uses have the potential to release contaminants, which could reach the Forge River via groundwater or stormwater runoff. Release of contaminants is not, however, something that is necessarily associated with industrial land unless there is inadequate site management. It is important to note that industrial land comprises a relatively small percentage of overall land area of the watershed. Industrial land cover is therefore assigned a weighting of 1. Industrial land within each subwatershed ranges from 0-55 percent of total industrial land within the entire watershed; two subwatersheds comprise the majority of industrial land in the watershed.

Agricultural Land – The presence of farms is significant in terms of the regular fertilizer and pesticide applications associated with farming. Agricultural land in the study area comprises

field crops, nurseries and duck farms. This subcategory only considers the contribution from fertilizers and pesticides, not animal waste. The contributions from animal wastes are included in the Nitrogen section under the STP sub-category. Similar to turf applications, only a fraction of the pesticides and fertilizers is utilized by plants or adsorbed by soil particles and organic matter. The balance of fertilizer and pesticide constituents reach the Forge River via groundwater or stormwater flow. As fertilizer and pesticide applications for farming use are typically greater per acre than residential use (*i.e.*, turf cover) a weighting of 2 was assigned. Agricultural land within each subwatershed ranges from 0 to 50 percent of total agricultural land within the entire watershed.

Acreage Preserved/No Development Potential – This category evaluates the impact of lands that have been placed in preservation through acquisition or purchase of development rights by the Town or County or which are not developable for other reasons. They will contribute little, if any, deleterious effects to the Forge River either via stormwater or groundwater flow. This category compares the preserved land in a given subwatershed against the total preserved land within the entire watershed and is weighted with a value of 1. Preserved lands in each subwatershed range from 0 to 25 percent of the total preserved area within the entire watershed.

Acreage with Development Potential – Parcels in this category are in private ownership. If developed, they could contribute additional nitrogen to the watershed via stormwater or groundwater flow to the Forge River. The land area with potential for development in a given subwatershed is assigned a weighting of 2 and such land within each subwatershed has values that range from 0-55 percent of their total area within the entire watershed.

21.2 Stormwater

No Recharge Areas – In these areas, which tend to be directly adjacent to the Forge River and its tributary creeks, runoff is collected via a network of catch basins and pipes and then discharged directly to surface water via stormwater outfalls. Because there are no recharge basins in these areas, they are termed “no-recharge” areas. These areas provide little or no recharge to groundwater where bacterial degradation and soil particle adsorption could remove stormwater contaminants detrimental to Forge River water quality. Instead, a majority of the stormwater from these areas flows untreated into the Forge River. No-recharge area values have been assigned a weighting of 2 and such land within each subwatershed has values that range from 0-30 percent of their total area within the entire watershed.

Impervious Cover – Areas with greater roadway, parking lot, and building coverage generate significant stormwater runoff and provide less infiltration than areas with less built acreage. With greater runoff comes an increase in the stormwater contaminants and, thus, greater potential for Forge River water quality degradation. Subwatershed impervious area is measured in acres and has been assigned a weighting of 2.

Development Adjacent to the Shoreline – Undeveloped, vegetated riparian areas of estuaries act as a filter for various upland contaminants. Conversely, developed riparian areas provide little natural nutrient or contaminant removal from stormwater runoff prior to its discharge to surface water. Developed areas within 75 feet of the shoreline – which are within the NYS Department of Environmental Conservation's tidal wetland jurisdiction – are included in this measure. The acreage of development within 75 feet of the shoreline is assigned a weighting of 2 and such land has values for each subwatershed that range from 0-25 percent of their total area within the entire watershed.

21.3 Nitrogen

Nitrogen Contribution to the Estuary – The nitrogen contribution was calculated from upland sources and atmospheric deposition; it does not include discharges from sewage treatment plants. (Refer to the characterization phase for additional details regarding this calculation). This is probably the most significant value of all watershed characteristics in terms of its impact on Forge River water quality. Thus, it has a weighting of 5, the highest possible weighting in the prioritization matrix. The subwatershed values range from 0 to 150 pounds of nitrogen per day.

Onsite Wastewater Treatment System Density – The density (*i.e.*, number per acre) of on-site wastewater treatment systems (OWTS) in a watershed is a key driver of the concentration of nitrogen in the underlying groundwater. While nitrogen is accounted for in the above category (Nitrogen Contribution to the Estuary), subwatersheds with a high density of OWTS may be a higher priority for sewering because of clustered infrastructure requirements. As these systems contribute directly to Forge River nitrogen loading, this characteristic is assigned a weighting of 5 and has values that range from 0-2.02 units per acre, *i.e.*, an average unit density based on the total land area of each subwatershed.

Number of OWTS less than 10 feet from Groundwater – The Suffolk County Department of Health Services regulates the installation of OWTS and requires a minimum of two feet between the bottom of the septic tank and groundwater. This distance is considered the minimum requirement for fine particle removal and adequate nitrogen degradation by soil bacteria. Adding all of the components of a typical OWTS together and its position relative

to the home requires that OWTS be a minimum of 9 to 10 feet below grade. Consequently, OWTS that are less than 10 feet from groundwater require the design of an alternate system or may be out of compliance with standards. Non-compliant systems would be operating less effectively. Given the age of the developments in the study area, a majority of homes in the watershed pre-date these SCDHS OWTS requirements. Furthermore, the older homes tend to be closer to the waterfront and thus tend to be located over shallower groundwater. It is reasonable to assume that a substantial number of OWTS are non-compliant. This characteristic is assigned a weighting of 5. The value is the number of all OWTS that are located in areas that are less than 10 feet from groundwater. The total number of OWTS – including both compliant and non-compliant OWTS – within these areas is used as a measure of impact for this category. This is acceptable because the percentage of non-compliant OWTS across the subwatersheds in these locations is likely constant (*i.e.*, given comparable ages of most waterfront homes in the watershed).

Wastewater Flow from OWTS within the 10-year Groundwater Travel Time – Groundwater travels toward the Forge River at a known rate within the contributing area. Thus, wastewater effluent from the cesspools and septic systems that are closest to the Forge River (*i.e.*, within a 0-to-10-year groundwater travel times) will reach the estuary sooner than OWTS that are further away. Improvements made to these systems or sewering of the homes in areas closer to the estuary will generate water quality improvements faster than the management of OWTS that are more distant from the estuary. Values for this characteristic range from 1 to 5,000 gallons per day per subwatershed and are assigned a weighting of 4.

Pre-1970 Homes – Homes built before the mid 1970's were typically constructed with cesspools. Septic systems were mandated for new construction after it became clear that they could be more easily maintained, could retain their effectiveness for a longer time, and – with associated leaching fields – could provide greater nitrogen treatment than the simpler but less effective cesspools. Septic systems are estimated to increase nitrogen removal by approximately ten percent over cesspools. Although some pre-1970 homes may have brought their OWTS into compliance with current SCDHS requirements, many others may be original and operating poorly relative to septic systems serving newer homes. This subwatershed characteristic utilizes US Census data to enumerate homes constructed prior to 1970 in each of the subwatersheds. Subwatersheds with greater numbers of older homes may be subjected to higher nitrogen loading from the OWTS. This characteristic is assigned a weighting of 3.

Groundwater Travel Time – The number of years it takes groundwater to travel and discharge to the Forge River is significant primarily in terms of the length of time required to

realize water quality improvements from the time that management changes are implemented. Although research on nitrogen degradation in groundwater is contradictory, the preponderance of work suggests that little nitrogen removal occurs in groundwater. Consequently, absent any intervention, nitrogen that enters groundwater will remain in the groundwater until it is discharged to surface water or flows to deeper aquifers. The sewering of areas where groundwater travel time is shorter will generate water quality improvements faster than in those areas where travel time is lengthy. If groundwater treatment is an option for nitrogen removal, then removing nitrogen from areas where groundwater travel time is shorter will be more immediately effective. Furthermore, if the nitrogen source is reduced, it will require less time and dollar investment than comparable areas where groundwater travel time is longer. This value of this characteristic is measured in terms of acres of subwatershed where groundwater travel time is less than ten years. This characteristic is assigned a weighting factor of 4.

STP and Duck Farm Discharges – This characteristic is significant enough to warrant a line item of its own due to its point source contribution. There are three sewage treatment plants (STPs) from residential subdivisions in the Forge River watershed that, coincidently, all discharge to groundwater in the Ely Creek subwatershed. The only other significant nitrogen point sources are the two duck farms that discharge to West Mill Pond. There are a number of options for STP discharge improvement or elimination in these subwatersheds. The values for the STP and duck farm discharges are measured in pounds of nitrogen discharged per day. This characteristic is assigned the highest weighting factor of 5.

21.4 Creek Ecology

Spartina Acreage – *Spartina alterniflora* and *Spartina patens* are the dominant wetland vegetation in a salt marsh. These plants are important in three respects: 1) they provide important habitat for many marine organisms, 2) they serve as a filter, trapping sediment from stormwater runoff and absorbing some of its contaminants, and 3) they absorb nutrients from groundwater underflow. Subwatersheds with greater *Spartina* acreage should be healthier and better able to manage stormwater and groundwater inputs. This characteristic is assigned a weighting factor of 2.

Phragmites Acreage – The presence of the common reed *Phragmites* in marine and brackish systems is usually a reflection of some natural or, more likely, anthropogenic disturbance. Although *Phragmites* provides little habitat value, it does absorb nutrients and stormwater contaminants and provides bank stabilization and erosion control. The plant is highly invasive, replacing the more ecologically valuable *Spartina* species. Its presence is therefore

overall a negative subwatershed characteristic. It is measured in acres and is assigned a weighting factor of 2.

Linear Feet of Hardened Shoreline – Hardened shoreline includes primarily bulkhead, but also stone and riprap banks. Where there is hardened shoreline there is usually no tidal wetland vegetation and its associated habitat. There is also frequently little upland buffer vegetation to absorb stormwater flow. Hardened shoreline, whose value is measured in terms of the percentage of hardened shoreline in a subwatershed with respect to the total within the entire watershed, ranges from 0-55 percent and is assigned a weighting factor of 2.

Depth of Creek Bottom Depressions – Depressions inside some of the Creeks retain stagnant and oxygen-depleted bottom water. As some of these basins are deeper than the main branch of the Forge River, little circulation occurs. Depressions are defined as all areas where the bottom elevation is less than that at the creek mouth – not including sills that may be present. The value for this characteristic is measured in feet and is assigned a weight of 1.

22 Subwatershed Prioritization Discussion

22.1 Land Use /Land Cover

The Land Use/Land Cover category for land cover types and development potential includes; forest cover, turf cover, industrial land, agricultural land, preserved acreage (*i.e.*, with no development potential) and acreage with development potential. The subwatershed impairment scores for land use are shown in Table 22-1. These impairment values are sorted in descending order with the highest value corresponding to the greatest impairment, and thus the highest ranking. The West Mill Pond subwatershed ranks highest because a greater percentage of the subwatershed comprises industrial and agricultural land; it also sustains a higher potential for development than any other subwatershed. The land use values for the Ely Creek and East Mill Pond subwatersheds are also high due to their substantial turf cover, industrial and agricultural land, and development potential. Ely Creek and East Mill Pond subwatersheds are thus ranked second and third, respectively, in terms of land-use driven impairments to estuary water quality.

Table 22-1. Land Use / Land Cover Impairment Scores

Subwatershed	Land Use
West Mill Pond	32
Ely Creek	31
East Mill Pond	27
Old Neck Creek	21
Poospatuck Creek	20
Middle Forge West	17
Home Creek	15
Wills Creek	15
Lons Creek	14
Upper Forge West	14
Upper Forge East	14
Middle Forge East	14
Lower Forge East	14
Lower Forge West	10

Table 22-2 provides the individual scores for the four land cover categories. Forest cover (expressed as a percentage of the forest cover within the entire Forge River watershed) is highest in West Mill Pond, followed by Ely and Wills Creek subwatersheds. Because a greater percentage of forest cover represents less impairment, these subwatersheds are scored low in terms of impairments from land use in the forest cover sub-category.

The Poospatuck and Ely Creek subwatersheds have the greatest turf cover as a percentage of the entire Forge River watershed. These subwatersheds are therefore scored highest among the subwatersheds for their level of impairment due to the fertilizer and pesticide usage that is associated with turf maintenance.

Industrial land as a percentage of the entire Forge River watershed is greatest in the Ely Creek and West Mill Pond subwatersheds. All other subwatersheds other than Wills and Old Neck Creeks have no industrial land. Industrial land has the potential to release a variety of contaminants to the watershed, although actual contamination may not be present.

The East and West Mill Pond subwatersheds have the vast majority of agricultural land, although some agricultural land is present in the Ely Creek and Old Neck Creek subwatersheds. There is virtually no agricultural land use in the other subwatersheds.

Table 22-2. Land Use Impairment Subwatershed Weighted Values

Subwatershed	Forest Cover
Lower Forge West	5
Home Creek	5
Lons Creek	5
Middle Forge West	5
Poospatuck Creek	5
Upper Forge West	5
East Mill Pond	5
Upper Forge East	5
Middle Forge East	5
Old Neck Creek	5
Lower Forge East	5
Wills Creek	4
Ely Creek	3
West Mill Pond	1

Subwatershed	Turf Cover
Poospatuck Creek	10
Ely Creek	10
Middle Forge West	6
Wills Creek	6
West Mill Pond	6
Old Neck Creek	6
Home Creek	4
East Mill Pond	4
Lons Creek	2
Upper Forge West	2
Upper Forge East	2
Middle Forge East	2
Lower Forge East	2
Lower Forge West	0

Subwatershed	Industrial Land
Ely Creek	5
West Mill Pond	4
Wills Creek	1
Old Neck Creek	1
Lower Forge West	0
Home Creek	0
Lons Creek	0
Middle Forge West	0
Poospatuck Creek	0
Upper Forge West	0
East Mill Pond	0
Upper Forge East	0
Middle Forge East	0
Lower Forge East	0

Subwatershed	Agric. Land
West Mill Pond	10
East Mill Pond	10
Ely Creek	4
Old Neck Creek	2
Lower Forge West	0
Home Creek	0
Lons Creek	0
Middle Forge West	0
Poospatuck Creek	0
Wills Creek	0
Upper Forge West	0
Upper Forge East	0
Middle Forge East	0
Lower Forge East	0

Preserved land is generally protective of the watershed and estuary water quality. The values in Table 22-3 for preserved land are lowest for West Mill Pond, Wills Creek, and Ely Creeks. These three subwatersheds, which share similar values with the forest cover category, are the least impaired subwatersheds in terms forest cover and preserved land.

In general, land development has a negative effect on estuarine water quality. Consequently, subwatersheds with greater development potential were assessed higher values in terms of Forge River impairment. The value for development potential in West Mill Pond subwatershed is the highest among all subwatersheds and is therefore assessed highest for potential impairments from future development. It is followed by the Ely Creek and East Mill Pond subwatersheds, which are ranked second and third with values of 10 and 6, respectively. All other subwatersheds rank equally (*i.e.*, have comparable scores) with the exception of the Lower Forge West subwatershed, which has near zero potential due to the large quantity of acreage in preservation.

Table 22-3. Preserved Land and Development Potential Subwatershed Weighted Values

Subwatershed	Preserved
Lower Forge West	5
Lons Creek	5
Upper Forge West	5
Upper Forge East	5
Middle Forge East	5
Old Neck Creek	5
Lower Forge East	5
Home Creek	4
Middle Forge West	4
East Mill Pond	4
Poospatuck Creek	3
Ely Creek	3
Wills Creek	2
West Mill Pond	1

Subwatershed	Dev Potential
West Mill Pond	10
Ely Creek	6
East Mill Pond	4
Home Creek	2
Lons Creek	2
Middle Forge West	2
Poospatuck Creek	2
Wills Creek	2
Upper Forge West	2
Upper Forge East	2
Middle Forge East	2
Old Neck Creek	2
Lower Forge East	2
Lower Forge West	0

22.2 Stormwater

Stormwater runoff contributes to water quality degradation. Runoff is greater in those subwatersheds where there is more impervious land cover. These tend to be the subwatersheds with greater development and hence more roads and driveways as a percentage of the overall watershed. Water quality degradation from stormwater inputs is greater in those subwatersheds where runoff enters the Forge River untreated (*i.e.*, where runoff is piped directly into the creeks and where little vegetation buffers the creek). Stormwater contributions to the Wills Creek (Score = 20) and West Mill Pond (Score = 18) subwatersheds are of the greatest concern, followed by Ely, Old Neck and Poospatuck, Creeks (Table 22-4) with scores of 16, 16 and 14, respectively. These five subwatersheds are where focused stormwater management may be most beneficial.

Table 22-4. Stormwater Subwatershed Scores

Subwatershed	Stormwater
Wills Creek	20
West Mill Pond	18
Ely Creek	16
Old Neck Creek	16
Poospatuck Creek	14
Lons Creek	12
East Mill Pond	12
Home Creek	10
Middle Forge West	10
Upper Forge West	10
Upper Forge East	6
Middle Forge East	6
Lower Forge East	6
Lower Forge West	2

Three stormwater components, which were evaluated and scored separately, include impervious surface area, 'no recharge' areas, and development within 75 feet of the shoreline (see Table 22-5 for scores). In terms of impervious surface area, Wills and Home Creeks scored highest followed by the Poospatuck, West Mill Pond, and Ely Creek subwatersheds.

In several subwatersheds, stormwater is collected and piped directly into surface waters. Runoff in these 'no-recharge' areas is untreated as it enters the estuary with the attendant potential to degrade water quality. These 'no-recharge' areas are greatest in the West Mill Pond, East Mill Pond, and Ely Creek subwatersheds (see Table 22-5 for scores).

Many of the lands along the Forge River shoreline are developed. Though these are the most desirable residential locations, they also have the potential to contribute more stormwater runoff than parcels located further from the water. Sheet flow – where rainfall runs horizontally across the land surface rather than infiltrating into the soil – can direct stormwater quickly into the Creeks. If there is no vegetation along the shoreline to serve as a buffer and filter, stormwater flow will enter the Creeks untreated. The creeks with the most development within 75 feet of the shoreline are Old Neck and Lons Creeks, which have the highest scores (10 and 8, respectively).

Table 22-5. Individual Stormwater-Related Subwatershed Weighted Values

Subwatershed	Impervious
Wills Creek	10
Home Creek	8
Poospatuck Creek	6
West Mill Pond	6
Ely Creek	6
Upper Forge West	4
East Mill Pond	4
Lons Creek	2
Middle Forge West	2
Upper Forge East	2
Middle Forge East	2
Old Neck Creek	2
Lower Forge East	2
Lower Forge West	0

Subwatershed	No Recharge
West Mill Pond	10
Ely Creek	6
East Mill Pond	6
Wills Creek	4
Upper Forge West	4
Old Neck Creek	4
Lons Creek	2
Middle Forge West	2
Poospatuck Creek	2
Upper Forge East	2
Middle Forge East	2
Lower Forge East	2
Lower Forge West	0
Home Creek	0

Subwatershed	Dev w/in 75'
Old Neck Creek	10
Lons Creek	8
Middle Forge West	6
Poospatuck Creek	6
Wills Creek	6
Ely Creek	4
Lower Forge West	2
Home Creek	2
Upper Forge West	2
West Mill Pond	2
East Mill Pond	2
Upper Forge East	2
Middle Forge East	2
Lower Forge East	2

22.3 Nitrogen

Nitrogen contributions to the Forge River are the most significant factor in the degradation of estuary water quality. This category includes several measures of nitrogen's impact on the Forge River. Some measures that may overlap others are ranked separately for prioritization purposes. The Wills Creek subwatershed sustains the greatest combined numerical impacts score and is thus ranked highest when all nitrogen factors are considered together. Poospatuck Creek and West Pond subwatersheds (Table 22-6) have slightly lower nitrogen

impact scores than Wills Creek and are ranked second and third, respectively in terms of water quality impacts from the various nitrogen sources.

Table 22-6. Nitrogen Impairment Subwatershed Scores

Subwatershed	Nitrogen
Wills Creek	116
Poospatuck Creek	96
West Mill Pond	89
Home Creek	68
Upper Forge West	62
Middle Forge West	57
Ely Creek	52
Lons Creek	51
Old Neck Creek	40
Lower Forge East	36
Middle Forge East	36
East Mill Pond	35
Upper Forge East	26
Lower Forge West	13

A more detailed breakdown of weighted values within categories for each subwatershed for factors that contribute to nitrogen impacts is found in Table 22-7 and Table 22-8. The top three highest scoring subwatersheds for nitrogen loading from all upland and atmospheric sources (Table 4-7) are the same as those for overall nitrogen impairment as shown in Table 22-6 (*i.e.*, highest in the Wills Creek subwatershed followed by the Poospatuck and West Mill Pond subwatersheds). These are the subwatersheds where reductions in nitrogen inputs are most needed.

Onsite wastewater treatment systems (OWTS) contribute the majority of nitrogen to the groundwater that flows into the estuary. Based on their scores, the Poospatuck, Wills Creek, and Upper Forge West subwatersheds scored highest for OWTS density (number/subwatershed acreage) in the subwatershed. Management of OWTS systems in these subwatersheds should be a priority over the other subwatersheds.

Groundwater travel time is important primarily in terms of the timing of potential intervention methods. Subwatersheds were ranked by the percentage of acres within the <10-year groundwater travel time boundary (Table 22-7). The West Mill Pond and Ely Creek subwatersheds scored highest followed by the Poospatuck Creek and Wills Creek subwatersheds. Successful interventions to reduce nitrogen inputs to groundwater or to treat groundwater *in situ* would be realized more quickly in these subwatersheds.

Table 22-7. Nitrogen Loading, Onsite Wastewater Systems and Groundwater Travel Time Weighted Values

Subwatershed	N Loading
Wills Creek	25
Poospatuck Creek	20
West Mill Pond	20
Home Creek	10
Middle Forge West	10
Upper Forge West	10
East Mill Pond	10
Ely Creek	10
Lower Forge West	5
Lons Creek	5
Upper Forge East	5
Middle Forge East	5
Old Neck Creek	5
Lower Forge East	5

Subwatershed	OWTS
Poospatuck Creek	25
Wills Creek	25
Upper Forge West	25
Lons Creek	20
Middle Forge West	20
Home Creek	15
Middle Forge East	15
Lower Forge East	15
Old Neck Creek	10
West Mill Pond	5
East Mill Pond	5
Upper Forge East	5
Ely Creek	5
Lower Forge West	0

Subwatershed	GW Time
West Mill Pond	20
Ely Creek	20
Poospatuck Creek	16
Wills Creek	16
Lower Forge West	8
Home Creek	8
Middle Forge West	8
Upper Forge West	8
East Mill Pond	8
Old Neck Creek	8
Lons Creek	4
Upper Forge East	4
Middle Forge East	4
Lower Forge East	4

Subwatershed	WW Flow-10yr
Wills Creek	20
Poospatuck Creek	16
Middle Forge West	8
Upper Forge West	8
West Mill Pond	8
Home Creek	4
Lons Creek	4
East Mill Pond	4
Upper Forge East	4
Ely Creek	4
Middle Forge East	4
Old Neck Creek	4
Lower Forge East	4
Lower Forge West	0

Wastewater flow (in gallons per day) from OWTS within the 10-year groundwater travel time zone is significant in terms of potential remediation. The subwatersheds with the greatest volume of wastewater flow in the 10-year travel zone are the Wills Creek and Poospatuck Creek subwatersheds (Table 22-7). These subwatersheds may benefit most from a connection to a centralized wastewater treatment system.

Onsite wastewater treatment systems that are less than 10 feet from groundwater (Table 22-8) likely do not meet Suffolk County Department of Health Services regulations. The effluent discharges from these systems are likely too close to groundwater for meaningful filtration by soil particles and degradation by soil bacteria. The subwatersheds that scored highest for impact from OWTS are the Home, Lons, and Wills Creeks subwatersheds. These are the subwatersheds where management or retrofitting of these systems would be most valuable to improving Forge River water quality.

Table 22-8. Onsite Systems <10FT to Groundwater, Homes Built <1970, Wastewater & STP Flow Weighted Values

Subwatershed	OWTS<10' to GW
Home Creek	25
Lons Creek	15
Wills Creek	15
Poospatuck Creek	10
Old Neck Creek	10
Middle Forge West	5
Upper Forge West	5
West Mill Pond	5
East Mill Pond	5
Upper Forge East	5
Ely Creek	5
Middle Forge East	5
Lower Forge East	5
Lower Forge West	0

Subwatershed	Homes <1970
Wills Creek	15
Poospatuck Creek	9
Home Creek	6
Middle Forge West	6
Upper Forge West	6
West Mill Pond	6
Lons Creek	3
East Mill Pond	3
Upper Forge East	3
Ely Creek	3
Middle Forge East	3
Old Neck Creek	3
Lower Forge East	3
Lower Forge West	0

Subwatershed	STP Flows
West Mill Pond	25
Ely Creek	5
Lower Forge West	0
Home Creek	0
Lons Creek	0
Middle Forge West	0
Poospatuck Creek	0
Wills Creek	0
Upper Forge West	0
East Mill Pond	0
Upper Forge East	0
Middle Forge East	0
Old Neck Creek	0
Lower Forge East	0

Most homes constructed prior to the mid 1970's were equipped with cesspools rather than septic systems. The introduction of septic systems improved the nitrogen treatment efficacy

of OWTS and made it easier to maintain them. Table 22-8 shows scores– and rankings when sorted in descending order – of subwatersheds based on the number of homes built prior to 1970 (based on census data). Wills Creek has by far the largest number of older homes, followed by Poospatuck Creek. These subwatersheds would be given priority for OWTS upgrading. Sewage treatment plants (STPs) discharge to only two subwatersheds, West Mill Pond and Ely Creek (Table 22-8). Treatment plant upgrades would improve the quality of the flow from these subwatersheds.

22.4 Creek Ecology

Ecological scores are based primarily on the presence of riparian vegetation (as a percentage of the subwatershed acreage), shoreline hardening (*e.g.*, bulkheading), and over-dredged creek basins. The Old Neck Creek subwatershed had the highest scores and thus is ranked highest in terms of ecological impairments (Table 22-9). Most of its western side is hardened by bulkheading and its eastern side is heavily overgrown with *Phragmites*. There is also an over-dredged basin in the Creek that may contribute to poor water quality conditions. Lons Creek, with the second highest scores, has minimal *Spartina* communities and a significant amount of hardened shoreline. The Middle Forge East subwatershed has little *Spartina* acreage, significant hardened shoreline and a relatively large *Phragmites* stand; it scored third highest among the subwatersheds in terms of impacts from ecological degradation. The Poospatuck Creek and Wills Creek subwatershed scored higher than the remaining lower-ranked subwatersheds due to the presence of over-dredged basins. *Spartina* coverage (as a percentage of all *Spartina* acreage in the Forge River watershed) is greatest in the Lower Forge West and Home Creek subwatersheds (Table 22-10). Therefore, these two subwatersheds scored lowest in terms of ecological impairment. All other subwatersheds scored equally and thus are ranked equivalently in terms of impact.

Table 22-9. Ecological Scores

Subwatershed	Ecology
Old Neck Creek	26
Lons Creek	21
Middle Forge East	18
Poospatuck Creek	18
Wills Creek	17
Lower Forge East	14
Upper Forge West	14
Upper Forge East	14
Ely Creek	14
Home Creek	13
West Mill Pond	12
Middle Forge West	12
Lower Forge West	12
East Mill Pond	10

Phragmites coverage was greatest in the Lower Forge West subwatershed (as a percentage of all *Phragmites* acreage in the Forge River watershed) followed by the Ely Creek and Middle Forge East subwatersheds (Table 22-10); these three watersheds have the highest values for this characteristic. The Middle Forge West and East Mill Pond subwatersheds had virtually no *Phragmites*. All other subwatersheds had similar percentages of *Phragmites*.

Hardened shoreline as a percentage of the entire Forge River shoreline was highest in the Old Neck Creek subwatershed (Score=10), relatively high in Lons Creek (Score=4) and Middle Forge East (Score=4) per Table 22-10. There is virtually no hardened shoreline in the following subwatersheds: Lower Forge West, Home Creek, West Mill Pond, East Mill Pond, and Ely Creek.

Table 22-10. Spartina, Phragmites, Hard Shore, and Basin Depth Weighted Values

Subwatershed	Spartina	Subwatershed	Phragmites	Subwatershed	Hard Shore	Subwatershed	Basin Depth
Lons Creek	10	Lower Forge West	10	Old Neck Creek	10	Lons Creek	5
Middle Forge West	10	Ely Creek	4	Lons Creek	4	Poospatuck Creek	4
Poospatuck Creek	10	Middle Forge East	4	Middle Forge East	4	Old Neck Creek	4
Wills Creek	10	Home Creek	2	Middle Forge West	2	Home Creek	3
Upper Forge West	10	Lons Creek	2	Poospatuck Creek	2	Wills Creek	3
West Mill Pond	10	Poospatuck Creek	2	Wills Creek	2	Upper Forge West	0
East Mill Pond	10	Wills Creek	2	Upper Forge West	2	West Mill Pond	0
Upper Forge East	10	Upper Forge West	2	Upper Forge East	2	East Mill Pond	0
Ely Creek	10	West Mill Pond	2	Lower Forge East	2	Upper Forge East	0
Middle Forge East	10	Upper Forge East	2	Lower Forge West	0	Ely Creek	0
Old Neck Creek	10	Old Neck Creek	2	Home Creek	0	Lower Forge West	0
Lower Forge East	10	Lower Forge East	2	West Mill Pond	0	Middle Forge West	0
Home Creek	8	Middle Forge West	0	East Mill Pond	0	Middle Forge East	0
Lower Forge West	2	East Mill Pond	0	Ely Creek	0	Lower Forge East	0

Basins, which may be the result of over-dredging in the creeks, are deepest (relative to the creek mouth) in Lons Creek, Poospatuck Creek, and Old Neck Creek; these have values within the basin depth characteristic of 5, 4, and 4, respectively. There are also basins in Home Creek and Wills Creek, but they are less deep and were assessed at basin depth values of 3 for both subwatersheds. Stagnant water in these basins can become anoxic from organic and sediment deposition and associated microbial activity. Dredging and filling decisions should consider these values.

Some of the above contributions to ecosystem conditions are reversible, others less so. *Spartina* acreage can be expanded where conditions are suitable or can be made so. Similarly, *Phragmites* acreage can be reduced, and in some cases replaced with *Spartina* or other tidal wetland or upper marsh vegetation.

Hardened shoreline is more difficult to change. The NYSDEC usually permits replacement bulkheads when the existing bulkhead can be shown to be relatively functional. It may be

possible to incentivize homeowners contemplating new or replacement bulkheading, to instead select naturalized shorelines. These options and other ecological improvements are discussed in the Management Plan.

22.5 Summary of Subwatershed Prioritization

The most impaired subwatersheds based on land use, nitrogen contributions, stormwater inputs, and ecological factors are the Wills Creek, West Mill Pond, and Poospatuck Creek subwatersheds with overall scores of 168, 151 and 148, respectively, per Table 22-11 (see also Table 19-1, Table 19-2, Table 19-3 and Figure 19-1). Wills Creek ranks highest overall among all of the subwatersheds due to several factors related to nitrogen contributions, stormwater runoff to the estuary, and a relatively short travel time for groundwater to the estuary.

Table 22-11. Subwatershed Overall Scores

Subwatershed	Value
Wills Creek	168
West Mill Pond	151
Poospatuck Creek	148
Ely Creek	113
Home Creek	106
Old Neck Creek	103
Upper Forge West	100
Lons Creek	98
Middle Forge West	96
East Mill Pond	84
Middle Forge East	74
Lower Forge East	70
Upper Forge East	60
Lower Forge West	39

The duck farms and other agricultural land uses in the West Mill Pond subwatershed – which scored second highest overall – contribute to the relatively large nitrogen input to the Forge River estuary from this subwatershed. The potential for development is high in this subwatershed and the travel time for groundwater to the estuary is short.

The Poospatuck Creek subwatershed, with the third highest score, is notable for its relatively high overall nitrogen contributions, in particular, from turf cover, OWTS density, and older onsite wastewater treatment systems.

Ely, Home and Old Neck Creek subwatersheds, with overall scores of 113, 106 and 103, respectively, are considered a second tier in terms of their collective impacts on Forge River water quality while Upper Forge West, Lons Creek and Middle Forge West form a third tier with overall scores of 100, 98 and 96, respectively. The remaining subwatersheds were assessed with overall scores that are less than half of the top tier impact subwatersheds (*i.e.*, Wills Creek, West Mill Pond, and Poospatuck Creek subwatersheds).

This prioritization exercise will be useful in the formulation of management alternatives for each of the components of the land use, nitrogen, stormwater, and ecological impairments discussed above. The goal of the Management Plan will be to find solutions to address the highest priority impairments in the highest priority locations. The approach to reducing impairments in lower priority subwatersheds may be different. Selected remedies for the impairments will depend on the priorities discussed above, as well as on the political, economic, and social realities of implementation.

23 Management Strategies Introduction

The Forge River has been a distressed estuary since the early part of the 20th century. Extensive duck farming in the 20th century along the banks of the Forge River contributed to the high-nitrogen sediment load that remains. Residential development booms in the mid-twentieth century added thousands of onsite wastewater treatment systems (cesspools and septic systems) inside the Forge River watershed. Residents of the Forge River watershed continue to report malodorous conditions and fish kills while local scientists report hypoxic and anoxic conditions that are inhospitable to aquatic life.

Several initial studies detailed the background necessary to establish management strategies that would improve water quality in the Forge River estuary. The Forge River groundwater and stormwater contributing areas comprise the 'watershed' for the purpose of the study. Each of the Forge River creeks drains its own subwatershed. The initial Watershed Characterization report includes descriptions of the geographic setting (topography, hydrology, infrastructure, etc.), existing and projected land use, land cover, and socioeconomics. The report covered living resources for the estuary and adjacent upland area, described the quality of the sediments and the history of dredging, and summarized the available water quality data (Coliform bacteria, chlorophyll, dissolved oxygen, and nitrogen). The Characterization includes detailed information on nitrogen sources and loading and the impacts on water quality and living aquatic resources derived in large part from research conducted by SUNY Stony Brook's School of Marine and Atmospheric Sciences.

Nitrogen loading, in order of quantity delivered to the estuary, is from residential septic systems, the duck farm, private treatment plants, release from the sediments, residential and agricultural fertilizer use, and to a lesser extent atmospheric deposition and stormwater. The Characterization report concludes that the severe dissolved oxygen depletion in the Forge River is primarily due to algal blooms fed by exceptionally high nitrogen. The majority of the nitrogen entering the estuary is from groundwater that is years or tens of years old and therefore reflects historic inputs. Groundwater continues to receive nitrogen from septic systems and fertilizer use. Dense algal blooms will recur annually, particularly during the summer, as long as new and historic nitrogen loading and circulation remains unchanged.

Stormwater–borne sediments, years of accumulated duck waste and organic matter from decades of decayed algal blooms, and leaf fall have shallowed the estuary and restricted circulation. Poor circulation further degrades water quality. Muddy, anoxic bottom conditions preclude habitation by most estuarine organisms. Only highly mobile benthic organisms and pelagic species can avoid the low oxygen conditions. Tidal wetlands are limited to areas with no shoreline hardening

and are more prevalent in the lesser developed southern reaches of the estuary. Large stands of *Phragmites* have invaded portions of the estuary.

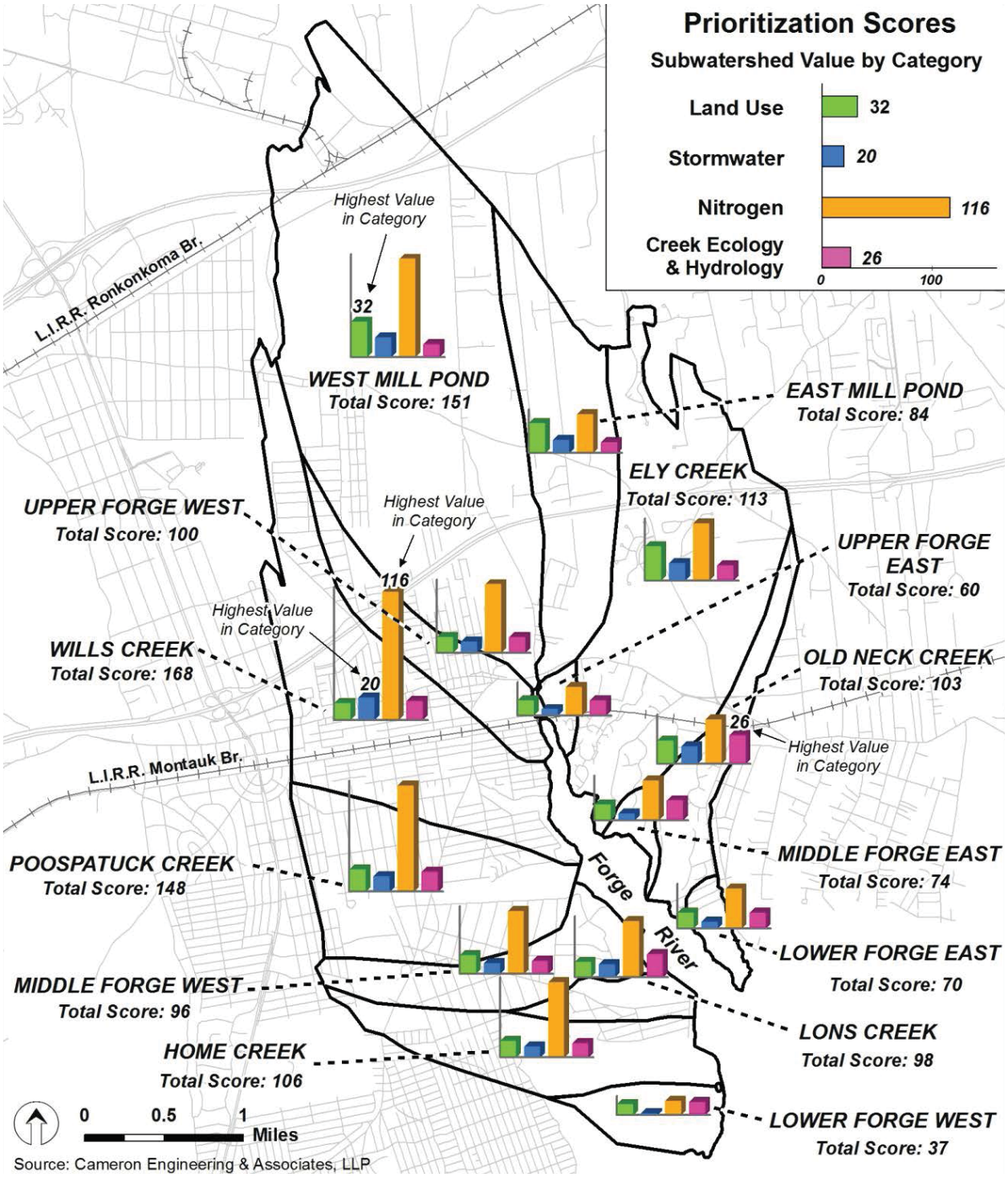
Another report, the Subwatershed Prioritization, examined data for each of the Forge River's 14 subwatersheds to quantify the degree of impairment experienced by each. The report established weighted values for land cover, land use, stormwater, nitrogen loading, habitat, and ecological conditions. Wills Creek, West Mill Pond, and Poospatuck Creek subwatersheds are the most impaired. Prioritization values (or scores) were calculated for each of the subwatersheds. A factor with values from 1-5 was then applied to each subwatershed characteristic to weight the characteristic according to its importance relative to the other factors. All characteristics were evaluated based on their value relative to the entire watershed in order to compare each subwatershed to the entire watershed. See Figure 2-1 for a summary of the prioritization.

The Management Plan identifies solutions that address the highest priority impairments in the highest priority locations. Based on the characterization of the waterbody and its watershed, an evaluation of the regulatory and programmatic environment affecting the management of the Forge River estuary, and a prioritization of the subwatersheds, watershed-based management strategies are identified to protect and restore the resources of the Forge River and its watershed.

It is important to note that the management strategies were devised to meet a number of objectives whose level of attainment of the overall goals of this plan, *i.e.*, water quality improvements and habitat restoration, can be measured via objective-specific indicators. The management strategy objectives and their associated performance measures are as follows:

- *Reduce nitrogen contributions*. Nitrogen is the primary pollutant responsible for the degradation of the estuary's water quality. Measurable indicators for this objective include concentrations of total nitrogen and dissolved oxygen and /or number of algal blooms.
- *Increase tidal flushing.* Anoxic conditions are exacerbated by stagnation of water in the creeks and poor flushing of the estuary in general. Significant increases in salinity of the waters of the estuary would be an indication of the attainment of this objective.
- *Enhance aquatic and riparian habitats.* Both aquatic and riparian environments have been degraded over time. The restoration of these habitats can be measured through a variety of plant, wildlife and marine life surveys.
- *Implement TMDL-allocated scenario.* The TMDL process will provide a long-term framework, particularly in a regulatory context, for achieving the restoration of the Forge River. Its success can be measured by the degree of completion of its adopted allocation scenario.
- *Increase public awareness* and support for Forge River protection and restoration. The successful implementation of this plan will depend heavily upon the public, that is, residents, businesses and institutions within the watershed. This indicator can be measured through public opinion surveys and compliance assessments (e.g., citations).

Figure 23-1 Subwatershed Prioritization by Category



24 Management Strategies Evaluation and Ranking Criteria

The Management Strategies for the Forge River estuary and its subwatersheds are based on the results of the characterization and prioritization, and the evaluation of the regulatory and programmatic environments. The Management Strategies are divided into Short-Term, Mid-Term, and Long-Term phases (see below). The following types of strategies are presented in one or more of the three phases:

- Land Use Management
- Stormwater Management
- Nitrogen Management
- Water Quality Improvements and Habitat Restoration
- Research and Data Collection
- Training, Education and Stewardship Programs

Each strategy has four associated factors, each assigned a value ranging from 1 through 10 that help measure its potential for achieving water quality improvements for the Forge River. The factors have the following parenthetical weightings based on their significance in improving water quality in the Forge River:

- Water quality benefits (4)
- Cost (3)
- Acceptance by the public (2)
- Technical and legal implementation difficulty (1)

24.1 Phasing - Short, Mid, and Long-Term Strategies

There are tens of short-, medium-, and long-term strategies that can be implemented to improve water quality in the Forge River. Some strategies are dependent on the implementation of earlier efforts. Strategies are prioritized within each short-, mid-, and long-term phase. Each of the phases includes a general discussion of the approximate time and steps required to implement each of the strategies along with measurable objectives.

Completion of *all* the recommended management strategies involves a long-term commitment of public and private resources. Furthermore, some of the later strategies depend on the results of the earlier projects or studies. For example, the selection of appropriate long-term management strategies will be determined by the TMDL implementation plan that follows from the preferred allocation scenario (discussed in Section 5.3.2).

The entities (public and private) and agencies that would be involved in each strategy are presented. Monitoring and evaluation of the effectiveness of each strategy are also discussed.

24.2 Water Quality Benefit

Nitrogen is the most critical parameter that determines water quality in the Forge River. Those strategies that lead to the greatest reduction in nitrogen loading to the estuary will have the largest impact on Forge River water quality.

The vast majority of nitrogen loading to the Forge River is from groundwater flow and sediment flux. The duck farm was also a significant source but has been shut down as of the fall of 2011.

Groundwater nitrogen concentrations are a reflection of nitrogen releases from land uses. The major nitrogen contributors to groundwater are onsite wastewater treatment systems (OWTS), sewage treatment plants (STPs), and fertilizer uses. Nitrogen from these uses infiltrates through the soils and enters groundwater some distance from the Forge River. The travel time for the groundwater to reach the Forge River from these uses may be as long as 50 years. Consequently, even if all these nitrogen releases ceased, it could be as long as 50 years before all the nitrogen accumulated in the groundwater was released to the estuary.

Sediment nitrogen flux is similarly affected by both historic and current inputs. Existing sediment deposits reflect years of accumulation. Phytoplankton and *Ulva* continue to bloom in the Forge River every spring, summer, and fall. These blooms die and sink to the bottom contributing new nitrogen to the sediments. Algal blooms will continue in the Forge River estuary as long as the flow of groundwater nitrogen continues unabated. Recent work by Stony Brook researchers suggests that estuarine water quality improves soon after high organic inputs (such as from duck farms) stops. Recommendations must therefore include management strategies to reduce the major source of algal bloom nutrients – groundwater nitrogen. Further research into sediment flux of nitrogen is needed to determine the sediment contribution of nitrogen to the water column in the absence of exogenous sources of nitrogen.

Management strategies for source reduction for nitrogen focus on bringing older on-site wastewater systems into compliance with current SCDHS requirements, OWTS that are close to groundwater, flows from OWTS that are within the 10-year groundwater contributing area, and sewage treatment plant discharges. Additional strategies are presented to reduce nitrogen already present in groundwater.

Water quality benefits are the primary concern of this plan and, as such, are assigned the highest weight of 4 within the weighting scale of 1 through 4.

24.3 Cost

Phasing of management strategies allows the responsible entity to distribute costs over time, to budget for higher cost items, and to utilize long-terms loans for major infrastructure investments. In general, the short-term strategies are also low cost, the mid-term strategies are moderate cost, and the long-term strategies represent the higher cost items. Each of the management strategies includes an order of magnitude cost estimate for budgeting purposes along with funding methods or sources. Though important, cost considerations are secondary to water quality improvements (which use a weighting factor of 4); cost is thus assigned a weighting factor of 3. See Appendix D for cost assignments.

24.4 Public Acceptance

Acceptance of a particular strategy by the public is an additional factor that must be considered; it can be decisive in choosing between the best strategies. A factor of 2 is utilized to appropriately weight this factor.

24.5 Technical Difficulty

Management strategies are ranked low, medium, and high in terms of the anticipated technical difficulty of implementation. Some of the strategies are easy to implement. Products or methodologies may already exist to achieve the recommended management strategy. Some strategies may only require a change in a Town ordinance. Others may involve simple devices to reduce water usage. These are ranked low for technical implementation difficulty.

Other strategies, such as area sewering, are technically challenging. These would likely require planning and engineering expertise and design. These types of strategies may be ranked medium or high depending on the technical difficulty involved.

Some of the recommended strategies have been implemented only outside the region or in research or demonstration projects. These may be large or complex, may require additional data, or may involve many components. These types of recommendations are ranked high in terms of technical difficulty.

Technical difficulties are typically easier to overcome than the first three factors. It is given the lowest weighting value of 1; technical difficulties are effectively not weighted.

24.6 Implementation Challenge

Implementing the recommended management strategies will, in most cases, require action by the Town Board. Many of the recommendations involve the commitment of Town resources,

some require significant expenditures, and other strategies involve imposition of fees on constituents. Some of the proposed strategies may therefore require difficult decisions by the Town Board, particularly during challenging economic times.

Legal implementation difficulties, like technical ones, are typically easier to overcome than the first three factors. Included with technical difficulties, legal issues are assigned a weighting factor of 1. Though minimal in comparison with the other three factors (*i.e.*, water quality benefit, cost and public acceptance), the inclusion of the technical and legal difficulty evaluation adds a final factor for fine-tuning closely ranked strategies.

25 Short Term Management Strategies

25.1 Land Use Management

All the recommended land use management strategies are for implementation within the Forge River watershed.

25.1.1 Establish a Forge River Protection Overlay District (S1)

As an impaired water body (*i.e.*, on the 303d list), the Forge River estuary deserves a heightened level of protection in order to facilitate its ecological restoration. The FRPOD would enable the Town of Brookhaven to implement special regulations inside the district to protect and improve water quality in the estuary. The proposed FRPOD would be overlaid on the official zoning map of the Town of Brookhaven and, when established, the official zoning map of the Incorporated Village of Mastic Beach. In addition to the standards ordinarily applicable to the underlying zoning districts, the properties within the FRPOD would be subject to the enhanced requirements set forth in the code of the FRPOD district. In terms of geographic extent, the FRPOD would comprise the watershed boundary (*i.e.*, the 50-year groundwater contributing area) of the Forge River.

The special regulations of the FRPOD would require enhanced review, restrictions and/or standards for a wide range of land use and development activities. Certain activities that are currently allowed under existing zoning would be banned within the FRPOD. Prohibited uses could include mining, the raising of livestock, fertilizer-intensive agriculture and any heavy and/or noxious industries.

The delineation of the FRPOD is a pre-requisite for many of the other strategies proposed here. These FRPOD-dependent strategies include the exploration and application of dedicated funding sources for water quality improvements, the establishment of a Forge River Protection Fund for program expenditures and the imposition of stricter clearing limits. These strategies are described in detail in the sections below.

The FRPOD would be implemented – and its associated code enforced – by the Town of Brookhaven and the Incorporated Village of Mastic Beach for their respective portions within the FRPOD. Overlay districts are common amendments to zoning codes and may be enacted readily. The Town of Brookhaven, for example, is currently considering the adoption of an overlay district for the Carmans River. Per the recommendations of the *Carmans River Watershed Protection and Management Plan*, the Town of Brookhaven would establish special stormwater requirements and modifications to zoning (*e.g.*, reductions in land use density) within the Carmans River Preservation Overlay District.

ACTION ITEM

- Establish a Forge River Protection Overlay District (FRPOD) for properties inside the 50-year contributing area to implement special regulations and improve water quality in the estuary.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-1. Establish a Forge River Protection Overlay District(S1)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	3	7	6	8	53
Note * Weighting					

25.1.2 Explore Dedicated Funding Sources (S2)

The FRP Fund would be a reliable and consistent means of funding water quality improvement programs in the Forge River watershed. The fee would support some of the specific management strategies recommended in this plan, including a low-interest loan program to bring on-site wastewater treatment systems into compliance with current SCDHS requirements, various 'green' infrastructure projects, and an expanded public education program in the FRPOD. Funds collected from the FRP Fund would only be allocated to projects and programs that benefit the watershed, its residents, and the Forge River estuary.

Legally, the fee imposed on properties within the watershed would comprise a special (tax) assessment district. Special assessment districts are commonly used to fund projects within a specified geographic area. The essential principle of the special assessment district is that the tax may only be levied on properties that would receive a unique and direct benefit from a project or set of projects, typically comprising infrastructure improvements. Watershed assessment districts, a certain type of special assessment district, have been established throughout the country to support water quality improvement programs.

It is recommended that the FRP Fund be based on both water usage and property value. For the latter component, a fixed mil rate would be applied to the assessed value of all properties within the FRWPD. The water usage component of the FRP Fund would be based on water consumption via the water bill. The rationale for the first part this two-part fee structure is that each property imposes an impact upon the Forge River in concert with its scale or size. For example, stormwater runoff varies directly with the size of a parcel. Higher property values are associated with property size and site improvements such as

buildings, driveways and parking areas, all of which are impervious surfaces that contribute stormwater runoff. Water usage, the second component of the FRP Fund, is also a significant measure of water quality impacts. Most of the FRPOD is unsewered and thus depends on cesspools and septic systems for wastewater treatment. The amount of sewage generated varies directly with water usage, and sewage effluent from on-site systems eventually reaches the estuary via groundwater. Thus, the water usage portion of the special assessment tax levy is fair in that it is in proportion to the degree of water quality impacts. This is also termed the "polluter pays" principle. Property owners who are already connected to private sewage treatment plants (STPs) would be assessed a lower fee. STPs remove a large portion, but not all of the nitrogen in sewage.

The FRP Fund would be implemented in the Town of Brookhaven and the Incorporated Village of Mastic Beach, the two relevant taxing authorities within the Forge River watershed. The amount of the annual total tax levy for the FRPOD should be approximately equivalent to the anticipated annual expenditures for any proposed water quality improvement programs and projects.

ACTION ITEMS

- **Explore potential dedicated funding sources such as a FRP Fund** to provide water quality improvement services to property owners based on water usage and assessed value.
- Add fee to property owners' tax bills.
- Assess lower fee for property owners connected to private STPs provided the STP complies with its SPDES permit discharge requirements.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-2. Explore Dedicated Funding Sources (S2)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	3	8	5	5	51
Note * Weighting					

25.1.3 Create a Forge River Protection Fund (S3)

A Forge River Protection Fund (FRP Fund) would be established, in large part, with the fees generated from FRPOD fee. It is recommended that the FRP Fund be augmented by a land development fee. This would comprise a one-time fee on new development projects and expansions within the FRPOD. The rationale for a land development fee is that construction activities, though occurring over the short term, impose a relatively high one-

time impact upon water quality as a result of land disturbances such as erosion associated with the clearing of vegetation and grading operations. Environmental grants from state, federal and county sources may also be obtained to supplement the FRP Fund.

Dedicated, environmental funds are used on Long Island and elsewhere in the United States to address water quality problems, purchase property for open space and recreation purposes and conduct environmental studies and research. The proposed FRP Fund could be used to finance a number of the proposed management strategies recommended in this plan. Potential applications of the FRP Fund include stormwater infrastructure projects to replace direct discharge stormwater systems with retention basins and/or sediment separators and implement 'green street' techniques such as vegetated swales and rain gardens. An initial focus of a 'green streets' program could be the watershed's most heavily traveled thoroughfares and those roadways whose runoff is piped to the estuary. The FRP Fund could also be utilized to restore wetland habitats and degraded shoreline along the Forge River estuary and its tributary creeks, harvesting or removal of *Phragmites* and the restoration of tidal wetland habitat. The FRP Fund could also serve as the seed money for a loan program used by property owners to bring their on-site wastewater treatment systems into compliance with current SCDHS requirements. Such strategies are described in greater detail later in this section.

The Town of Brookhaven and the newly incorporated Village of Mastic Beach would be responsible for establishing and maintaining the FRP Fund, arranging loans, supervising grants and conducting other administrative functions. The fund could be apportioned to serve specific programs, each of which implements a particular short-term management strategy such as: 1) on-site wastewater treatment system improvements, 2) small-scale habitat restoration projects, 3) stormwater treatment improvements and 4) a public education program.

ACTION ITEMS

- **Create a Forge River Protection (FRP) Fund** for program expenditures, green infrastructure, and loans to property owners for eligible improvements.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-3. Create a Forge River Protection Fund (S3)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	4	5	6	9	52
Note * Weighting					

25.1.4 Establish a Low-Interest Loan Program to bring OWTS into Compliance (S4)

Effluent from OWTS, which travels to the Forge River via groundwater, is a major contributor of nitrogen to the estuary. A portion of the OWTS within the watershed may not be operating efficiently at present. For example, there are likely many cesspools still in operation within the watershed. Current Suffolk County Health Department Standards, which were established in the early 1980s, require the installation of septic systems for all new construction and replacements. Cesspools that are currently in use are more than 30 years old and are likely at or near the end of their useful life. Furthermore, septic systems are more efficient than cesspools at nitrogen degradation and thus contribute less nitrogen to groundwater. In the lower lying areas of the watershed, it is likely that older OWTS are regularly inundated by groundwater eliminating any real bacterial degradation of nitrogen. This condition would be especially prevalent near the shorelines during high tides.

Proposed mandatory inspections of OWTS would reveal operational deficiencies and subsequently require property owners to bring their systems into compliance with current SCDHS requirements. However, such fixes can be cost prohibitive for some property owners, especially given current economic realities. A low-interest loan program, funded with seed money from the FRP Fund, would be one approach for financing upgrades of OWTS. Property owners could use the low-interest loan program to finance their OWTS improvements and make payments back to the Fund. This would allow the FRP Fund to make new loans for additional OWTS improvements, *i.e.*, as a revolving loan fund. To further facilitate the program and reduce administrative costs, loan payments could be made through the property owners' tax bills. Such loans would survive changes in property ownership and stay with the property until the loan is paid off.

ACTION ITEMS

- Establish a low-interest loan program for property owners for onsite wastewater treatment system (OWTS) improvements.
- Provide initial funding from the FRP Fund.
- Property owners repay the loans through their tax bill.
- Loans would survive changes in property ownership and stay with the property.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-4. Establish a Low-Interest Loan Program to bring OWTS into Compliance (S4)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	4	8	4	5	53
Note * Weighting					

25.1.5 Identify Properties for Open Space Acquisition or Purchase of Development Rights (S5)

Reducing future development in the Forge River watershed can lower future nitrogen generation and release. Two typical approaches for reducing future development are acquisition (through fee simple ownership) and purchase of development rights (PDR). In the latter instance, the only remaining rights and value of the property would be for agricultural purposes and passive use. In a PDR program, land owners effectively sell a conservation easement; the easement is placed on the land owner's deed and stays with the land in perpetuity. In return for the restrictions placed on their land, the land owners receive compensation equivalent to the development rights of the property. Land owners who sell their development rights would retain the title to their property and the right to use it for agricultural purposes. The value of the development rights is usually the difference between the market value of the property and its agricultural value.

Land conservation can also be accomplished through fee simple ownership wherein all rights to a property are acquired. Under such ownership, the Town of Brookhaven or the Village of Mastic Beach may purchase high-conservation value properties outright from willing sellers within the watershed. The properties may then be deed-restricted as permanent open space. The acquisition of vacant land for open space and/or the purchase development rights should be governed by an analysis of environmental and ecological assets of each property such as its species diversity, uniqueness of habitat, outstanding physical features, the presence of, or proximity to water bodies and the availability of scenic vistas.

A significant portion of the upper reaches of the Forge River watershed comprises vacant parcels that are in private ownership. These undeveloped parcels, located mostly in the West Mill Pond and Ely Creek Subwatersheds, are unprotected from future development. Most of the active farmland is located within the central portion of the watershed. A significant portion of these farm parcels have been permanently protected through the purchase of development rights including the Jurgielewicz Duck Farm and several active farm parcels to the east. The Town should consider the acquisition of the remaining farming rights of the duck farm parcels which, given their proximity to the upper reaches of the Forge River, could continue to impact the estuary through future agricultural operations. There remain a number of unprotected farmland parcels within the watershed, most of which are located north of Montauk Highway. The purchase of development rights for these farms is recommended to protect them from commercial and/or residential development. This management strategy would evaluate the remaining agricultural

properties within the watershed in terms of their status, value and development potential and make recommendations on the acquisition or purchase of development rights for the most development-threatened properties. The evaluation would include an assessment of the estimated nitrogen release from the farms relative to the potential release from other future uses of the property.

The Town of Brookhaven has identified areas within the township that are most suitable for future development. The Town has, in some cases, revised the zoning in existing or proposed hamlets to encourage mixed use development. These are also the areas that are or will be sewered. Developers can purchase Transfer of Development Rights (TDR) credits to make development in the selected compact hamlets more economically attractive. Those TDRs come from 'sending areas' identified by the Town. Sending areas are typically places that the Town or County has identified for preservation as open space, as environmentally sensitive, or important to the public in some other way and therefore less appropriate for development. Those hamlets that the Town has identified for TDR redemption are referred to as 'receiving areas.'

ACTION ITEMS

- Identify properties for acquisition or purchase of development rights based on location and environmental resources.
- Develop property acquisition list based on location and environmental sensitivity.
- Consider acquiring the development rights for additional agricultural acreage.
- Develop a strategy to permit limited and controlled greenhouse farming on properties where development rights have been acquired. Limit lot coverage by greenhouses on these parcels.

APPLICABLE SUBWATERSHED

- West Mill Pond
- East Mill Pond
- Ely Creek

Table 25-5. Identify properties for acquisition or purchase of development rights (S5)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC	1	8	8	5	49
Note * Weighting					

25.1.6 Acquire Duck Farm Properties, Conduct Environmental Assessment and Prepare Remediation Plan (S6)

The Jurgielewicz Duck Farm absorbed the adjacent Barnes Road Duck Farm to the north. The Titmus Duck Farm extends from Sunrise Highway south to the Barnes Road Duck Farm. The Jurgielewicz Duck Farm is just north of West Mill Pond between Barnes Road

and the freshwater portion of the Forge River that empties into West Mill Pond. The Jurgielewicz farm reared ducks in this location since 1919. Tens of millions of ducks were reared here in its 92 years of operation. The Town of Brookhaven and Suffolk County purchased the development rights for the Jurgielewicz Duck Farm in 2007 for $5.6 million. The Jurgielewicz Duck Farm entered bankruptcy and closed in the summer of 2011.

Much, or likely most of the waste from the ducks reared there entered the West Mill Pond and from there, the Forge River. Duck waste likely remains on the property. Duck farmers sometimes buried deceased ducks on their properties. These may be present and if so are unlikely to have decomposed significantly. The farms utilized settling and aeration lagoons, which are visible on the aerial (Figure 25-1). Duck farms typically utilize a variety of machinery and vehicles that can leak petroleum products. Suffolk County has requested proposals for the evaluation and cleanup of another closed duck farm, Robinson's Duck farm, in East Patchogue. The work that will be completed for that project will establish procedures for the assessment and remediation of closed duck farms that adjoin sensitive waterbodies. Work on the Robinson Duck Farm will likely begin in early 2012 with remediation completed by 2014.

The DEC issued an order on consent to the owners of the Jurgielewicz Duck Farm to clean up the property. The property will likely be auctioned off by the bankruptcy court before a cleanup takes place. The Town of Brookhaven or Suffolk County should acquire the property from the court either individually or in partnership.

The development rights for the Jurgielewicz Duck Farm (not including the former Barnes Road Duck Farm) were acquired by the Town of Brookhaven, yet the parcels which comprise the farm still retain the right to support future agricultural uses. Depending upon the type of future agricultural activity, the former duck farm could potentially once again impact the estuary. There may be additional threats to the estuary from past duck farm activities. In particular, the waste settling and treatment lagoon contains a large reservoir of nutrient-rich sediments that could leach into the groundwater of surface water. Additional historic duck waste or other potential estuary contaminants may be present on the parcels. For these reasons, the purchase and remediation of the former duck farm is highly recommended. It is important to note that the development rights for the Jurgielewicz Duck Farm, which represent most of original value of the farm, are owned by the Town. The agricultural rights, which now comprise a fraction of the farm's original value, could be purchased by the Town at relatively minimal cost.

Environmental due diligence would precede the development of any land use and engineering plans for the former duck farm properties. Given the many years of duck farm

operations, there exists the potential for a number of environmental concerns and potential hazards on the site. In addition to duck waste, there may also contamination of the soils and groundwater with hazardous substances such as volatile and semi-volatile organic compounds. Thus, an important initial step in the development of restoration plans would be to conduct an environmental site assessment.

The acquisition of the Jurgielewicz Duck Farm and the associated environmental assessment and remediation plan is a short-term strategy, but would likely follow the closure plan required by the NYSDEC and would be subject to NYSDEC approval. The closure plan should be coordinated with the Town and/or County if it is publicly acquired. Cleanup of the Jurgielewicz Duck Farm property as soon as possible following acquisition could improve water quality relatively quickly. Because accumulated duck waste continues to leach into groundwater and West Mill Pond, its quick removal would be immediately beneficial. Similarly, restoration of the riparian areas of the property even before a land use plan is prepared would benefit Forge River water quality and provide wildlife habitat for a variety of aquatic and terrestrial organisms. Preparation of a land use plan in the mid-term is recommended subsequent to the cleanup and riparian restoration (see strategy M3) followed by its implementation in the long-term (see strategy L1). Future uses would be limited to agriculture or more likely, to passive recreational use.

A Phase I environmental site assessment would help assess the risks of acquiring the Jurgielewicz Duck Farm, including the potential investment in cleanup activities. If evidence of site contamination exists (and which is likely), a more detailed investigation (*i.e.*, Phase II environmental site assessment) involving the collection and analysis of soil, sediment and water samples would be conducted. Following the environmental site assessment, a remediation plan will be required to treat and/or remove the contaminants.

Development rights for the former Barnes Road Duck Farm or the Titmus Duck Farm were not purchased by the Town. Both of these farms may be candidates for public acquisition and cleanup. One or the other could be utilized temporarily for dredged material dewatering, composting, and removal and in the long-term for a regional sewer plant.

ACTION ITEMS

- Acquire Jurgielewicz Duck Farm.
- Perform site assessment and cleanup.
- Restore riparian area.
- Restore adjacent stream system.
- Consider acquisition and cleanup of the Barnes Road and Titmus Duck Farms and their use for temporary dredged material handling and long-term for a regional sewer plant.

APPLICABLE SUBWATERSHED

- West Mill Pond

Table 25-6. Acquire and remediate the duck farm properties (S6)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	4	5	5	6	47
Note * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

Figure 25-1. Jurgielewicz Duck Farm

25.1.7 Impose Stricter Clearing Limits (S7)

It is recommended that the clearing standards for any new developments match the standards in the Clearance Standards of the Central Pine Barrens Comprehensive Land Use Plan. According to these clearance standards, maximum site clearance varies from 90 percent for 1/4-acre residential lots to 20 percent for 4-acre and larger residential lots. The Central Pine Barrens Comprehensive Land Use Plan establishes a maximum site clearance of 65 percent for commercial, industrial and other or mixed uses.

ACTION ITEMS

- **Impose stricter clearing limits inside the FRPOD** to retain existing native, non-fertilizer dependent vegetation.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-7. Impose stricter clearing limits (S7)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	1	9	3	5	42
Note * Weighting					

25.2 Stormwater Management

25.2.1 Replace Direct Discharges to the Estuary (S8)

The drainage infrastructure in the Forge River watershed consists of typical stormwater collection and conveyance structures such as catch basins, leaching basins, manholes, pipes, outfalls, and recharge basins. There are approximately 24 outfalls that discharge to the Forge River and the creeks upstream. These collect stormwater from the neighborhoods and roads immediately adjacent to the Forge River and discharge directly to the estuary with no treatment.

Systems that discharge directly to the estuary do not capture stormwater contaminants and nutrients prior to their release to surface waters. The Town should replace these systems with one of a variety of ‘green’ alternatives that increase infiltration and degradation by soil bacteria by directing stormwater into vegetated swales, bio-retention areas, rain gardens, etc. Stormwater directed into these more natural vegetated systems is absorbed into the soil where plants take up nutrients and soil bacteria degrade nutrients and stormwater-borne contaminants. These systems are usually fitted with overflows that discharge to waterbodies, but only during high intensity, large volume rain events. Usually the systems are designed to store better than 90 percent of rain events.

ACTION ITEM

- **Replace direct discharge stormwater systems** with vegetated swales, rain gardens and other 'green' treatments designed to store 90 percent or more rain events.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-8. Replace direct discharge stormwater systems with green treatments (S8)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	1	4	7	8	38
Note * Weighting					

25.2.2 Adopt a Green Streets Policy (S9)

According to the USEPA, "A Green Street uses a natural systems approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods." Green Streets treatments can include vegetated curb extensions, sidewalk planters, landscaped medians, vegetated swales, permeable paving, and street trees. Such a policy would include requirements for managing roadway runoff for new developments as well as for upgrades of existing roadways. The Green Streets Policy would illustrate the different types of preferred treatments, their applicability, and effectiveness. Development of the policy would involve the Town's planning, highway, and engineering departments and would be best implemented on a Town-wide basis. It might also include the parks department as some of the treatments could become part of area parks. Rain gardens, for example, provide an attractive vegetated solution to the storage and infiltration of stormwater.

The Green Streets Policy might require a Green Streets evaluation for road projects over a proscribed cost or number of linear feet, for any that require engineering design, and for those in identified environmentally sensitive areas (such as the FRPOD). The Green Streets evaluation would determine which, if any, Green Streets treatments would be possible. If technically feasible, the treatments would be required for both public and private roadways.

ACTION ITEM

- **Adopt a 'Green Streets' policy** to improve roadway design, capture and treat stormwater, improve 'walkability,' and lower vehicle miles travelled.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-9. Adopt a 'Green Streets' policy (S9)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	1	8	5	5	43
Note * Weighting					

25.2.3 Develop a Low-Impact Stormwater Management Demonstration Site (S10)

Numerous options are available to manage stormwater on residential and commercial sites. Although numerous manuals and publications are available, a demonstration site can sometimes be most useful. A demonstration site provides contractors, nursery owners, property owners, designers, and others an opportunity to see, touch, and evaluate landscape and hardscape treatments, plant types, and devices that are actually in service. Demonstration sites may be best located inside other attractions, such as public parks, ecology centers (such as the Holtsville Center), botanical gardens, or even as part of a municipal facility. Nassau County installed retrofit stormwater treatments on the sites of its two largest wastewater treatment plants. In addition to improving stormwater treatment, the County's objectives included use of the sites for demonstration purposes. The County sites included rain gardens, bioretention areas, vegetated swales, porous asphalt, tree boxes, and manufactured treatment wetlands. Perhaps the best demonstration sites are those that the intended audience visits most frequently. For designers and contractors, Town Hall may be the best place. For homeowners, it may be the local park. For the nursery trade it might be the Parks Department yard. The location(s) of the demonstration site(s) can be posted on the Town's website along with further information on the design and implementation of the various recommended treatments and the associated plants.

ACTION ITEM

- **Develop one or more demonstration low-impact stormwater management sites** to provide examples of improved stormwater management techniques for builders, nursery owners, and homeowners.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-10. Develop a demonstration low-impact stormwater management site (S10)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	1	5	5	4	33
Note * Weighting					

25.3 Nitrogen Management

All the following recommendations will reduce the release of nitrogen to groundwater. They will *not* reduce the concentration of nitrogen already present in groundwater that will continue to be released to the Forge River over the next several decades.

25.3.1 Impose Strict Limits on Nitrogen Fertilizer Use (S11)

The Town should institute a ban on fertilizer use in the FRPOD during all months except April. April is the beginning of the growing season on Long Island and is therefore the month that fertilizer applications are most useful to landscapers and homeowners. Additional applications of fertilizer are not required.

Based on land use data described in the Characterization report, residential and commercial fertilizer applications contribute 66.7 lbs. N per day to groundwater in the Forge River watershed. This represents 87 percent of the total fertilizer contribution (agricultural inputs are estimated at 13 percent). If fertilizer use were banned within the FRPOD 8.25 % of nitrogen would not enter groundwater. Although a total ban would be most protective of Forge River water quality, restricting nitrogen fertilizer applications to the month of April can have a significant positive effect on water quality.

Enforcement of a fertilizer restriction would be primarily through a 'Good Neighbor Policy.' Retailers who sell fertilizer within the FRPOD would be required to post a notice near fertilizer displays that includes the FRPOD boundary and the date restrictions. Licensed landscapers within Suffolk County are currently required to participate in a mandatory information session for their license renewal (sponsored by Cornell Cooperative Extension). Information pertaining to Forge River fertilizer restrictions and FRPOD boundary maps could be distributed during those sessions. The Town could made information on fertilizer use available to homeowners on its website and through direct distribution of pamphlets to residents of the FRPOD (see section on public education).

ACTION ITEMS:

- Limit the use of nitrogen fertilizer to licensed commercial applicators and only in the month of April.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-11. Impose strict limits on nitrogen fertilizer use (S11)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Owner	4	8	5	9	59
Note * Weighting					

25.3.2 Develop Installation Requirements for Replacement of OWTS (S12)

Property owners that choose to or must replace (due to failure) their onsite wastewater treatment systems (OWTS) are bound by few regulations. The Town and County have no regulations for the replacement of existing systems unless the property owner has applied for a building permit for an addition, remodeling, or a sanitary system upgrade. Consequently, replacement of failed systems is conducted at the discretion of the contractor. Considerations such as distance to groundwater and the leaching ability of the soils may not be considered. Improper installation of OWTS can lead to inefficient and inadequate operation of sanitary systems that can have a detrimental effect on area groundwater and ultimately, the Forge River. For this reason, the Town should institute regulations for the replacement of OWTS inside the FRPOD.

The regulations should be based on Suffolk County Department of Health Services (SCDHS) guidelines for new construction/remodeling, including distance to groundwater, detention time in septic tank etc.

These new installation requirements would also serve as standards that Town inspectors would utilize as part of a new OWTS inspection program. That program, described below, would be required before property ownership could be transferred. These standards would help inspectors identify OWTS such as cesspools constructed of brick or cement blocks. This type of construction not only fails to treat wastewater to County standards, but also poses a threat of collapse when emptied.

Draft Town standards should be reviewed and approved by the SCDHS. The new Town standards would not replace SCDHS standards, but would cover replacement of, or improvements to existing systems that are not currently regulated by the County. Town law (Wetlands and Waterways ordinance) already requires OWTS compliance with SCDHS requirements, but only when property owners apply for building permits for additions.

ACTION ITEM

- Develop Town OWTS installation requirements for replacement systems using SCDHS standards as guidelines.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-12. Develop installation requirements for replacement of OWTS (S12)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	4	7	3	8	51
Note * Weighting					

25.3.3 Require OWTS Inspections (S13)

The Town should require an inspection of all on-site wastewater treatment systems (OWTS) located within the FRPOD for compliance with new Town requirements. Property owners would have three years from the inspection date to bring their OWTS into compliance with the new requirements. The FRP Fund would cover the cost of the inspection. Inspectors would be Town employees that have received special training.

The Town could make low interest loans available from the Forge River Protection Fund for system improvements such as replacement of cesspools with modern septic systems and installation of leaching fields for properties with high groundwater.

According to 2000 census data, there are approximately 2,900 homes within the Forge River's watershed that were constructed prior to 1970. Prior to 1973, cesspools were typically installed and constructed of brick or cement blocks. Since the 1970s, the SCDHS has required septic tanks with leaching pools. Detention time in cesspools is usually inadequate. They have insufficient leaching capacity, and often do not meet the minimum requirements for groundwater separation. All these factors contribute to the poor performance of cesspools

Depth to groundwater is another critical factor that affects OWTS performance. The Characterization and Prioritization reports estimated that 850 properties have OWTS that are less than nine feet to groundwater (the County standard for typical septic tank and leaching pool systems). The SCDHS standards require installation of 'alternative systems' under these conditions. A typical septic tank and leaching pool configuration would not be acceptable. Those OWTS that do not meet groundwater separation requirements and discharge directly to groundwater do not benefit from the estimated 10 percent nitrogen removal that occurs in the soil.

The cost of bringing OWTS into compliance with current SCDHS requirements can range from $1,000 for improvements, to $5,000 for a typical residential small system replacement, to greater than $10,000 for large commercial OWTS.

ACTION ITEMS:

- **Require inspections of all OWTS** at no cost to the property owner.
- Require property owners to bring systems into compliance with new Town requirements within three years of the initial inspection.
- Utilize the FRP Fund to cover the cost of inspections.
- Utilize low interest loans from the FRP Fund for replacement systems.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-13. Require OWTS inspections (S13)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Owner	4	9	2	10	57
Note * Weighting					

25.3.4 Enact Ordinance Requiring Pumpouts for all OWTS within FRPOD Every Five Years (S14)

The Town (and in fact most Long Island towns) do not require OWTS maintenance. Without regular pump-outs of the septic tank portion of the OWTS, accumulated solids will reduce the effective capacity of the system. This accumulation reduces the time available for biological degradation of nitrogen. Excessive solids accumulation also allows new solids to pass through (short-circuit) the septic tank and move directly to the leaching field. This can plug the connecting pipes and can eventually clog the surrounding soils causing system back-ups and failures. Regular pump-outs can not only ensure adequate wastewater treatment, but can also prevent a public health hazard.

Inspections can reveal these kinds of problems. Improvements or system replacements may be necessary to fix them. Regular pump-outs, however, are necessary to maintain systems in good working order. Consequently, FRPOD property owners should be required to have regular OWTS pump-outs. Aged, failing, or improperly maintained OWTS increase the nitrogen contribution to groundwater and ultimately the Forge River.

The Buzzards Bay National Estuary Program recommends and the Chesapeake Bay Preservation Act requires onsite wastewater systems pump outs every five years for system maintenance. Although regular OWTS pump outs will help these systems function effectively and will help avoid public health problems, sewering is ultimately the more effective choice for nitrogen reduction. On average, OWTS effluent contains 50 mg/l total nitrogen, whereas an advanced treatment plant can discharge effluent with nitrogen concentrations less than 10 mg/l.

There are a number of strategies that must be implemented prior to requiring regular OWTS maintenance. After the Town forms the FRPOD, it must develop OWTS requirements and then inspect all systems. Scheduled maintenance should be performed only on those OWTS that have passed inspection. Those OWTS that have not passed the Town's inspection must have improvements completed prior to maintenance being performed. This will avoid the danger of aged systems collapsing once emptied. Town contracts for septic tank pump-outs should be for a period of five years to allow for

consistent recordkeeping. Property owners would not be charged for pump-outs as the cost would be paid by the FRP Fund.

ACTION ITEMS

- Provide pump-outs for all OWTS at least once every five years.
- Cover the cost of the service from the FRP Fund.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-14. Provide pump-outs for all OWTS (S14)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	4	8	3	8	54
Note * Weighting					

25.3.5 Require all OWTS to Meet New Town Requirements (S15)

All on-site wastewater treatment systems (OWTS) should meet the new Town requirements for these systems prior to the sale of the property. For properties in wetland areas, the Town currently requires that owners bring their systems into compliance with Suffolk County requirements as part of building permit applications for additions greater than 10 percent of the building footprint. Additions to buildings result in additional flow to what may be an already inadequately sized OWTS. The placement of a deck or other accessory structure near the cesspool may pose a structural danger to the property owner (*i.e.* collapse of system). The placement of a deck/accessory structure may also make the cesspool less accessible for regular maintenance.

The Town's new requirements may be more stringent than the County's as they will apply to existing properties in a special environmental protection district. The inspections and required improvements would be paid for by the seller/owner. Inspectors would likely be Town employees. An approval certificate would be required prior to transfer of a deed or issuance of a building permit.

ACTION ITEMS

- Require all OWTS to meet new Town requirements on sale of property.
- Require inspections of all OWTS prior to the sale of property with fee paid by seller.
- Require that systems that do not meet new Town OWTS requirements be brought into compliance prior to sale of the property (similar to existing Wetland and Waterways requirement for building extensions).

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-15. Require all OWTS to meet new Town requirements (S15)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Owner	4	8	1	7	49
Note * Weighting					

25.3.6 Reduce Residential Water Use (S16)

Require dual flush toilets and faucet aerators for all new bathroom and kitchen installations or remodels. Reduced wastewater volume increases residency time and treatment efficiency in OWTS.

Household and/or business water conservation will increase the performance, lengthen the useful life, and reduce overflows or failures of existing OWTS. Reducing water use increases nitrogen degradation by increasing the residency time in the septic tank. This provides additional time for settling in the septic tank and more soil contact when the flow reaches the drainfield/leaching pool.

Dual flush toilets utilize 0.8 gallons of water for “rinse” flushes and 1.6 gallons for “full flushes”. Dual flush toilets have become more available in recent years with multiple models/colors to choose from. They cost approximately $300 each. If a toilet has not been replaced in the past 30 years, it may use up to 5-7 gallons of water per flush. As the average person flushes approximately six times per day (6 flushes x 5 gallons of water/flush = 30 gallons of water). Installing a new dual flush toilet could save approximately 25 gallons per day per person.

There are also dual-flush converter kits available for approximately $25 each. They can be installed on most flush valve toilets.

Typical faucet aerators use approximately two gallons of water per minute (gpm); older faucets may use more water. The aerator on the faucet’s spout determines the volume of water that exits the faucet. Typically, the only difference on a low-flow faucet is the aerator piece at the faucet’s spout. Therefore, any faucet could be retrofitted to have a low-flow aerator. Low-flow aerators are available from 0.35 gpm – 2 gpm. Faucet aerators and the adapters (if required) typically cost under $5 and are installed by screwing the aerator on the spout of the faucet.

During the Town permit application process, the make and model of the dual-flush toilet and faucet aerator should be included on the plans that are submitted for approval. The proposed aerator must have a flow rate of less than or equal to two gpm.

ACTION ITEMS

- **Reduce residential water use** to reduce wastewater volume and increase residency time and treatment efficiency in OWTS.
- Require dual flush toilets for all new bathroom installations or remodels.
- Require low flow faucets for all new or remodeled bathrooms and kitchens.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-16. Reduce residential water use (S16)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	1	9	2	7	42
Note * Weighting					

25.3.7 Provide Water Conservation Kits (S17)

Provide free water conservation kits to homeowners with funding from the FRP Fund. Reduced wastewater volume increases residency time and treatment efficiency in OWTS. Household and/or business water conservation will increase the performance of the existing OWTS with better treatment, increasing the life of the OWTS and reduce the potential for overflow or failures. If the OWTS receives less flow, the treatment will be improved by increasing the residency time in the septic tank. This provides additional time for settling in the septic tank and more soil contact when the flow reaches the drainfield/leaching pool.

The USEPA states that "minimizing wastewater volumes can improve the efficiency of onsite treatment and lessen the risk of hydraulic or treatment failure" (USEPA, 1995). The USEPA reports the most common OWTS failure is from hydraulic overloading. Detention is reduced, which decreases pollutant removal and overloads the infiltration field. The USEPA recommends reducing water use to decrease hydraulic loading and improve system performance.

Typical water conservation kits include:

- (1) 1.5 GPM Water Saving Spray Kitchen Faucet Aerator
- (1) 1.0 GPM water saving bath faucet aerator
- (1) 2.0 GPM water saving showerhead
- (1) toilet tank water bag
- Flush valve repair kit with adjustable flapper
- Installation instructions with water saving tips

Typical faucet aerators use approximately 2 gallons of water per minute (gpm); older faucets may use more water. The aerator on the faucet's spout determines the volume of

water that exits the faucet. Typically, the only difference on a low-flow faucet is the aerator piece at the faucet's spout. Therefore, any faucet could be retrofitted to have a low-flow aerator. Low-flow aerators are available from 0.35 gpm – 2 gpm.

The average flow rate for showerheads made prior to 1992 is approximately 5.5 gpm; newer showerheads have a much reduced average flow rate of 2.5 gpm. The cost savings from showerheads extends past water usage into energy consumption as less hot water is consumed.

The toilet tank water bag is the least complex water conservation device. The bag (usually 80 ounces/0.625 gallons) is filled with water and placed in the toilet tank. The space that the bag occupies displaces the amount of water necessary to fill the tank. Therefore, with one bag installed, 0.625 gallons of water is saved per flush.

A flush valve repair kit is also a typical component. A leaking toilet could greatly decrease performance of an OWTS by providing a constant flow of water to the septic tank. This extra flow reduces the ability of solids to settle out and increases chances of clogging the system, the surrounding soils and causing a failure.

Water conservation kits could be customized per the local community. If the water usage of the community is known to peak in the summer, it is typically due to lawn irrigation and other landscaping needs. A customized outdoor kit may include the following components:

- (1) Deluxe 7-spray water saving hose nozzle
- (1) Hose timer
- (1) Hose repair kit
- (1) Rain gauge

Water conservation kits could be purchased by the Town from the FRP Fund. When purchased in high quantities, the cost of the kits ranges from $5-$10 each. The kits may be distributed by volunteers or distributed at a community center (*i.e.* library, fire department).

ACTION ITEMS

- **Provide free water conservation kits to homeowners** with funding from the FRP Fund. Reduced wastewater volume increases residency time and treatment efficiency in OWTS.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-17 Provide free water conservation kits (S17)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	1	6	5	8	40
Note * Weighting					

25.4 Water Quality Improvements and Habitat Restoration

25.4.1 Encourage Riparian Area Restoration (S18)

Riparian zones provide a buffer between developed properties and the estuary that can help capture contaminants before they enter surface water. The Town's Wetlands and Waterways ordinance (Chapter 81) requires a natural buffer 25 feet landward of the wetland line for all new residential and commercial construction and additions to existing residential structures that exceed 10 percent of the floor area of the original structure (or which have undergone more than one addition since the issuance of the earliest certificate of occupancy).

Development of much of the Forge River shoreline, however, predates these regulations. Consequently, much of the shoreline is devoid of a buffer. Conventional residential lawns are not considered buffers. In fact, they permit the sheet flow of stormwater that is often laden with fertilizer, pesticides, and animal waste directly into adjacent waterbodies. Wetland buffers that are vegetated with native grasses and shrubs can capture stormwater flow before it enters the estuary. Tidal wetland buffers can include intertidal, high marsh, and upland areas that can support a variety of aquatic and terrestrial wildlife.

The Town could encourage voluntary restoration of the buffer area by property owners by offering a tax rebate equal to all or part of the cost of the restoration (depending on the total cost). The property owner would be required to submit the restoration plan to the Town for approval. Construction would be limited to pre-approved restoration contractors. Rebates would be capped and would be applied over several years. Property owners applying for a building permit within three years of the completion of a restoration would be required to reimburse the Town all or part of the rebate. Alternatively, qualified property owners might obtain a grant from the FRP Fund for all or part of the project cost.

ACTION ITEMS

- **Encourage riparian area restoration** by offering tax rebates to property owners for voluntary restoration of the wetland buffer in the absence of a building permit or,
- Offer grants from the FRP Fund to qualified property owners for voluntary restoration of the wetland buffer in the absence of a building permit.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-18 Encourage Riparian Area Restoration (S18)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC, Owner	2	8	3	6	44
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

25.4.2 Encourage Use of Indigenous Landscape Plants (S19)

Property owners that apply for a permit to increase the floor area of their home by more than 10 percent are required by the same code (Wetlands and Waterways - Chapter 81) to "revegetated previously cleared areas adjacent to the wetlands with local indigenous vegetation species as directed by the Director or his designee."

The Town might offer the same type of tax rebate or FRP grant described above to property owners that elect to install new landscaping on properties adjacent to wetlands that conforms to the code in the absence of a building permit. Replacement of exotic ornamentals and turfgrass with indigenous vegetation would help reduce fertilizer and pesticide use.

ACTION ITEMS

- **Encourage use of indigenous landscape plants** by offering tax rebates to property owners for installing new landscaping that limits nonindigenous vegetation to no more than 15 percent of the lot area in properties adjacent to wetlands or,
- Offer grants from the FRP Fund to qualified property owners for voluntarily limiting nonindigenous vegetation to no more than 15 percent of their lot area in properties adjacent to wetlands in the absence of a building permit.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-19. Encourage Use of Indigenous Landscape Plants (S19)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Owner	1	8	3	7	41
Note: * Weighting					

25.4.3 Install Oyster Grow-Out Systems for Algal Bloom Control (S20)

Algal bloom control is important to maintaining dissolved oxygen for aquatic organisms in the Forge River. Dense populations of microscopic algae (phytoplankton) are responsible

for oxygen depletion during the night as the cells respire. Consequently, removal of the algae can help sustain higher dissolved oxygen in the water column.

Oysters feeding on phytoplankton are capable of filtering 10 liters of seawater an hour. Large populations of oysters can clear the entire volume of an estuary in weeks or even days.

When oysters remove phytoplankton from the water column, they convert algal protein nitrogen into oyster protein. Thus, for nitrogen to be removed from the estuary by oysters, the oysters themselves must ultimately be removed from the estuary. Because the DEC has not certified the Forge River for shellfish harvesting, the agency would require transfer of oysters to certified water for depuration (cleansing) prior to harvest.

The Forge River is not, however, conducive to the growth of natural populations of oysters today. Dissolved oxygen concentrations are too low and bottom sediments are too muddy. It may be possible to grow oysters in the Forge River by altering their immediate environment. Aeration can be provided and the oysters can be grown off the bottom using some form of cage culture. Various systems are available that can be attached to existing docks. Some oyster grow-out systems float and can be towed just before the oysters reach market size to certified waters. The Town has already investigated use of these systems in the Forge River and should implement a program in the priority subwatersheds that experience the most serious algal blooms.

ACTION ITEMS

- Install oyster grow-out systems for algal bloom control in priority subwatershed creeks.
- Transfer oysters grown in the Forge River to certified waters for cleansing.

APPLICABLE SUBWATERSHED

- Poospatuck Creek
- Wills Creek
- Lons Creek
- Ely Creek
- Old Neck Creek
- Home Creek

Table 25-20. Install an oyster grow-out system for algal bloom control (S20)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC	5	6	6	8	58
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

25.4.4 Install Surface and Water-Column Creek Aerators (S21)

The DEC has determined that dissolved oxygen concentrations greater than 4.8 mg/L are necessary to maintain a healthy marine environment. The Forge River, however, experiences frequent periods of low or no oxygen. Few aquatic organisms are capable of surviving these low oxygen periods. Mobile species move to more oxygenated areas, whereas sessile species die and contribute to the bacterial decay that exacerbates the problem. Anaerobic bacteria are active in hypoxic and anoxic waters and release aesthetically displeasing gases.

Aeration will not solve the low oxygen problem caused by eutrophication. Provision of aerators will, however, allow many aquatic species to better survive the warmer months in the Forge River. Aeration can also reduce the generation of odors from bacterial decay processes. Near surface agitation or aeration is preferable as aeration near the bottom can cause re-suspension of nitrogen-rich bottom muds into the water column.

The Town should consider installation of subsurface aerators or agitators in the priority subwatersheds either run by solar power or supplied from the shore side by electric power (though this option requires a public power supply and electric cables that could interfere with navigation). A series of aerators will likely be required down the center of the selected creeks. Aerators might be activated by low-oxygen sensors.

ACTION ITEM

- **Install surface and water-column creek aerators in priority subwatershed creeks** to improve dissolved oxygen concentrations and help support aquatic organisms.

APPLICABLE SUBWATERSHED

- Poospatuck Creek
- Wills Creek
- Lons Creek
- Ely Creek
- Old Neck Creek
- Home Creek

Table 25-21. Install surface and water-column creek aerators (S21)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC	7	4	7	8	62
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

25.5 Research and Data Collection

25.5.1 Collect Additional Groundwater Data (S22)

Additional information is needed on the fate of the different forms of nitrogen that reach groundwater. Specifically, research is needed to determine how inorganic and organic nitrogen concentrations and forms (nitrate, nitrite, ammonia, etc.) change over time (if at all) in groundwater. It is possible that the few bacteria found in groundwater are capable of degrading specific forms of nitrogen as it travels through the water table. The fate of the nitrogen in the effluent from onsite wastewater treatment systems as it travels through Long Island soils to groundwater is not precisely known. Some studies suggest that less than 10 percent of nitrogen released from septic system leaching fields is denitrified and escapes as nitrogen gas. Information on the nitrification of septic system effluent as it passes through the soils to groundwater would be useful. Precise measurements of groundwater flow in the Forge River watershed would also help determine how quickly changes in nitrogen management become evident in surface waters. Area academic institutions and/or environmental firms should research the vertical and horizontal fate of groundwater nitrogen forms in the priority subwatersheds.

ACTION ITEM

- Determine groundwater nitrogen types, vertical and horizontal concentrations, and travel time.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-22. Collect additional groundwater data (S22)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	3	6	6	6	48
Note: * Weighting					

25.5.2 Continue Research on Benthic Nitrogen Flux (S23)

Nitrogen flux from Forge River sediments likely recycles a substantial quantity of nitrogen back into the water column. Researchers at SUNY Stony Brook's School of Marine and Atmospheric Sciences have been actively engaged in this research. Researchers acknowledge that there remains insufficient information to precisely quantify benthic flux. There are several feet of highly enriched sediments in portions of the Forge River. The material has accumulated since the last major dredging program in the mid-1960s. The duck farms are responsible for some of the material. Much, however, comes from the

decay of intensive and extensive algal blooms that have recurred in the Forge River annually for years. Some studies have suggested that when major nitrogen inputs cease, so too does benthic flux. Other research suggests that only the first few centimeters of sediments are responsible for benthic flux.

This kind of information is critical when determining the extent and value of dredging. It may be that dredging is most useful for increasing creek circulation and providing for adequate navigation for recreational vessels. It could, however, be valuable in removing a persistent source of nitrogen, particularly if new groundwater and overland nitrogen sources are reduced. A better estimate of the contribution of sediment nitrogen will help determine the value of extensive long-term dredging in the Forge River.

ACTION ITEM

- **Continue research on benthic flux** to determine the flux of nitrogen from sediments into the water column.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-23. Continue research on benthic flux (S23)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	4	6	7	6	54
Note: * Weighting					

25.6 Training, Education and Stewardship Programs

25.6.1 Develop Methods to Reduce Agricultural Fertilizer Use and Stormwater Runoff (S24)

There are approximately 400 acres of farmland within the watershed. Improved management of these farmlands can help improve the Forge River's water quality. Nitrogen loading of the estuary, as a result of fertilizer application, is the key issue concerning farming practices in the watershed. For example, excessive and uncontrolled application of fertilizer can result in fertilizer runoff during precipitation events or the rapid leaching of fertilizer below crop root systems and into groundwater. Strategies to mitigate or prevent unintended nitrogen loads include the application of optimal amounts of fertilizer, the appropriate selection of fertilizer type, and the control of nitrogen-laden stormwater runoff from farmland.

Organic fertilizers typically release nitrogen slowly, allowing efficient, steady uptake by plants. Thus, there is less danger of over-fertilization with organic fertilizers and the potential for nutrient runoff is minimized. In addition, the use of organic fertilizers improves soil structure and increases the moisture-retention capacity of the soil. On the other hand, organic fertilizer is not immediately available to plants due to the slow release of nutrients. The use of organic fertilizers also poses the risk of nitrogen depletion.

Inorganic fertilizers are immediately available to plants and precise amounts for application can be determined. However, there are significant disadvantages with the application of inorganic fertilizer, especially with respect to groundwater and surface water quality. Inorganic fertilizers are easily washed below the root zone via precipitation and irrigation. Unfortunately, nitrogen retention in south shore soils is poor and it is quickly leached from the sand and gravel into groundwater. As much as 40-50 percent of applied nitrogen reaches groundwater. Excessive applications of inorganic fertilizer can damage roots, cause the buildup of toxic salts in the soil, and can increase nitrogen-laden runoff into nearby surface waters.

An outreach program is recommended to the farmers within the watershed to ensure that they: 1) are employing optimal fertilizer application methods, 2) understand the fertilizer requirements of specific crops and 3) conduct a soil test before applying additional fertilizer. It would also be prudent for the Town to work with the agricultural community to find ways to reduce the use of fertilizer by changing the types of crops that are grown inside the Forge River contributing area.

The farmer outreach program can also comprise free evaluations of other farming practices and specific recommendations on crop selection, crop rotation and the management of farm runoff. For example, crop selection can be geared toward those plants that require very little nitrogen (*e.g.*, grapes) as opposed to those that require large quantities of nitrogen (*e.g.*, potatoes). Stormwater controls – such as berms and swales that direct runoff to retention basins – can mitigate the impacts of nitrogen-laden farm runoff.

Although greenhouse agriculture has been controversial on properties where development rights have been acquired, greenhouse farming could be more protective of the environment. Agricultural additives (fertilizers and pesticides) can be better controlled in enclosed structures than in open field farming. Greenhouses can utilize controlled systems to administer pesticides and fertilizers and limit or eliminate releases to the ground and groundwater. Farming that utilizes these types of systems may be more protective of groundwater than single-family homes where fertilizer and pesticide usage is uncontrolled. It should be possible to permit intensive and controlled greenhouse farming and

simultaneously limit lot coverage by greenhouses on parcels where development rights have been acquired.

ACTION ITEMS

- Work with farmers on strategies to reduce fertilizer use and control stormwater runoff including changing fertilizer types, crops, and practices.
- Work with farmers on strategies to control stormwater runoff.

APPLICABLE SUBWATERSHED

- West Mill Pond
- East Mill Pond
- Ely Creek

Table 25-24. Reduce Agricultural Fertilizer Use and Stormwater Runoff (S24)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Owner	3	8	6	5	53
Note: * Weighting					

25.6.2 Provide Educational Programs for Property Owners (S25)

Public acceptance and participation, which will be key factors in the implementation of the proposed management strategies, can be enhanced through increased outreach to the community. To this end, this plan proposes both broad and targeted community outreach and education programs. The goals of the outreach programs are to: 1) raise public awareness of the management strategies, 2) educate the public on the importance of their implementation, 3) encourage behavioral changes in support of the strategies, and 4) coordinate with the stakeholders and elected officials for the promotion and support of goals 1) through 3).

The broad community outreach program will reach the general public through a variety of media. The current project web site could be expanded with new pages that provide a definition, graphical depiction, purpose and costs for each of the proposed management strategies. In addition to management strategy web pages, an introductory web page to the strategies would deliver the following central principles that: a) almost every activity within the watershed impacts water quality, b) all residents and business owners are a part of the solution and c) restoration and protection of the Forge River offers significant benefits to present and future generations. Visitors to the web site would be invited to join an e-mail list for updates on the implementation schedule. Audio and video links of management strategy presentations and advocacy statements from the stakeholders could

also be provided to better reach and inform the general public. The Town or the County could transfer the existing website to their servers for future updates.

The broad community outreach program would also provide brochures and fact sheets for the purposes of general information about the plan and specifics on the proposed management strategies. Such brochures and fact sheets could be made available at public buildings such as schools, libraries and community centers as well as accommodating commercial establishments. The general public could also be reached through radio public service and local television station announcements, outdoor advertising (*e.g.*, billboards) and general circulation newspapers that feature special articles and regular updates on the implementation of the proposed management strategies.

The targeted portion of the public outreach program would comprise speaking engagements and/or workshops with local civic groups and other organizations to explain how the management strategies can help improve the health of the Forge River estuary. Such events would be hosted by one or more of the stakeholders (*e.g.*, members of the Watershed Advisory Committee or Save the Forge River) and local elected officials. The purpose of these targeted outreach session is to educate civic leaders and build support for the plan. It is anticipated that much public concern and, potentially, public opposition may be generated during the implementation phase of the plan. Such workshops would provide a forum in which details about the strategies would be provided and questions answered.

ACTION ITEMS

- **Provide educational programs** for property owners on implementation of Forge River management strategies.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 25-25. Provide educational programs for property owners (S25)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Owner	1	7	7	7	46
Note: * Weighting					

25.6.3 Short-Term Management Strategy Summary

A summary of the evaluation scores for all of the short-term management strategies is provided in Table 25-26.

Table 25-26. Evaluation scores for short-term management strategies

DRAFT FORGE RIVER MANAGEMENT STRATEGIES - SHORT-TERM (1-3 YEARS) - LOW-MODERATE COST											
Management Strategy		Responsible Parties*					Water Quality Benefit (4)	Cost (3)	Technical & Legal Difficulty (1)	Public Accept-ance (2)	Weighted Total
							Weight: (4) very high, (3) high (2) medium (1)				
		Town	SC	DEC	ACE	Other	1(L)-10(H)	1(H)-10(L)	1(H)-10(L)	1(L)-10(H)	
Land Use Management Strategies											
S1	Establish FR Protection Overlay District (FRPOD) for properties inside 50-yr contributing area	Town					3	7	8	6	53
S2	Explore potential dedicated funding sources such as a FRPOD fee to provide water quality improvement services to property owners	Town					3	8	5	5	51
S3	Create a Forge River Protection (FRP) Fund for program expenditures, green infrastructure and loans to property owners for eligible improvements	Town					4	5	9	6	52
S4	Establish a low-interest loan program for property owners for OWTS improvementswith FRP Fund. Loans repaid via tax bill and stay with property.	Town					4	8	5	4	53
S5	Identify properties for acquisition or purchase of development rights based on location and environmental resources	Town	SC				1	8	5	8	49
S6	Acquire duck farm properties, conduct environmental assessment and prepare remediation plan	Town	SC	DEC			4	5	6	5	47
S7	Impose stricter clearing limits inside the FRPOD to retain existing native, non-fertilizer dependent plants	Town					1	9	5	3	42
Stor											
S8	Replace direct discharge stormwater systems with vegetated swales, and other 'green' treatments	Town					1	4	8	7	38
S9	Adopt a Green Streets policy	Town					1	8	5	5	43
S10	Develop one or more demonstration low-impact stormwater management site	Town					1	5	4	5	33
Nitrogen Reduction Strategies											
S11	Impose strict limits on nitrogen fertilizer use, allowing fertilizer application only in the month of April	Town				Owner	4	8	9	5	59
S12	Develop OWTS installation requirements for replacement systems using Suffolk County Department of Health Services standards as guidelines	Town					4	7	8	3	51
S13	Require inspections of all OWTS.	Town				Owner	4	9	10	2	57
S14	Require pump-outs for all OWTS within the FRPOD every five years through Town ordinance	Town					4	8	8	3	54
S15	Require all OWTS to Meet new Town Requirements	Town				Owner	4	8	7	1	49
S16	Reduce residential water use by requiring dual flush toilets and low-flow faucets for all new bathroom installations or remodels.	Town					1	9	7	2	42
S17	Provide home owners with free water conservation kits	Town					1	6	8	5	40
Water Quality Improvements and Habitat Restoration											
S18	Encourage riparian area restoration by offering tax rebates to property owners for voluntary restoration of the wetland buffer.	Town		DEC		Owner	2	8	6	3	44
S19	Encourage use of indigenous landscape plants by offering tax rebates for their installation	Town				Owner	1	8	7	3	41
S20	Install oyster grow-out system for algal bloom control in priority subwatershed creeks	Town		DEC			5	6	8	6	58
S21	Install surface and water column creek aerators in priority subwatershed creeks	Town		DEC			7	4	8	7	62
Research and Data Collection											
S22	Collect additional groundwater data for determining nitrogen types, concentrations and travel time	Town					3	6	6	6	48
S23	Continue research on benthic flux to determine nitrogen contribution from sediments to water column	Town					4	6	6	7	54
Training, Education, and Stewardship Programs											
S24	Develop methods to reduce agricultural fertilizer use and runoff and work with farmers to implement them	Town				Owner	3	8	5	6	53
S25	Provide educations programs for property owners on implementation of watershed management strategies	Town				Owner	1	7	7	7	46

***Note**: - Town of Brookhaven (Town), Suffolk County (SC), Army Corps of Engineers (ACE), US Geological Survey (USGS), NYS Department of Environmental Conservation (DEC), NYS Department of Transportation (DOT) Suffolk County Department of Health Services (SCDHS), Property Owners (Owners)

****Note:** Coordinate with Town Stormwater Program

26 Mid-Term Management Strategies

26.1 Land Use Management

26.1.1 Acquire Selected Open Space and Direct Development to Developed Areas outside the FRPOD or to Future Sewered Areas in the Watershed (M1)

The criteria established (in the short-term management strategies) for the selection of properties for preservation and their subsequent rankings would guide open space acquisition. The Town of Brookhaven and, potentially, the Village of Mastic Beach would acquire vacant properties that offer the greatest water quality and ecological value to the watershed and the estuary. The implementation of the proposed property acquisition(s) would depend, of course, on the availability of funds and public support. Brookhaven residents, like the majority of Long Islanders, are generally supportive of open space preservation.

Another method of preserving open space is to implement a Transfer of Development Rights (TDR) program within the FRPOD. The FRPOD would be configured as a 'Sending Area,' while selected hamlets and commercial areas outside the FRPOD would be designated as 'Receiving Areas.' The Town's long-term land use strategy encourages development in hamlet centers and commercial areas to preserve green space and the character of single-family neighborhoods. The TDR program provides a mechanism to incentivize development in designated mixed-use centers.

ACTION ITEMS

- Acquire selected open space and direct development to developed areas outside FRPOD or to future sewered areas in the watershed through the Town Transfer of Development Rights (TDR) program.
- Utilize the FRPOD as a 'Sending Area,' and designate selected hamlets and commercial areas outside the FRPOD as 'Receiving Areas.'

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 26-1. Acquire selected open space and direct development areas (M1)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Pine Barrens Comm, Owner	2	4	3	2	28
Note: * Weighting					

26.1.2 Purchase Development Rights for Existing Farms (M2)

The Town and County recognize the value of existing farms to Long Island and have purchased the development rights for thousands of acres of existing farms, including the duck farm properties of the Forge River. The purchase of additional development rights would be guided by the criteria and ranking established in the short-term management strategies.

In addition to the permanent protection of farmland through purchase of development rights, the Town could consider provisions to support local farmers while reducing nitrogen runoff associated with fertilizer applications. The Town should work with representatives of the agricultural industry and researchers from Cornell Cooperative Extension to select crops and management methodologies that require less nitrogen fertilizer. Similarly, farmers should be encouraged to utilize organic farming techniques and integrated pest management that reduce or eliminate the use of pesticides. Greenhouse farming, can, when well-managed, exert greater control over fertilizer applications (with drip 'fertigation' and recirculation), which can thereby reduce total application rates. The potential for visual impacts from greenhouse farming, however, should be reduced using lot coverage limits and a requirement for buffers.

ACTION ITEMS

- Purchase development rights for existing farms.
- Encourage organic farming and IPM
- Permit greenhouse farming with zero pesticide and fertilizer discharge and lot coverage limits that is buffered by vegetation from adjoining uses.

APPLICABLE SUBWATERSHED

- West Mill Pond
- East Mill Pond
- Ely Creek

Table 26-2. Purchase development rights for existing farms (M2)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, Owner	2	3	7	5	36
Note: * Weighting					

26.1.3 Prepare a Land Use Plan for the Jurgielewicz Duck Farm (M3)

Following acquisition and remediation, the Town may wish to establish a new use for the former Jurgielewicz Duck Farm, *i.e.*, one that supports the restoration and long-term

protection of the estuary. The Town purchased the development rights for the duck farm and therefore future uses are limited to agriculture or passive recreation and preserve use. Future agricultural use is inadvisable due to the use of fertilizer and pesticide for most agricultural activities. An agricultural use that required neither fertilizer nor pesticide might be considered, if careful controls and frequent inspections were possible by an independent authority.

Passive recreational use may be more appropriate particularly if preceded by restoration of the duck farm to its original condition comprising wetlands, floodplain forest and upland forest habitats.

The Jurgielewicz Duck Farm is in an important location by the freshwater marshes that flow to the Forge River. The property across the stream from the duck farm is in public ownership and forested. Restoring the riparian area and the stream itself along the duck farm properties would help protect the water that flows into West Mill Pond and from there into the Forge River. The duck farm borders the eastern side of these waters but is highly disturbed. The riparian area should be restored to a condition similar to the western side where forested wetlands support wildlife and protect the headwaters of the Forge River.

ACTION ITEMS:

- Prepare land use and engineering plans for the restoration of the Jurgielewicz Duck Farm.

APPLICABLE SUBWATERSHED

- West Mill Pond

Table 26-3. Prepare Plans for the Restoration of the Duck Farm Properties (M3)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, Owner	3	4	6	4	40
Note: * Weighting					

26.2 Stormwater Management

26.2.1 Provide Treatment Systems at Creek Heads (M4)

There are opportunities to construct wetlands and install other stormwater treatments at the heads of Wills and Poospatuck Creeks and potentially others. Both Poospatuck and Wills creeks have relatively undeveloped creek heads. These areas are the low points of the subwatershed where stormwater is directed flows to and can be treated prior to discharging to the creek. Engineered systems, such as hydrodynamic separators, could be installed on existing drainage pipes. In particular, hydrodynamic separators are designed to have a centrifugal (vortex) action within the chamber. This captures suspended solids (sediment) and the associated contaminants. They also have a baffle component that captures floatables. Other options include wetland treatments, bioretention areas, vegetated swales, or other passive, 'green' stormwater treatments that involve few engineered structures and yet provide treatment and increase infiltration to allow soil bacteria to remove contaminants. This strategy may require the acquisition of undeveloped property, depending on the size of the preferred treatment.

ACTION ITEMS

- Provide stormwater treatment systems at selected creek heads.

APPLICABLE SUBWATERSHED

- Wills Creek
- Poospatuck Creek

Table 26-4. Provide stormwater treatment systems at selected creek heads (M4)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, Owner	4	4	7	5	47
Note: * Weighting					

26.2.2 Provide Treatment for Runoff into Mill Ponds (M5)

Providing treatment for runoff into Mill Ponds from Montauk Highway and into Forge River south of highway could be accomplished by implementing a combination of engineered and 'green' improvements. Since Montauk Highway has an existing network of drainage structures (catch basins and piping), one method for capturing sediment, floatables, and other contaminants (*i.e.* petroleum) is installing catch basin inserts. These inserts catch floatables and sediments and may include filters that are designed to capture a particular contaminant. Another engineered system, the hydrodynamic separator, which

also captures sediment and floatables, could be installed as an end-of-pipe treatment. This is typically located at a large discharge. Other options include wetland treatments, bioretention areas, vegetated swales or other 'green' stormwater treatments. This strategy may require the acquisition of undeveloped property, depending on the size of the preferred treatment. It may also require changes to the drainage systems that discharge to the Mill Ponds.

ACTION ITEMS

- Provide stormwater treatment for runoff into the East and West Mill Ponds and the Forge River from Montauk Highway.

APPLICABLE SUBWATERSHED

- West Mill Pond
- East Mill Pond

Table 26-5. Provide Treatment for Runoff into Mill Ponds (M5)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, Owner, DOT	4	5	7	5	50
Note: * Weighting					

26.3 Nitrogen Reduction

26.3.1 Determine the Total Maximum Daily Load for Nitrogen (M6)

The Town issued a Request for Proposals to establish a Total Maximum Daily Load (TMDL) for nitrogen that would maintain a dissolved oxygen concentration in the estuary above 4.8 mg/L (the DEC standard). The TMDL is critical as it will set the maximum number of pounds of nitrogen that can be loaded into the Forge River from all sources. The necessary nitrogen reduction would be determined from that value. The TMDL value will help determine the most appropriate mid- and long-term management strategies necessary to achieve the nitrogen reduction. It may be possible to achieve the required nitrogen reductions by applying multiple smaller (and less expensive) strategies and fewer of the more expensive techniques.

Proposals from consultants for the TMDL Study have been received by the Town and are currently under review. Funds for this project have already been allocated by the Town.

The TMDL Study will also establish metrics to determine how compliance will be measured, the spatial location for assessment, and the temporal scale assessment.

Source load quantification will include surface water, groundwater, and benthic sediments, which will be sufficient inputs into the receiving water model (see below).

A model based on the source loads will be developed for the Forge River (the receiving water body). The model will: 1) evaluate pollutant loads and water quality responses in the Forge River for existing conditions, 2) identify critical conditions, 3) identify the pollutant loading capacity, and 4) evaluate management strategies to correctly allocate loads to achieve water quality standards. A pollutant loading calculation will be performed which will recommend nitrogen loading capacity (with an appropriate margin of safety). The Town will have the ability to use the model in subsequent watershed management planning activities.

Allocation scenarios will be developed and evaluated for their effectiveness in achieving the new TMDL standard. The scenarios will be adjusted until the compliance metrics are met to guide allocations. These scenarios should include the extent of sewering that may be required.

ACTION ITEMS

- **Determine the Total Maximum Daily Load (TMDL) for nitrogen** that allows for a dissolved oxygen concentration in the estuary above 4.8 mg/L.
- Develop allocation scenarios for each of the various loads.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 26-6. Determine the Total Maximum Daily Load for nitrogen (M6)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC	6	5	5	5	54
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

26.3.2 Develop a TMDL Implementation Plan (M7)

The Town should develop a TMDL implementation plan based on the final allocation scenario that is chosen in conjunction with Forge River stakeholders as part of the TDML Study. The implementation plan should provide preliminary engineering/phasing plans that detail how each of the reductions could be implemented and where. The implementation plan will include the extent and type of sewering, if any, required within the FRPOD. The

same stakeholders that took part in the selection of the final allocation scenario should also be part of the implementation plan.

This plan and phasing of strategies may take into account available funds, legal actions that may be required to acquire land and/or rights and potential sewer district formation. The plan would also include a schedule and develop preliminary annual budgets for the responsible parties. This accounting exercise is necessary in order to provide realistic outcomes for the final allocation scenario and a schedule for the restoration of the Forge River. The schedule would need to take into account groundwater travel time in terms of when each of the strategies would become effective. For example, the effects of sewering within the 20-year groundwater contributing zone might not be seen for 30 years, as the time required to form a sewer district and construct the collection system and treatment plant can be up to 10 years.

ACTION ITEMS

- **Develop a TMDL implementation plan** based on the preferred allocation scenario.
- Provide preliminary engineering/phasing plans that detail how each of the reductions could be implemented and where.
- Include the extent and type of sewering, if any, required within the FRPOD.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 26-7. Develop a TMDL implementation plan (M7)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	8	5	5	2	59
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

26.3.3 Evaluate Need & Locations for Regional Wastewater Treatment Plant (M8)

If the Town or County determines that regional sewering is the best option for meeting the nitrogen TMDL, then a suitable location must be identified. Regionalization may include the adjacent hamlet of Center Moriches or the entire adjacent Moriches peninsula. The County is currently conducting a sewering feasibility study for the downtown area of this adjacent hamlet. The County's Center Moriches Study includes both the Forge River and Moriches Bay groundwater contributing areas. The size and location of a treatment plant required will be determined by many factors including current ownership and the site

preparation required. The technology required and discharge location (either groundwater or surface water), would be determined in part by the results of the TMDL Study.

Should the DEC approve the STP for surface water discharge, the agency would likely require that it meet a discharge limit lower than the current standard of 10 mg/L of total nitrogen.

If groundwater discharge were permitted, the new STP would be required to follow the SPDES limits as determined by the NYSDEC as part of the final allocation scenario of the TMDL Study. A groundwater discharge would be either in the form of recharge basins or subsurface leaching pools, which both have setback requirements. An STP with groundwater discharge would require a larger site than an STP with surface water discharge.

Surface water discharge is another option for an STP. A surface water discharge could help flushing in the head of the estuary.

The duck farm, if acquired as part of the short term strategies, may be a good location for an STP, as it is centrally located, sufficiently large, already disturbed, and has few residential neighbors. Depending on the size of the STP required, the property may also be large enough to permit a substantial riparian restoration that could be utilized for further polishing of the facility's effluent.

Two other potential sites for an STP include the Brookhaven Airport and the Town of Brookhaven's Sewer District #2 STP. A portion of the Brookhaven Airport is currently being considered for a regional STP with groundwater discharge located in the 10-25 year groundwater contributing area of the Forge River. The Town's Sewer District #2 STP located adjacent to the LIE (in the vicinity of the William Floyd Parkway), is located in the 25-50 year groundwater contributing area of the Carman's River. There is currently an STP at this location, however expansion of the STP may be considered.

ACTION ITEMS

- **Evaluate the need for a regional wastewater treatment plant** to serve the FRPOD as well as the adjacent communities of Center Moriches and Mastic.
- Consider locations including the duck farm, Brookhaven Airport, and an expansion of the Town's Sewer District #2.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 26-8. Evaluate the need for a regional wastewater treatment plant (M8)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	4	7	2	3	44
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

26.3.4 Impose Stricter Nitrogen Limits on STPs within the FRPOD (M9)

Stricter nitrogen limits on STPs within the FRPOD would be based on the allocations of the nitrogen TMDL. New developments that exceed density requirements in the Forge River watershed would require an STP. The final allocation scenario from the TMDL Study may recommend that STP discharges to groundwater be lowered from the current SCDHS effluent standard of 10 mg/L nitrogen. The stricter nitrogen standard would take into account the limits of technology and the cost-benefit associated with the potential upgrades

Referencing the TMDL Study's recommendations, the Town could impose a revised limit on all existing and proposed plants within the FRPOD through the State Pollutant Discharge Elimination System (SPDES). When an STP applies for a SPDES permit (for a new plant or a renewal for an existing plant) the NYSDEC sets the new limit based on its requirements or local requirements, whichever is lower. Coordination with SCDHS is also required for this strategy, as they are the agency that enforces the SPDES groundwater discharge limits.

ACTION ITEMS

- Impose stricter nitrogen limits on STPs within the FRPOD based on the nitrogen TMDL.

APPLICABLE SUBWATERSHED

- Ely Creek

Table 26-9. Impose stricter nitrogen limits on STPs within the FRPOD (M9)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	4	8	5	3	53
Note: * Weighting					

26.4 Water Quality Improvements and Habitat Restoration

The County is currently developing a plan to dredge the Forge River and its tributaries for maintenance 'navigational' purposes. Suffolk County includes environmental factors and marine productivity among the criteria it uses to determine if a dredging project is in the public interest. The County's plan should therefore be expanded to recognize the importance of dredging to Forge River water quality. Dredging will not only improve navigation, but tidal circulation as well. The dredging plan should be reviewed by the County's Dredging Projects Screening Committee and should include the following several strategies to improve Forge River water quality.

26.4.1 Dredge Sills at Creek Mouths and at Mouth of the Forge River (M10)

The removal of the deposits at the mouths of selected creeks will increase circulation in the creeks and improve water quality. Sediment has accumulated at the heads of some of the creeks, particularly on the western side of the Forge River. The sediment accumulation is likely due to stormwater runoff and wave or wind-driven circulation that eroded creek banks and deposited the eroded sediments typically on the south side of the creek mouths. The accumulated sediments created sills (blockages) in these locations that impeded the flow of seawater from the main body of the Forge River into the shallower creeks reducing circulation and creating static conditions. The restriction causes a lack of exchange between tidal flow (salt water) and groundwater (fresh water), raises water temperature, and contributes to eutrophic conditions. The restricted circulation thus contributes to higher nitrogen concentrations algal blooms die and settle to the bottom of the creeks rather than being swept out of the estuary. The additional sediment organic matter from the algal blooms further exacerbates the eutrophication. Reduced circulation may also lower creek salinity creating a more suitable environment for the growth of *Phragmites*. The sill at the mouth of the Forge River itself reduces circulation into the main branch of the estuary. Removal of the sills will allow the restoration of adequate tidal flow. This, in turn, will lower water temperature, increase salinity, decrease nitrogen concentrations, and reduce the frequency and intensity of algal blooms.

ACTION ITEMS

- Dredge sills at mouths of creeks.
- Dredge accumulation at the mouth of the Forge River.

APPLICABLE SUBWATERSHED

- Wills Creek
- Poospatuck Creek
- Old Neck Creek
- Home Creek (to a lesser degree)
- Lons Creek (to a lesser degree)

Table 26-10. Dredge sills at creek mouths and at mouth of Forge River (M10)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
SC	8	3	10	8	69
Note: * Weighting					

26.4.2 Remove Deposits South of Montauk Highway (M11)

The discharges from the Mill Ponds enter the Forge River through two large culverts under Montauk Highway where a large area of *Phragmites* spans most of the width of the river less than 100 feet south of the discharges. This peninsula and the mudflats south of it represent years of sediment accumulation deposited primarily from the West Mill Pond discharge. Winter sanding and stormwater runoff from Montauk Highway enters the East Pond by its discharge and is carried directly into the Forge River. The presence of this deposit, in conjunction with the restricted tidal flow under the LIRR trestle, has allowed the adjacent upland to expand into the river. This large deposit is likely due to the deposition of both organic and inorganic materials from the Mill Ponds.

Removal of the substantial deposits at the head of the Forge River will increase water depths and circulation in this portion of the estuary while the removal of the invasive reed *Phragmites* will increase available area for other plant species and benthic organisms.

ACTION ITEM

- Remove deposits downstream of the Mill Pond discharges including *Phragmites.*

APPLICABLE SUBWATERSHED

- West Mill Pond
- East Mill Pond

Table 26-11. Remove deposits south of Montauk Highway (M11)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
SC	5	3	8	6	51
Note: * Weighting					

26.4.3 Remove Deposits by LIRR Trestle (M12)

The LIRR trestle has restricted tidal flow for a portion of the Forge River. This has resulted in a brackish water body north of the trestle with poor circulation that has wide

swings in salinity. The brackish conditions and disturbances have made conditions suitable for the growth of *Phragmites*.

The removal of flow restrictions will increase circulation between the main body of the Forge River and the upper Forge area between Montauk Highway and the trestle. An increase of circulation between these two areas of the Forge River will lower temperatures, increase salinity, and help support a greater diversity of aquatic wildlife.

ACTION ITEM

- **Dredge by the LIRR trestle** to improve flushing of the Forge River estuary north of the railroad trestle, increase salinity, and reduce the growth of *Phragmites*.

APPLICABLE SUBWATERSHED

- Upper Forge East
- Upper Forge West

Table 26-12. Dredge by the LIRR trestle (M12)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
SC	6	5	10	8	67
Note: * Weighting					

26.4.4 Deepen Ely Creek (M13)

Ely Creek has one of the largest groundwater contributing areas and yet has one of the smallest areas of open water. The shallow depth of Ely Creek – which is a mud flat at low tide – severely limits circulation and thus degrades water quality. The topography immediately adjacent to Ely Creek is flatter than the creeks on the west side of the Forge River. This gradual topography and large contributing area may have influenced its shallow depth. The creek's bottom is currently classified as "unconsolidated sediments". This shallow muddy substrate prohibits tide water from reaching the creek head. Restricted title flow lowers salinity, increases the growth of *Phragmites* , and reduces habitat for intertidal vegetation. As a consequence, Ely Creek supports a far less diverse environment for aquatic organisms.

In addition, *Phragmites* thrives under such conditions spreading further into the creek and its riparian areas, particularly in the upper portions. Ely Creek should be deepened to improve tidal circulation and reduce *Phragmites* growth.

ACTION ITEM

- Deepen Ely Creek to improve tidal circulation and reduce *Phragmites* growth.

APPLICABLE SUBWATERSHED

- Ely Creek

Table 26-13. Deepen Ely Creek (M13)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
SC	6	5	10	8	67
Note: * Weighting					

26.4.5 Harvest and Dispose of Ulva (M14)

Ulva lactuca, a type of Sea Lettuce, inhabits bodies of water from the low tide mark up to ten feet of water depth. *Ulva* is a free floating algae that is attached to the bottom, often forming dense mats at the water's surface. *Ulva*, grows rapidly in high nitrogen waters and may inhibit the growth of other algal species.

The *Ulva* should be removed to eliminate a major source of organic nitrogen to the sediments. Ulva blooms after it has used the available nitrogen. The oxygen level has then declines precipitously as a result of algal respiration. The *Ulva* then dies and falls to the bottom and it decays. Bacterial decay of the *Ulva* removes additional oxygen and releases inorganic nitrogen to the sediment. Benthic flux then returns that nitrogen to the water column, continuing the cycle.

Previous studies examined removal of *Ulva* by hand and by machine. One study collected readings of turbidity and dissolved oxygen before and after *Ulva* removal to determine changes in water quality. Another study by the New York City Department of Environmental Protection in Jamaica Bay, was conducted to assess the total nitrogen and phosphorus reduction. Results were not reported. The NYCDEP used a custom made algae skimmer with a removal rate of 1.9 m^3 (or 67 ft^3) in 90 minutes of skimming. The Town should investigate the use of an algae skimmer for the Forge River and other eutrophied waterbodies. Collected Ulva could be composted or dried and used as biofuel.

ACTION ITEM

- **Harvest and dispose of *Ulva*** to remove the assimilated nitrogen and avoid the aesthetic and water quality problems engendered by its decay.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 26-14. Harvest and dispose of Ulva (M14)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC	8	5	9	6	71
Note: * Weighting					

26.4.6 Restore Native Riparian Vegetation on Public Land (M15)

Riparian vegetation provides multiple environmental benefits to the Forge River and its upland and aquatic wildlife. Riparian vegetation includes woody species, grasses, sedges, rushes and forbs. The vegetation provides creek bank stabilization, which reduces erosion. The leafy stems trap sediment from overland flow, preventing it from entering the waterbody. Studies have also shown that riparian vegetation has the ability to denitrify, releasing 25-35 lbs. of nitrogen (in a gaseous state) per acre per year. A riparian buffer, of 25-ft from the high water line inward, is required by current Town of Brookhaven Wetland and Waterways code. Riparian buffer areas serve a vital role between landscaped residential areas and the surface water of the Forge River for both contaminant and nutrient removal from stormwater. Many riparian areas along the Forge River, however, have been eroded or overrun by exotic and invasive plants. Some of these areas are under Town ownership and should be restored.

ACTION ITEM

- **Restore native riparian vegetation** including tidal wetlands and high marsh on public property.
- Reduce road width where possible to expand riparian area.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 26-15. Restore native riparian vegetation on public land (M15)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC	2	5	5	5	38
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

26.5 Research and Data Collection

26.5.1 Measure Nitrogen Removal by *Phragmites*, Spartina, and Mudflats (M16)

The invasive common reed *Phragmites* and *Spartina*, a native, are known to serve an important role in removing nitrogen from surface waters and the waters of the interstitial areas of tidal wetland sediment. Bacteria associated with the roots of both *Phragmites* and *Spartina* also play a significant role in nitrogen degradation in tidal area soils. Intertidal areas that are devoid of vegetation (mudflats) support the growth of bacteria which are important in the nitrogen cycle.

What is not known are the different rates of nitrogen degradation by *Phragmites*, *Spartina* and mudflats. It is important to be able to quantify the amount of nitrogen removed from groundwater by the plants and soil bacteria found in mudflats.

If the plants are proven to be effective nitrogen removers, they might be harvested annually to remove the nitrogen from the estuary. It may be, however, that soil bacterial are as effective as *Phragmites*. In this case, there would be a strong argument for the removal of the invasive *Phragmites*. If *Phragmites* is shown to be more effective, however, then annual cutting and disposal would be advisable.

ACTION ITEMS:

- **Measure groundwater nitrogen removal by *Phragmites, Spartina,* and mudflats**.
- Consider harvesting *Phragmites* annually if an effective nitrogen remover.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 26-16. Measure Nitrogen Removal by Phragmites, Spartina, and Mudflats (M16)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town	3	7	5	7	50
Note: * Weighting					

26.5.3 Test Permeable Reactive Barriers for Groundwater Nitrogen Removal and Obtain Conservation Easement in Priority Subwatershed (M17)

Permeable reactive barriers (PRBs) can be used for removing nitrogen from groundwater in high-nitrogen watersheds, preferably in a riparian conservation easement. Permeable reactive barriers are groundwater treatment systems that are installed in a trench upgradient of the shoreline. They utilize non-toxic materials like wood chips and vegetable oil as a substrate for bacteria to remove nitrogen from groundwater. If as effective as reported, PRBs could significantly reduce nitrogen loading from groundwater into the estuary.

The installation of a demonstration PRB upgradient of the shoreline would test the PRBs ability to denitrify groundwater prior to release to the Forge River. Groundwater monitoring wells would be required to measure the nitrogen concentrations both up and downgradient of a PRB. Installation would require an area that could be accessible to excavation equipment. Temporary sheeting would be required for installation. The depth of the sheeting would be determined by data collected from groundwater monitoring wells.

The installation of the PRB would likely require a conservation easement from the property owner for the Town to install and monitor the device. Easements would likely conform to the Town's Wetland and Waterways code that requires a 25-foot buffer of native plantings.

Development of much of the Forge River shoreline, however, predates these regulations and is consequently devoid of the buffer.

An easement would also grant the homeowner the right to access the water (and existing docks) via a proscribed walkway. It would grant the Town the right to install certain types of groundwater treatment devices that would not obscure the property owner's view of or access to the water. It would also permit the Town to restore the shoreline in the easement area (riparian buffer) according to an approved design and maintenance plan. Restoration and long-term management of the easement area could be contracted to an appropriate non-profit. Properties with conservation easements would have their tax assessment lowered. Property owners could utilize the tax savings from the reduced assessment to fund any required improvements to their onsite wastewater treatment system.

ACTION ITEM

- **Test permeable reactive barriers (PRBs)** for their effectiveness in removing nitrogen from groundwater.
- Obtain conservation easement for installation in a priority subwatershed riparian zone.

APPLICABLE SUBWATERSHED

- Poospatuck Creek or
- Wills Creek or
- Ely Creek

Table 26-17. Test permeable reactive barriers for groundwater nitrogen removal (M17)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC, SCDHS	6	5	4	3	50
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

26.5.4 Test Nitrogen Reduction by Septic System Bio-Augmentation (M18)

Bio-augmentation is the addition of selected bacterial strains to septic systems to improve biological nitrogen degradation. Strains of bacteria have been developed that are more effective at degrading nitrogen that those found in conventional systems. These proprietary strains of bacteria are non-disease causing. Modifications may also be necessary to septic systems to increase bio-augmentation effectiveness.

ACTION ITEM

- Test septic system bio-augmentation to improve OWTS nitrogen removal.
- Determine if septic system modifications can increase bio-augmentation effectiveness.

APPLICABLE SUBWATERSHED

- Poospatuck Creek or
- Wills Creek or
- Ely Creek

Table 26-18. Test septic system bio-augmentation to improve OWTS nitrogen removal (M18)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SCDHS	3	6	5	4	44
Note: * Weighting					

26.5.6 Test Nitrogen Reduction by Groundwater Bio-Augmentation (M19)

Bio-augmentation may also be effective in reducing groundwater nitrogen. Groundwater bio-augmentation and carbon source injection can create the conditions necessary to stimulate the growth and survival of the anaerobic bacteria required for denitrification. Groundwater bio-augmentation could increase nitrogen removal from groundwater through the use of non-disease causing bacteria and a non-toxic carbon source such as vegetable oil or molasses.

ACTION ITEM

- **Test groundwater bio-augmentation and carbon source injection for nitrogen removal.** Test various bacterial species and carbon sources for their effectiveness in removing groundwater nitrogen.

APPLICABLE SUBWATERSHED

- Poospatuck Creek or
- Wills Creek or
- Ely Creek

Table 26-19. Test groundwater bio-augmentation to improve nitrogen removal (M19)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC, SCDHS	3	5	5	3	40
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

26.5.7 Mid-Term Management Strategy Summary

A summary of the evaluation scores for all of the mid-term management strategies is provided in table 5-20.

Table 26-20. Evaluation scores for mid-term management strategies

DRAFT FORGE RIVER MANAGEMENT STRATEGIES - MID-TERM (3-5 YEARS) - MODERATE-HIGH COST											
Management Strategy		Responsible Parties*					Water Quality Benefit (4)	Cost (3)	Technical & Legal Difficulty (1)	Public Accept-ance (2)	Weighted Total
							Weight: (4) very high, (3) high (2) medium				
		Town	SC	DEC	ACE	Other	1(L)-10(H)	1(H)-10(L)	1(H)-10(L)	1(L)-10(H)	
Land Use Management Strategies											
M1	Acquire selected open space and direct development to developed areas outside FRPOD or to future sewered areas in watershed through TDR program. FRPOD as 'Sending Area,' downtowns & commercial areas outside FRPOD	**Town**				**Pine Barrens Comm., Owners**	2	4	2	3	28
M2	Purchase development rights for farms in watershed. Allow greenhouse farming with lot coverage limits.	**Town**	**SC**			**Owners**	2	3	5	7	36
M3	Prepare land use plans for restoration of duck farm properties. Consider property for regional STP.	**Town**	**SC**				3	4	4	6	40
Stormwater Management Strategies											
M4	Provide stormwater treatment systems at creek heads - may require property acquisitions	**Town**	**SC**			**Owners**	4	4	5	7	47
M5	Provide stormwater treatment for runoff into the Mill Ponds and FR from Montauk Highway.	**Town**	**SC**			**Owners, NYSDOT**	4	5	5	7	50
Nitrogen Reduction Strategies											
M6	Determine TMDL for nitrogen	**Town**		**DEC**			6	5	5	5	54
M7	Develop a TMDL implementation plan based on the preferred allocation scenario	**Town**	**SC**	**DEC**			8	5	2	5	59
M8	Evaluate need and locations for a regional wastewater treatment plant	**Town**	**SC**	**DEC**			4	7	3	2	44
M9	Impose stricter nitrogen effluent limits on STPs within FRPOD based on nitrogen TMDL	**Town**					4	8	3	5	53
Water Quality Improvements and Habitat Restoration											
M10	Dredge sills at mouths of creeks and accumulation at mouth of Forge River		**SC**				8	3	8	10	69
M11	Remove deposits downstream of East and West Mill Pond discharges including Phragmites.		**SC**				5	3	6	8	51
M12	Dredge in vicinity of LIRR trestle to improve flushing of waterbody north of trestle.		**SC**				6	5	8	10	67
M13	Deepen Ely Creek to improve tidal circulation and reduce Phragmites growth.		**SC**				5	3	5	9	52
M14	Harvest and dispose of Ulva to remove assimilated nitrogen and its associated water quality problems	**Town**	**SC**				8	5	6	9	71
M15	Restore riparian vegetation including tidal wetlands and high marsh on public property and reduce road width where possible to expand riparian area.	**Town**		**DEC**			2	5	5	5	38
Research and Data Collection											
M16	Measure groundwater nitrogen removal by Phragmites, Spartina, and a mud flat.	**Town**					3	7	7	5	50
M17	Test permeable reactive barrier pilot system in high nitrogen subwatershed, preferably in riparian conservation easement	**Town**		**DEC**		**SCDHS**	6	5	3	4	50
M18	Test bioaugmentation in septic systems to improve OWTS efficiency	**Town**				**SCDHS**	3	6	4	5	44
M19	Test groundwater bioaugmentation and carbon source injection for nitrogen removal effectiveness	**Town**		**DEC**		**SCDHS**	3	5	3	5	40

***Notes:** - Town of Brookhaven (Town), Suffolk County (SC), Army Corps of Engineers (ACE), US Geological Survey (USGS), NYS Department of Environmental Conservation (DEC), NYS Department of Transportation (DOT) Suffolk County Department of Health Services (SCDHS), Property Owners (Owners)

****Note**: Water quality benefit for experimental treatments assumes reported effectiveness

27 Long-Term Management Strategies

27.1 Land Use Management

27.1.1 Implement the Land Use Plan for the Jurgielewicz Duck Farm (L1)

The Jurgielewicz Duck Farm – which historically has been a major detriment to the estuary – has shut down. The site would be investigated and any contamination and residual duck waste removed in the short term. Riparian area restoration would follow in the mid-term. Plans for the property's use would be developed in the mid-term and implemented in the long-term. The property could serve a significant future role in the Forge River's restoration and rehabilitation. . The Town of Brookhaven would be the party responsible for the implementation of this land use plan.

ACTION ITEM

- Implement the land use plan for the duck farm properties for the uses determined by the Town and community to be most appropriate for the restoration of the estuary.

APPLICABLE SUBWATERSHED

- West Mill Pond

Table 27-1. Restore the duck farm properties (L1)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	2	3	9	4	39
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

27.2 Nitrogen Management

27.2.1 Install Permeable Reactive Barriers (L2)

Install permeable reactive barriers if proven effective, in the riparian area of selected high priority creeks to remove historic groundwater nitrogen. This would require securing conservation easements for the installation, monitoring, and maintenance of the systems from property owners. The extent of PRB installation would be determined in part by the results of the TMDL Study. It may be that other nitrogen reductions are sufficient to achieve the TMDL. It may be that PRB's are only recommended in one or two of the most impaired creeks.

ACTION ITEMS

- **Install permeable reactive barriers** if proven effective, in the riparian area of selected high priority creeks to remove historic groundwater nitrogen.

- Secure conservation easements for the installation, monitoring, and maintenance of the systems from property owners.
- Determine extent of installation based on extent of TMDL.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-2. Install permeable reactive barriers (L2)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	10	1	2	2	49
Note: * Weighting					

27.2.2 Pump Groundwater to Treatment Location (L3)

Intercepting groundwater by installing wells and pumping to an existing or restored freshwater treatment wetland or reed bed, is a long term strategy that requires additional data collection. However, it may be an approach that would decrease the nitrogen concentration in groundwater while augmenting the flow of the Forge River with freshwater with lower nitrogen concentrations. Additional groundwater flow and water quality data would be needed to determine the appropriate zone of influence of the wells and the most effective locations for their installation. Water quality data would also be used to evaluate the wetland detention time needed to reduce the nitrogen concentration. Horizontal and vertical flow wetlands can provide both nitrification and denitrification.

Other considerations would include proximity of wells to drinking water wells and surface water. The cost and feasibility of moving and treating large volumes of water would need to be measured against the costs of other treatment options.

ACTION ITEMS

- Pump groundwater to freshwater treatment wetlands.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-3. Pump groundwater to treatment locations (L3)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	10	1	5	3	56
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

27.2.3 Improve Operation of Private STPs (L4)

The three existing STPs inside the Forge River Watershed contribute a total of 25 lbs./day of nitrogen to groundwater and the estuary. Not all of the STPs consistently meet the existing SPDES discharge limits. As discussed in mid-term strategies, the final allocation strategy of the TMDL Study may recommend a stricter nitrogen effluent limit for theses STPs. Modification of these STP's SPDES permits would be the instrument used to implement this. There may be opportunities for STP upgrades or potential expansions.

Should the strategy for a regional STP be implemented, it may be cost-beneficial to consolidate the flow from a poorly performing STP to the new regional facility. By closing the treatment portion of the facility and converting it to a pump station. This would increase the population being served by the STP, thus lowering the cost per user.

An existing STP may also have the potential to be considered for a regional plant. For example, the Waterways at Bay Pointe STP is centrally located and may have sufficient land for an expansion of the facility to handle a portion of the Forge River study area's wastewater. However, the site may not have sufficient land for groundwater recharge. Therefore, an alternative site may be required for recharge only.

If a regional STP is not considered, Suffolk County Department of Public Works (SCDPW) may choose to acquire the non-compliant STPs and operate them with County staff. Should this occur, an upgrade of these facilities might be required to meet not only County standards, but also the stricter nitrogen limits that may be implemented as a result of the TMDL.

Since this strategy involves many parties (NYSDEC, SCDHS, SCDPW, STP owners), coordination should start immediately after the final allocation strategy is chosen for the TMDL Study.

ACTION ITEMS

- **Improve the operation of private STPs** for additional nitrogen removal or,
- Convert to pump stations connected to a future regional STP.

APPLICABLE SUBWATERSHED

- Ely Creek

Table 27-4. Improve the operation of private STPs (L4)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
SC, DEC, Owners	4	3	5	8	43
Note: * Weighting					

27.2.4 Sewer Part or All of the FRPOD (L5-L8)

Prior engineering studies and those currently in progress may assist in determining the most advisable sewering strategy for the Forge River and adjacent communities. The TMDL implementation plan may identify the need for and extent of sewering required for nitrogen reduction. Plans for achieving the goals of the TMDL will be required and may include the following sewering options: a) construct a conventional collection system and treatment plant, or b) construct advanced onsite systems for individual FRPOD parcels to avoid collection system cost, or c) collect septic system effluent from all FRPOD parcels and treat it at a centralized community STP, or d) incorporate adjacent areas (Mastic, Shirley and Center Moriches) into the sewer district to reduce per parcel cost and expand environmental benefits.

a) **(L5) - Construct a conventional collection system and treatment plant**. Suffolk County Department of Public Works (SCDPW) completed a sewering feasibility study in the Mastic-Shirley area in January 2009. Below are descriptions of the sewered areas as well as the estimated annual cost per parcel.

Mastic - Mastic Beach - Shirley Alternative #1

Sewered Area: The business district on Montauk Highway from the Forge River to William Floyd Parkway, all parcels east of William Floyd Parkway to the Forge River and north of Neighborhood Road (including those parcels on Neighborhood Road). This alternative includes both commercial and residential parcels.

Estimated annual cost per parcel: $7,500

Mastic - Mastic Beach - Shirley Alternative #2

Sewered Area: All parcels along Montauk Highway from the Forge River to William Floyd Parkway, parcels on William Floyd Parkway from the Montauk Highway to Neighborhood Road and parcels on Neighborhood Road from William Floyd Parkway to the Forge River. This alternative focuses on commercial parcels; some residential parcels fall within the commercial areas intended for sewering.

Estimated annual cost per parcel: $30,000

Mastic - Mastic Beach - Shirley Alternative #3

Sewered Area: The business district on Montauk Highway from the Forge River to William Floyd Parkway. This alternative focuses on commercial parcels; some residential parcels fall within the commercial areas intended for sewering.

Estimated annual cost per parcel: $28,000

The County report also included groundwater simulation results where the average total nitrogen concentration was reported in shallow groundwater before and after sewering. The results included sewering just main Street as well as sewering the entire area:

Existing conditions:	12.58 mg/L
Re-development conditions:	
• No Sewers	15.05 mg/L
• Sewering Main Street	14.30 mg/L
• Sewering Entire Study Area	4.08 mg/L

The County study verifies that sewers are needed to affect a substantial reduction in groundwater nitrogen concentration. The high cost per property for conventional sewers would, however, impose an economic burden on property owners without public funding.

ACTION ITEM

- **Sewer part or all of the FRPOD**.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-5. Sewer part or all of the FRPOD (L5)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
DEC, Owner	8	1	2	4	43
Note: * Weighting					

b) **(L6) - Construct advanced on-site systems for individual FRPOD parcels to avoid collection system cost**.

Suffolk County is conducting an Innovative/Alternative On-Site Sewage Disposal Systems Study to determine the effectiveness of multiple advanced onsite systems. Thirteen manufacturers were selected by the consultant to examine for use at individual homes. Eight manufacturers were selected by the consultant for detailed examination for use in small communities (~100 homes). These systems are currently in use in other parts of the country, but are being tested at a controlled site to determine if they can meet Suffolk County's 10 mg/L effluent standard for total nitrogen. If the units cannot consistently meet SCDHS standards, additional tertiary treatment may be required. Once SCDHS approves a system, it could be installed throughout the County. Costs for such single-family house systems are estimated at $20,000 per unit plus maintenance costs. If SCDHS approves one or more of these systems, property owners may be able to secure an installation loan through the FRP Fund.

ACTION ITEM

- **Construct advanced on-site systems** for individual FRPOD parcels

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-6 Construct advanced on-site systems (L6)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC, SCDHS, Owner	8	2	2	4	46
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

c) (L7) - Collect septic system effluent from all FRPOD parcels and treat it at a centralized community STP.

Inspections of and improvements to existing OWTSs would be required to bring them into compliance with current SCDHS standards prior to implementing this strategy. This concept involves the collection of wastewater that has been pretreated by OWTS septic tank. Such pretreatment lowers nitrogen concentrations as compared to typical wastewater. Since the septic tank removes settleable solids, the diameter of sewer collection pipes could be reduced and minimum pipe slope requirements could be relaxed as high velocity is only required to keep solids from settling in the pipe. The reduction in slope requirements reduces the required burial depth, which is useful in flat areas and areas with high groundwater.

Portions of the Village of Patchogue are using these low pressure collection systems. In addition, pump-out of septic tanks would be required with hauling of sludge to a permitted facility (*i.e.*, Bergen Point). Therefore, an ordinance requiring scheduled septic tank pump-outs would be required as recommended elsewhere in this document. Small diameter pressure sewers do not function in the event of a power failure.

The initial costs of such a system is likely to be less than a conventional system due to the smaller diameter pipe, reduced dewatering, and reduced treatment required. However, operation and maintenance costs would be similar and property owners would be required to pump-out their septic tanks regularly.

ACTION ITEMS

- **Collect septic system effluent from all FRPOD parcels and treat it at a centralized community STP**.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-7. Collect septic system effluent from all FRPOD parcels (L7)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC, SCDHS, Owner	8	1	2	4	43
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

d) **(L8) - Incorporate adjacent areas (Mastic, Shirley, and Center Moriches) into the sewer district to reduce per parcel cost and expand environmental benefits**.

The Town or County may determine that regional sewering is the best option for meeting the nitrogen TMDL for the Forge River. A regional system may include the adjacent hamlets of Center Moriches, Mastic, and Shirley. These areas are characterized by concentrated development, high groundwater, and groundwater discharge to Moriches Bay. Sewering would reduce groundwater nitrogen concentrations and thereby lower nitrogen loading to the estuary.

Sewering could also benefit the hamlet centers of these communities (Montauk Highway and Neighborhood Road). Sustaining these 'hamlet centers' is important to the surrounding communities. To compete effectively with area malls and larger commercial corridors, hamlet centers must provide sufficient necessities, unique merchandise, local dining, and cultural offerings to draw customers. Expansion by some of the businesses in these commercial districts is constrained by sanitary flow restrictions. Sewering can help retain existing businesses by allowing then to expand and can make it possible for new businesses to locate there.

A regional sewer district would spread costs over a greater number of property owners and thereby impose a more equitable tax on those in the larger district. Regionalizing sewage treatment would also increase the likelihood of government subsidies (financing incentives, grants, etc.) that would further lower costs. Land costs, maintenance, and administration (*i.e.*, 'spread costs') would likely be lower for a regional plant than a series of smaller local plants. In addition, oversight and good O&M practices are easier to deliver in a regional plant than in multiple small ones.

ACTION ITEMS

- Incorporate adjacent areas (Mastic Shirley and Center Moriches) into the sewer district to reduce per parcel cost and expand environmental benefits.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-8. Incorporate adjacent areas (L8)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, DEC, SCDHS, Owner	8	1	2	3	42
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

27.3 Water Quality Improvements and Habitat Restoration

27.3.1 Pump Bay Water to Head of Forge River and Priority Creeks (L9)

Pumping bay water to the head of the Forge River and the priority creeks would increase circulation and oxygen concentrations, while reducing temperatures and nitrogen concentrations. Such a strategy would not be a long-term solution, as nitrogen concentrations would not be reduced throughout the entire estuary. Rather, higher nitrogen water would be moved from circulation-restricted creeks to the main body of the Forge River and thereby to Moriches Bay. Such a system could increase aquatic wildlife habitat in the creeks and could improve the aesthetics of the highly eutrophied creeks.

This strategy would require a substantial investment in pumping equipment and operational costs. Due to these high costs, this strategy might operate in limited months (*i.e.* spring months when algal blooms are prevalent as well as warmer months when the creeks are more stagnant).

ACTION ITEM

- **Pump bay water to the head of the Forge River and into the priority creeks** to increase circulation and increase dissolved oxygen to support marine life.

APPLICABLE SUBWATERSHED

- Poospatuck Creek
- Wills Creek
- Ely Creek
- Upper Forge East
- Upper Forge West

Table 27-9. Pump bay water to head of the Forge River and priority creeks (L9)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	4	3	4	5	38
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

27.3.2 Dredge to Remove Accumulated Organic Material (L10)

Long-term dredging could remove accumulated organic matter from the estuary if determined effective by benthic flux studies. Organic material accumulates in the Forge River estuary and particularly in the creeks as a result of the high nitrogen groundwater stimulating algal blooms that subsequently die and settle to the bottom. The decaying algal material on the bottom is degraded by bacteria which convert the organic nitrogen into inorganic nitrogen and release it into the water column. Removal of this organic material from the bottom sediments, in particular from top several centimeters of sediments, may be a method of removing a significant nitrogen contribution to the water column. Further benthic flux studies will help determine if this strategy could be effective.

The County is planning to dredge the Forge River and its tributaries for 'navigational' purposes. The County's dredging plan for the Forge River should include long-term removal accumulated nitrogen-rich sediments if future benthic flux studies demonstrate that such an initiative could lower water-column nitrogen. In addition, as described in a prior strategy, the Barnes Road and Titmus duck farm properties should be evaluated for acquisition and possible temporary use for dredge spoil management (dewatering, composting, staging).

ACTION ITEMS

- **Institute a long-term dredging operation** to remove accumulated organic matter from the estuary if proven effective at lowering water column nitrogen.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-10. Dredge to remove accumulated organic material (L10)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
Town, SC, DEC	7	5	8	3	62
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

27.3.3 Fill Creek Depressions (L11)

Depressions were created in the creeks through dredging operations. Such depressions, however, create stagnant water areas which, in turn, promote anoxic conditions. The filling of these creek depressions with sand would eliminate stagnant, anoxic areas. Eliminating these depressions would also help improve circulation, increase dissolved oxygen, and lower temperatures in the affected creeks. This strategy would also create additional benthic aquatic habitat. Such filling would require a tidal wetland permit and special approval from the DEC.

ACTION ITEM

- Fill creek depressions with sand to eliminate stagnant anoxic areas.

APPLICABLE SUBWATERSHED

- Wills Creek
- Poospatuck Creek
- Old Neck Creek
- Home Creek (to a lesser degree)
- Lons Creek (to a lesser degree)

Table 27-11. Fill creek depressions (L11)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
SC, DEC	4	5	5	3	44
Note: * Weighting					

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

27.3.4 Maintain Moriches Inlet (L12)

Studies by the School of Marine and Atmospheric Science at SUNY Stony Brook (SoMAS) have shown that during times when Moriches Inlet was dredged that the tidal range inside Moriches Bay was greater. Subsequently, the tidal range inside the Forge River was also affected. The summer temperatures of these water bodies declined as well as the rise/improvement of dissolved oxygen and conditions for aquatic organisms. This strategy would have to be implemented through long-term maintenance of Moriches Inlet through regular dredging.

ACTION ITEM

- **Conduct long-term maintenance dredging of Moriches Inlet** to improve flushing of Moriches Bay and the Forge River.

APPLICABLE SUBWATERSHED

- Entire Watershed

Table 27-12. Maintain Moriches Inlet (L12)

Responsible Party(s)	Water Quality Benefit (4*)	Cost (3*)	Public Acceptance (2*)	Technical & Legal Difficulty (1*)	Weighted Total
	1(L)-10(H)	1(H)-10(L)	1(L)-10(H)	1(H)-10(L)	
ACE	5	3	5	1	40
Note: * Weighting					

27.3.5 Long-Term Management Strategy Summary

A summary of the evaluation scores for all of the mid-term management strategies is provided in table 6-13.

Table 27-13. Evaluation scores for long-term management strategies

DRAFT FORGE RIVER MANAGEMENT STRATEGIES - LONG-TERM (5-10 YEARS) - HIGH COST											
Management Strategy		Responsible Parties*					Water Quality Benefit (4)	Cost (3)	Technical & Legal Difficulty (1)	Public Accept-ance (2)	Weighted Total
							Weight: (4) very high, (3) high (2) medium (1) low				
		Town	SC	DEC	ACE	Other	1(L)-10(H)	1(H)-10(L)	1(H)-10(L)	1(L)-10(H)	
Land Use Management Strategies											
L1	Implement the land use plan for the duck farm properties to support restoration of the Forge River	**Town**	**SC**	**DEC**			2	3	4	9	39
Nitrogen Reduction Strategies											
L2	Install permeable reactive barriers (if proven effective) in riparian area of all high priority creeks to remove historic groundwater nitrogen.	**Town**	**SC**	**DEC**			10	1	2	2	49
L3	Pump groundwater to treatment location which may be a wetland or denitrification reactor (large volumes of water are involved)	**Town**	**SC**	**DEC**			10	1	3	5	56
L4	Improve operation of private STPs by upgrading for additional nitrogen removal or connect private STPs to future regional STP		**SC**				4	3	8	5	43
L5	Sewer entire FRPOD. Construct conventional collection system and treatment plant **OR**			**DEC**		**Owner**	8	1	4	2	43
L6	Construct advanced onsite systems for individual FRPOD parcels; avoids collection system cost, but requires regular maintenance **OR**	**Town**		**DEC**		**Owner**	8	2	4	2	46
L7	Collect septic system effluent from all FRPOD parcels, treat at centralized community STP **OR**	**Town**		**DEC**		**Owner**	8	1	4	2	43
L8	Incorporate adjacent areas (Mastic Shirley and Center Moriches) to reduce per parcel cost and expand environmental benefits.	**Town**		**DEC**		**Owner**	8	1	3	2	42
Water Quality Improvements and Habitat Restoration											
L9	Pump bay water to head of Forge River and priority creeks to increase circulation, reduce algal blooms, and increase dissolved oxygen.	**Town**	**SC**	**DEC**			4	3	5	4	38
L10	Institute long-term dredging operation to remove accumulated organic matter from estuary if determined effective by benthic flux studies.	**Town**	**SC**	**DEC**			7	5	3	8	62
L11	Fill creek depressions with sand to eliminate stagnant anoxic areas (presumptively incompatible with wetland permit - requires DEC approval)		**SC**	**DEC**			4	5	3	5	44
L12	Conduct long-term maintenance dredging of Moriches Inlet to improve flushing of Moriches Bay and FR.					**ACE**	5	3	1	5	40

*Notes: - Town of Brookhaven (Town), Suffolk County (SC), Army Corps of Engineers (ACE), US Geological Survey (USGS), NYS Department of Environmental Conservation (DEC), NYS Department of Transportation (DOT) Suffolk County Department of Health Services (SCDHS), Property Owners (Owners)

28 Phasing of Management Strategies

28.1 Introduction

This portion of the plan prioritizes the proposed management strategies and recommends their phasing in order to achieve water quality improvement and habitat restoration goals. The categorization of the management strategies by short-, mid- and long-term implementation periods, as provided in Section 4 through 6 above, establishes an initial phasing of the strategies. The scoring of each of the strategies according to the four evaluation criteria, however, permits a ranking, or prioritization, of the strategies within the short-, mid- and long-term strategy categories. Thus, the strategies that received the highest scores should be considered for earliest implementation. Furthermore, depending upon the availability of funding, it may be possible to implement only a portion of the management strategies. Under such conditions, the highest ranked strategies would offer the greatest benefit for the available funding.

In addition to phasing, certain strategies require sequencing within or across the short-, mid- and long-term management periods. For example, the efficacy of certain long-term strategies for nitrogen removal must be proven through either short- or mid-term strategies that involve research and testing. There is also a group of short-term strategies that share a degree of interdependence, *i.e.*, the implementation of one short-term strategy requires the completion of a related strategy. The selection of appropriate long-term management strategies is also highly dependent upon the preferred allocation scenario to be defined by the TMDL development, a mid-term management strategy. The phasing of the management strategies – which includes their proper sequencing where applicable is presented in Sections 7.2 through 7.4 below for the short-, mid-, and long –term strategies.

28.2 Phasing of Short-Term Management Strategies

Short-term strategies are ranked in descending order in Table 28-1 according to their scores, which range from 33 to 62. The six highest ranked strategies, *i.e.*, the top one-quarter of the short-term set, are S23, S14, S13, S20, S11, and S21. With scores ranging from 54 to 62, these strategies occupy the first tier of the rankings and are recommended for earliest implementation. Strategy S21, which provides for the installation of surface and water column aerators, is the highest ranked strategy. With a value of 7 for Water Quality Benefit, S21 offers the highest possible improvements to water quality among all of the short-term strategies.

Table 28-1. Ranking of short-term management strategies by weighted total

Management Strategy		Water Quality Benefit	Cost	Technical & Legal Difficulty	Public Acceptance	Weighted Total
S21	Install surface and water column creek aerators in priority subwatershed creeks	7	4	8	7	62
S11	Impose strict limits on nitrogen fertilizer use, allowing fertilizer application only in the month of April	4	8	9	5	59
S20	Install oyster grow-out system for algal bloom control in priority subwatershed creeks	5	6	8	6	58
S13	Require inspections of all OWTS	4	9	10	2	57
S14	Require pump-outs for all OWTS within the FRPOD every five years through Town ordinance	4	8	8	3	54
S23	Continue research on benthic flux to determine nitrogen contribution from sediments to water column	4	6	6	7	54
S24	Develop methods to reduce agricultural fertilizer use and runoff and work with farmers to implement them	3	8	5	6	53
S1	Establish FR Protection Overlay District (FRPOD) for properties inside 50-yr contributing area	3	7	8	6	53
S4	Establish a low-interest loan program for property owners for OWTS improvementswith FRP Fund. Loans repaid via tax bill and stay with property.	4	8	5	4	53
S3	Create a Forge River Protection (FRP) Fund for program	4	5	9	6	52
S12	Develop OWTS installation requirements for replacement systems using Suffolk County Department of Health Services standards as guidelines	4	7	8	3	51
S2	Explore potential dedicated funding sources such as a FRPOD fee to provide water quality improvement services to property owners	3	8	5	5	51
S15	Require all OWTS to Meet new Town Requirements	4	8	7	1	49
S5	Identify properties for acquisition or purchase of development rights based on location and environmental resources	1	8	5	8	49
S22	Collect additional groundwater data for determining nitrogen types, concentrations and travel time	3	6	6	6	48
S6	Acquire duck farm properties, conduct environmental assessment and prepare remediation plan*	4	5	6	5	47
S25	Provide educations programs for property owners on	1	7	7	7	46
S18	Encourage riparian area restoration by offering tax rebates to property owners for voluntary restoration of the wetland buffer.	2	8	6	3	44
S9	Adopt a Green Streets policy	1	8	5	5	43
S16	Reduce residential water use by requiring dual flush toilets and low-flow faucets for all new bathroom installations or remodels.	1	9	7	2	42
S7	Impose stricter clearing limits inside the FRPOD to retain existing native, non-fertilizer dependent plants	1	9	5	3	42
S19	Encourage use of indigenous landscape plants by offering tax rebates for their installation	1	8	7	3	41
S17	Provide home owners with free water conservation kits	1	6	8	5	40
S8	Replace direct discharge stormwater systems with vegetated swales, and other 'green' treatments	1	4	8	7	38
S10	Develop one or more demonstration low-impact stormwater management site	1	5	4	5	33

Although the cost of S21 is moderate to slightly high, technical and legal difficulty are deemed minimal while public acceptance is expected to be high. Imposing strict limits on fertilizer use (S11) and the installation of oyster grow-out systems (S20) would offer moderate water quality improvements though at minimal cost to implement. Ranked second and third overall, these strategies would engender moderate to high public acceptance owing to their insignificant impact upon homeowners and businesses.

Strategies S13 and S14, ranked fourth and fifth overall, address deficiencies in OWTS. Strategy S13 would require the inspection of all OWTS while S14 would mandate pump-outs of OWTS at least once every five years, promulgated via an amendment to the Town code. Although public reaction may be mixed, the costs of inspection and pump-outs are minimal compared with other strategies. In addition to minimal cost, S13 and S14 offer the potential for moderate water quality benefits and relative ease of implementation.

Additional research on benthic flux to determine nitrogen contribution (S23) is very important to several mid- and long-term strategies and, thus, S23 is appropriately located within the top six short-term strategies. For example, a more accurate estimate of nitrogen contribution from benthic flux will better inform the calculation of the TMDL and the development of the preferred allocation scenario. The portion of nitrogen that is contributed from benthic flux – via recycling of nitrogen from sediments through the water column – will help determine the amount of dredging that is required to maintain the TMDL.

A second tier of short-term strategies, *i.e.*, those that would be considered next for implementation following the first tier, comprise ten strategies, ranked in descending order as follows: S24, S1, S4, S3, S12, S2, S15, S5, S22 and S6. With one exception, all of the second-tier strategies offer moderate improvement in water quality with low to moderate cost to implement. However the ease of implementation with respect to technical and legal considerations and public support is generally less for this tier than the first tier. The one notable exception is strategy S5 which would identify properties for acquisition or purchase of development rights. The public would likely be very supportive of S5, though the water quality improvement benefits would be minimal, particularly in the short-term.

Within the second tier of short-term strategies are those that address OWTS, the designation of a zoning overlay district (FRPOD), and the funding of the Forge River Protection (FRP) Fund. Such strategies affect the public directly as they would require new expenditures (*e.g.*, FRP Fund fee and OWTS improvement costs) by homeowners and businesses and compliance with new regulations. Strategy S15 would require homeowners to make improvements to comply with current OWTS standards just prior to the sale of a property while S12 would mandate improvements to failed (*i.e.*, typically older) OWTS to current

standards. Both S12 and S15 might be considered a nuisance to property owners, though the actual cost of upgrading would be low to moderate.

The strategies that would establish and fund the FRP Fund, *i.e.*, S2 and S3, may receive low-to-moderate public support owing to the imposition of a new fee based on water usage and property value. However, strategy S4 which would provide for low-interest loans from the FRP Fund for OWTS and other property improvements could mitigate the negative perception of the fee-based strategies. The establishment of the FRP Fund, its funding mechanisms, and the maintenance of the loan program could pose some difficulties in terms of legal and administrative issues. It is important to note that certain short-term strategies, such as S12 and S15, depend upon the designation of the FRPOD (S1) to establish their administrative boundary. In a like manner, the exploration of potential funding sources (S2) will identify the funds needed to establish the FRP Fund (S3) which, in turn, would make possible a low-interest loan program (S4) for OWTS and other improvements. Thus, strategies (S1) and (S2) are initial steps in the sequence of related short-term management strategies.

Strategy S6 comprises the acquisition and environmental assessment of the former duck farm properties. Though moderately costly and minimally difficult, there are only low-to-moderate benefits to be attained in the near terms by the acquisition of the remaining agricultural value of the properties. However, the acquisition of the remaining agricultural rights would ensure against any future use of the property that may impact the estuary.

The second tier of short-term management strategies includes methods to reduce agricultural fertilizer use (S24) and collection of additional groundwater data to determine nitrogen types, concentrations and travel times (S22). S22 addresses an important data gap identified during the development of the Watershed Characterization Report, particularly the fate of nitrogen in groundwater and the contribution of nitrogen from groundwater in the upper reaches of the watershed as compared to that in the lower reaches (*i.e.*, nearest to the estuary). As a research project, S22 is considered important to the selection of long-term management strategies, but not as important as S23 which would resolve more significant uncertainties in the quantification of nitrogen from benthic flux. S24 would engage local farmers in a program to optimize fertilizer application methods. This strategy is projected to have a moderate impact on nitrogen reduction owing to the limited amount of farming conducted within the watershed at present.

The third and last tier of short-term management strategies offer minimal improvements in water quality benefits, but are relatively inexpensive (*i.e.*, compared to the first and second tier strategies) and are easy to implement from technical and legal perspectives. These third

tier strategies are, in order of descending rank, S25, S18, S9, S16, S7, S19, S17, S8 and S10. Strategies S18, S7, and S19 comprise improvements in land management such as riparian area restoration, stricter land clearing limits and the use of native plants in landscaping. Improvements in stormwater treatment are offered in strategies S9, S8 and S10, with the last of these comprising a demonstration project. Options for the reduction of residential water use – which would slightly improve the operation of OWTS – are provided by strategies S16 and S17. A watershed education program that is targeted to homeowners is outlined in S25.

Recommendation. Implement the first-tier strategies, *i.e.*, S21, S11, S20, S13, S14 and S23 immediately; these have the greatest potential for short-term water quality improvement benefits at reasonable cost to implement, *i.e.*, are the most cost-effective strategies. The first-tier short-term strategies also require the long lead times for implementation, providing an additional justification for their early project initiation. Strategies S24, S1, S4, S3, S12, S2, S15, S5 S22 and S6 offer significant water quality benefits – though less than the first tier – and at reasonable cost. However, moderate to minimal public support combined with technical and administrative challenges to implementation relegate these strategies to secondary importance; their implementation should follow the first-tier strategies. Third-tier strategies, *i.e.*, S25, S18, S9, S16, S7, S19, S17, S8 and S10, are easy to implement but offer less significant benefits; their implementation should follow the second-tier strategies.

28.3 Phasing of Mid-Term Management Strategies

The mid-term strategies are ranked in descending order in Table 28-2 according to their scores, which range from 28 to 71. Three strategies, (M14, M10 and M12) received very high scores and stand out demonstrably among the 19 mid-term strategies, particularly for their water quality benefits and expected ease of implementation. Strategies M6 and M7 – which comprise the TMDL development process –are absolutely essential to the proper selection of appropriate long-term management strategies as well as some of the mid-term strategies. These five highest-ranked strategies comprise the top quarter of the mid-term strategies and are grouped into the first tier of recommended mid-term strategies.

Table 28-2. Ranking of mid-term management strategies by weighted total

Management Strategy		Water Quality Benefit	Cost	Technical & Legal Difficulty	Public Acceptance	Weighted Total
M14	Harvest and dispose of Ulva to remove assimilated nitrogen and its associated water quality problems	8	5	6	9	71
M10	Dredge sills at mouths of creeks and accumulation at mouth of Forge River	8	3	8	10	69
M12	Dredge in vicinity of LIRR trestle to improve flushing of waterbody north of trestle.	6	5	8	10	67
M7	Develop a TMDL implementation plan based on the preferred allocation scenario	8	5	2	5	59
M6	Determine TMDL for nitrogen	6	5	5	5	54
M9	Impose stricter nitrogen effluent limits on STPs within FRPOD based on nitrogen TMDL	4	8	3	5	53
M13	Deepen Ely Creek to improve tidal circulation and reduce Phragmites growth.	5	3	5	9	52
M11	Remove deposits downstream of East and West Mill Pond discharges including Phragmites.	5	3	6	8	51
M17	Test permeable reactive barrier pilot system in high nitrogen subwatershed, preferably in riparian conservation easement	6	5	3	4	50
M16	Measure groundwater nitrogen removal by Phragmites, Spartina, and a mud flat.	3	7	7	5	50
M5	Provide stormwater treatment for runoff into the Mill Ponds and FR from Montauk Highway.	4	5	5	7	50
M4	Provide stormwater treatment systems at creek heads - may require property acquisitions	4	4	5	7	47
M8	Evaluate need and locations for a regional wastewater treatment plant	4	7	3	2	44
M18	Test bioaugmentation in septic systems to improve OWTS efficiency	3	6	4	5	44
M3	Prepare engineering plans for restoration of duck farm properties. Consider property for regional STP.	3	4	4	6	40
M19	Test groundwater bioaugmentation and carbon source injection for nitrogen removal effectiveness	3	5	3	5	40
M15	Restore riparian vegetation including tidal wetlands and high marsh on public property and reduce road width where possible to expand riparian area.	2	5	5	5	38
M2	Purchase development rights for farms in watershed. Allow greenhouse farming with lot coverage limits.	2	3	5	7	36
M1	Acquire selected open space and direct development to developed areas outside FRPOD or to future sewered areas in watershed through TDR program. FRPOD as 'Sending Area,' downtowns & commercial areas outside FRPOD as 'Receiving Areas.'	2	4	2	3	28

With a score of 71, the harvesting and disposal of *Ulva* (Sea Lettuce) to remove nitrogen (M14) is the highest ranked mid-term strategy. The water quality benefits of M14 are very significant and exceptionally cost-effective given the moderate cost of purchasing a harvesting machine, particularly a less expensive used harvester, if available. Minimal technical difficulty and broad public acceptance would support this strategy. M14 would be an interim strategy, conducted until long-term strategies (*e.g.*, sewering, STP and OWTS improvements, etc.) would be permanently in place. M10 and M12, which are ranked second and third, respectively, among the mid-term strategies, are dredging options. Dredging of the mouths of the creeks and the Forge River (M10) and in the vicinity of the LIRR trestle (M12) – which would significantly increase tidal flushing – would offer immediate and significant water quality benefits to the estuary. M10 and M12 would also enjoy broad public acceptance and incur minimal technical and legal constraints. The costs of dredging for both options M10 and M12 are moderate to high but would have the greatest positive impact among all of the dredging options. One-time dredging is considered a mid-term strategy as dredging is never permanent; areas subject to tidal flushing must be re-dredged to remove newly accumulated sediments.

The TMDL strategies, *i.e.*, M6 and M7, are also included in the first tier of mid-term strategies by virtue of their critical role in this plan. The determination of the TMDL (M6), *i.e.*, the maximum amount of nitrogen that can be assimilated by the estuary while still supporting designated uses, is a critical determinant in the future restoration of the Forge River. Following the determination of the TMDL, an implementation plan should be developed based upon the preferred allocation scenario (M7). The implementation plan would specify the long-term management strategies for maintaining nitrogen loads in the estuary within an acceptable limit. Thus, the TMDL strategies M6 and M7 are the starting point in the proper sequencing of all long-term and certain mid-term strategies. It is noted that, at the time of this writing, proposals have been submitted in response to a Request for Proposals for the development of a Forge River TMDL. These proposals are currently under review by the Town of Brookhaven.

The evaluation and ranking process conducted herein reveals a second tier of eleven potential mid-term strategies with evaluation values ranging from 40 to 53 (Table 28-2.) All of these mid-term strategies, comprising M9, M13, M11, M17, M16, M5, M4, M8, M18, M3 and M19, are either significant enough to include among the strategies to be considered in the TMDL's preferred allocation scenarios or provide additional research and test data to better inform the selection of long-term strategies to include in the preferred allocation scenario. Strategies M16, M17, M18 and M19 are research and demonstration projects designed to test the nitrogen removal efficacy of 1) different habitats (*i.e.*, invasive *Phragmites*, *Spartina*

marsh, and a mud flat), 2) permeable reactive barriers, 3) bio-augmentation in septic systems and 4) bio-augmentation and carbon source injection into groundwater, respectively. The last three strategies (M17-M19) would provide data concerning their effectiveness as long-term management strategies. The imposition of stricter nitrogen effluent limits on STPs within the watershed (M9) and the evaluation of the need and locations for a regional STP (M8) – including the consideration of the duck farm as a regional STP (M3) – are strategies that will be considered for potential inclusion within the TMDL preferred allocation scenario. Four other mid-term strategies that comprise two more dredging strategies (*i.e.*, M13 and M11) and two stormwater treatment strategies (*i.e.*, M4 and M5), offer potentially significant water quality benefits. In the interests of cost-effectiveness, the implementation of these four strategies could be delayed until their efficacy can be more accurately evaluated during the development of the TMDL preferred allocation scenario.

Three remaining mid-term strategies, (M1, M2 and M15) offer less significant water quality benefits and are relatively expensive to implement. Given their anticipated lower measures of cost-effectiveness, these strategies – which entail the implementation of a transfer-of-development rights program (M1), the purchase development rights from the remaining farms in the watershed (M2) and the restoration of riparian vegetation along public properties – should be grouped into the third tier of mid-term strategies.

Recommendation. Implement the first-tier mid-term strategies, (M6, M7, M10, M12 and M14) immediately. These have the greatest potential for mid-term water quality improvements. The first-tier mid-term TMDL strategies, (M6 and M7), are key to the implementation of long-term strategies and should be expedited. The second-tier, mid-term strategies that provide data on potential long-term strategies should also be initiated, as soon as is feasible in order to support the development of the TMDL preferred allocation scenario. The implementation of third-tier mid-term strategies should follow that of the second-tier strategies.

28.4 Phasing of Long-Term Management Strategies

The long-term management strategies are ranked in descending order in Table 28-3 according to their scores, which range from 38 to 62. There are twelve management strategies – considered here – whose implementation would occur in the long-term. Upon evaluation per Table 7-3, two strategies, (L10 and L3), stand out among the set of long-terms strategies with the highest values of 62 and 56, respectively. Strategy L10 provides for the long-term dredging of the estuary to remove accumulated organic matter while L3 offers a solution that would remove past, present and future nitrogen loads from groundwater, a major contributor to poor water quality in the estuary.

Table 28-3. Ranking of long-term management strategies by weighted total

Management Strategy		Water Quality Benefit	Cost	Technical & Legal Difficulty	Public Acceptance	Weighted Total
L10	Institute long-term dredging operation to remove accumulated organic matter from estuary if determined effective by benthic flux studies.	7	5	3	8	62
L3	Pump groundwater to treatment location which may be a wetland or denitrification reactor (large volumes of water are involved)	10	1	3	5	56
L2	Install permeable reactive barriers (if proven effective) in riparian area of all high priority creeks to remove historic groundwater nitrogen.	10	1	2	2	49
L6	Construct advanced onsite systems for individual FRPOD parcels; avoids collection system cost, but requires regular maintenance **OR**	8	2	4	2	46
L11	Fill creek depressions with sand to eliminate stagnant anoxic areas (presumptively incompatible with wetland permit - requires DEC approval)	4	5	3	5	44
L4	Improve operation of private STPs by upgrading for additional nitrogen removal or connect private STPs to future regional STP	4	3	8	5	43
L5	Sewer entire FRPOD. Construct conventional collection system and treatment plant **OR**	8	1	4	2	43
L7	Collect septic system effluent from all FRPOD parcels, treat at centralized community STP **OR**	8	1	4	2	43
L8	Incorporate adjacent areas (Mastic Shirley and Center Moriches) to reduce per parcel cost and expand environmental benefits.	8	1	3	2	42
L12	Conduct long-term maintenance dredging of Moriches Inlet to improve flushing of Moriches Bay and FR.	5	3	1	5	40
L1	Implement the land use plan for the duck farm properties to support restoration of the Forge River	2	3	4	9	39
L9	Pump bay water to head of Forge River and priority creeks to increase circulation, reduce algal blooms, and increase dissolved oxygen.	4	3	5	4	38

It is noted, for example, that the sewering and advanced OWTS treatment options address only present and future nitrogen loads. Even after sewering, there would be many years of nitrogen contribution to the estuary given its existence in groundwater reservoir. Long-term strategy L3, *i.e.*, the pumping and treatment of groundwater, like L10, addresses this reality. Ultimately, there may be a mix of strategies – including short-, mid- and long-term ones – that will be employed to restore the Forge River. The selection of appropriate long-term strategies will be determined in the TMDL preferred allocation scenario.

Recommendation. All of the long-term strategies presented and evaluated here should be included for evaluation in the development of the TMDL preferred allocation scenario.

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APPENDICES

Appendix A. Aquatic Habitat Maps

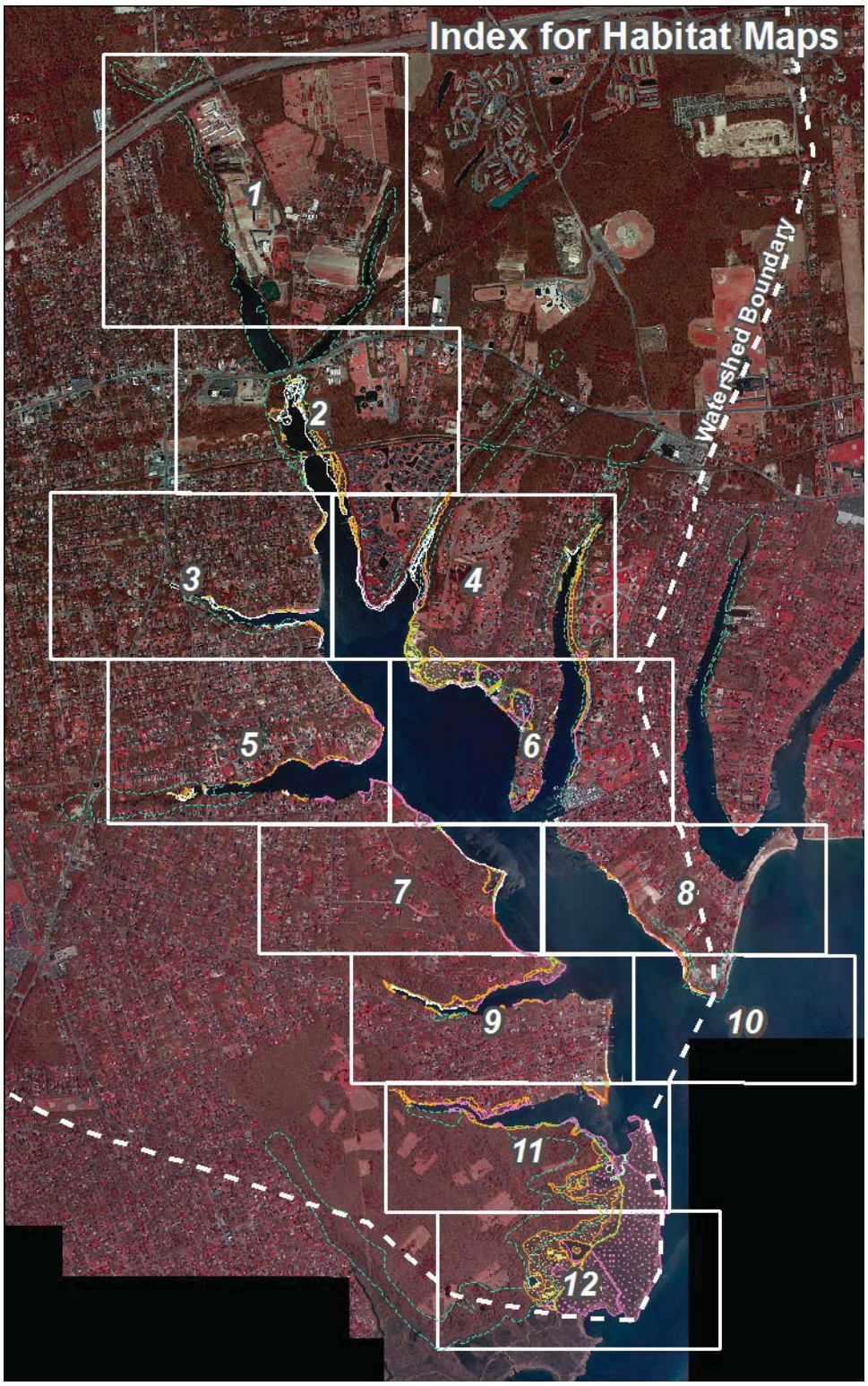
Appendix B. Atmospheric Deposition Data for Peconics

Appendix C. Forge River Priority Waterbody Listing

Appendix D – Cost Information for Strategies

Appendix E – Response to Comments

APPENDIX A
Aquatic Habitat Maps


Index for Habitat Maps
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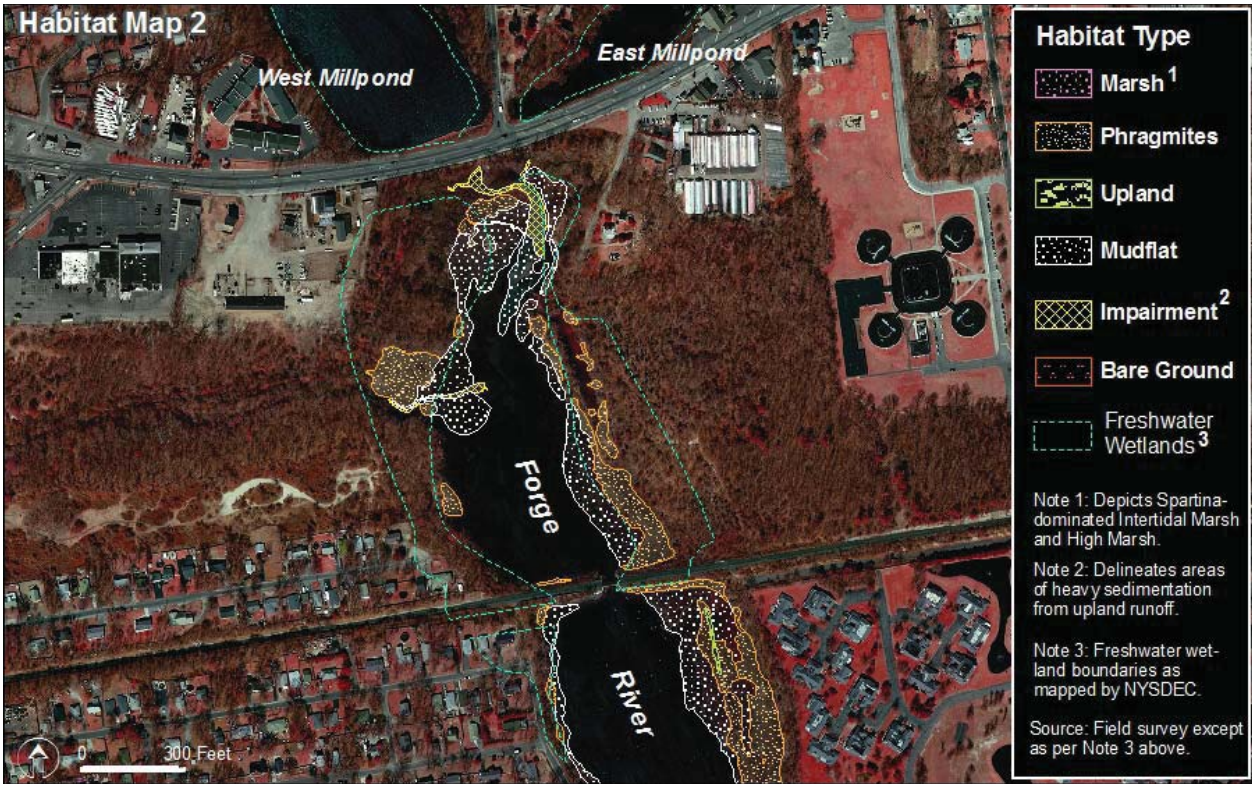
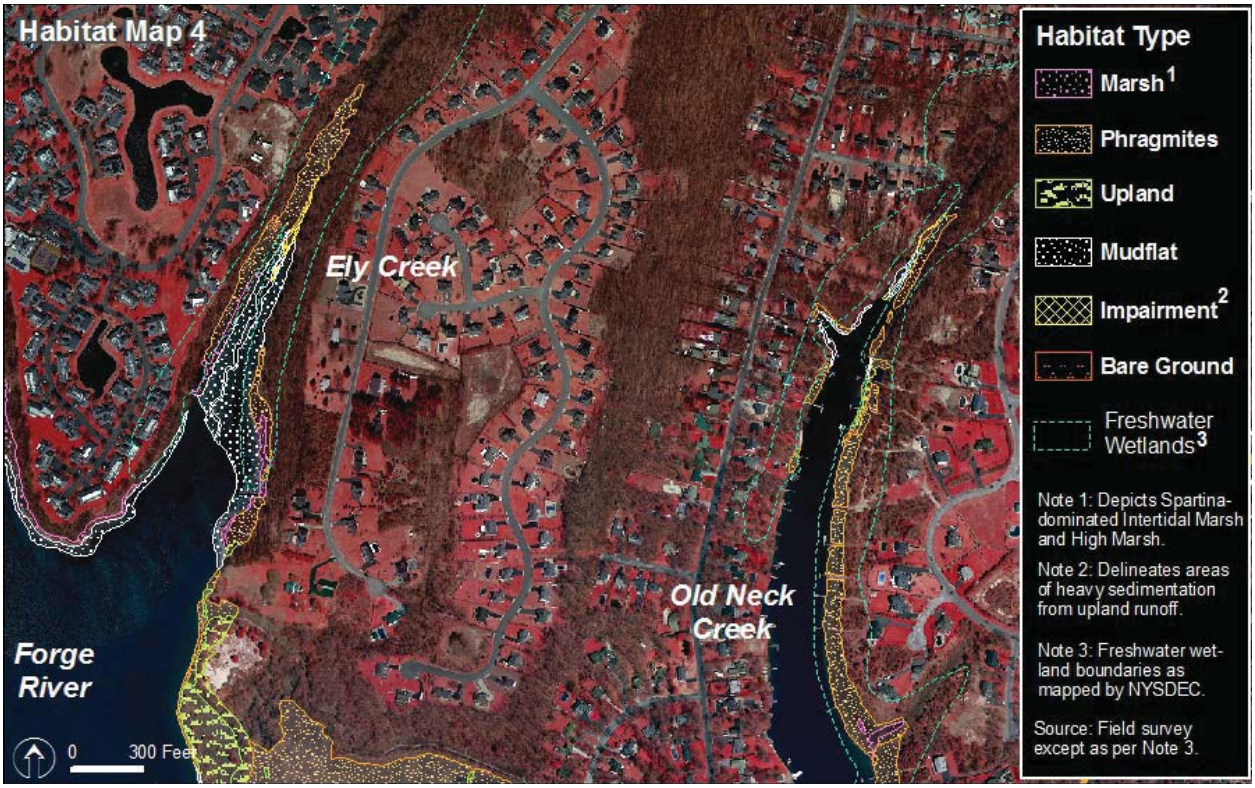
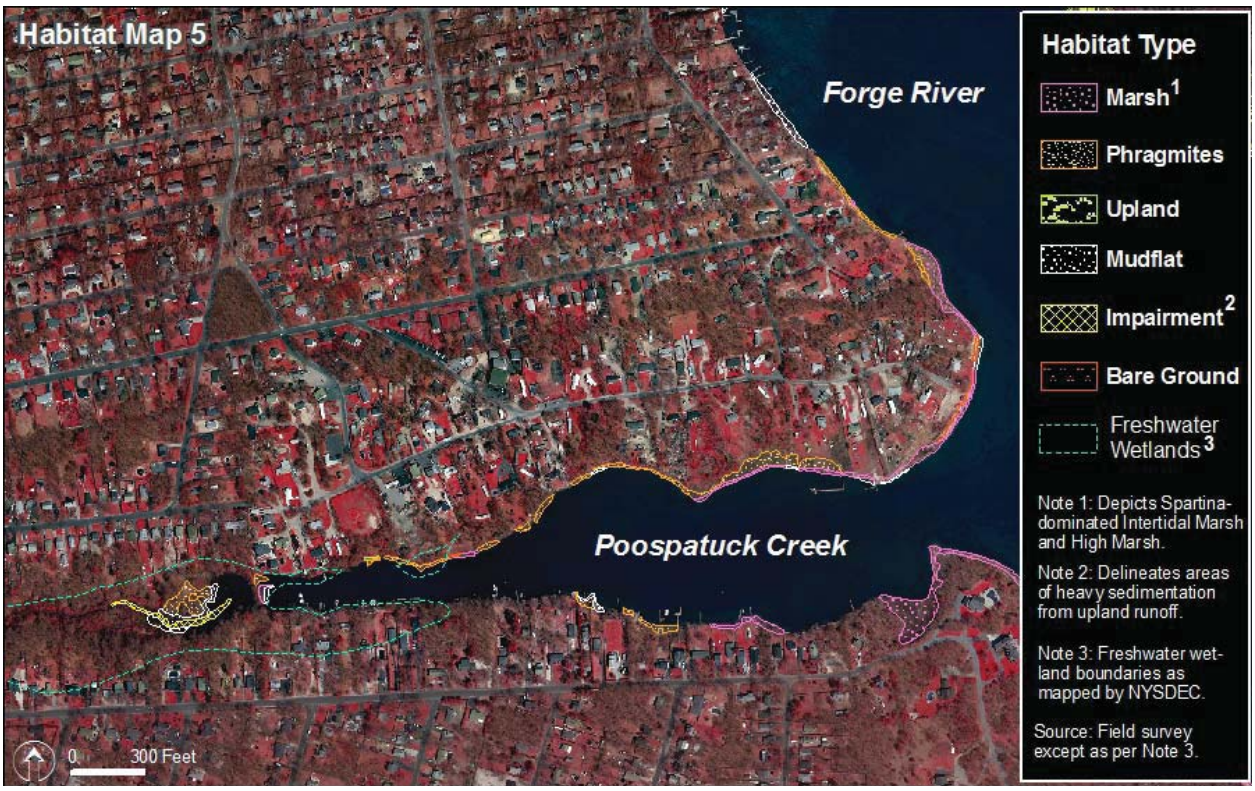
11
12
Watershed Boundary

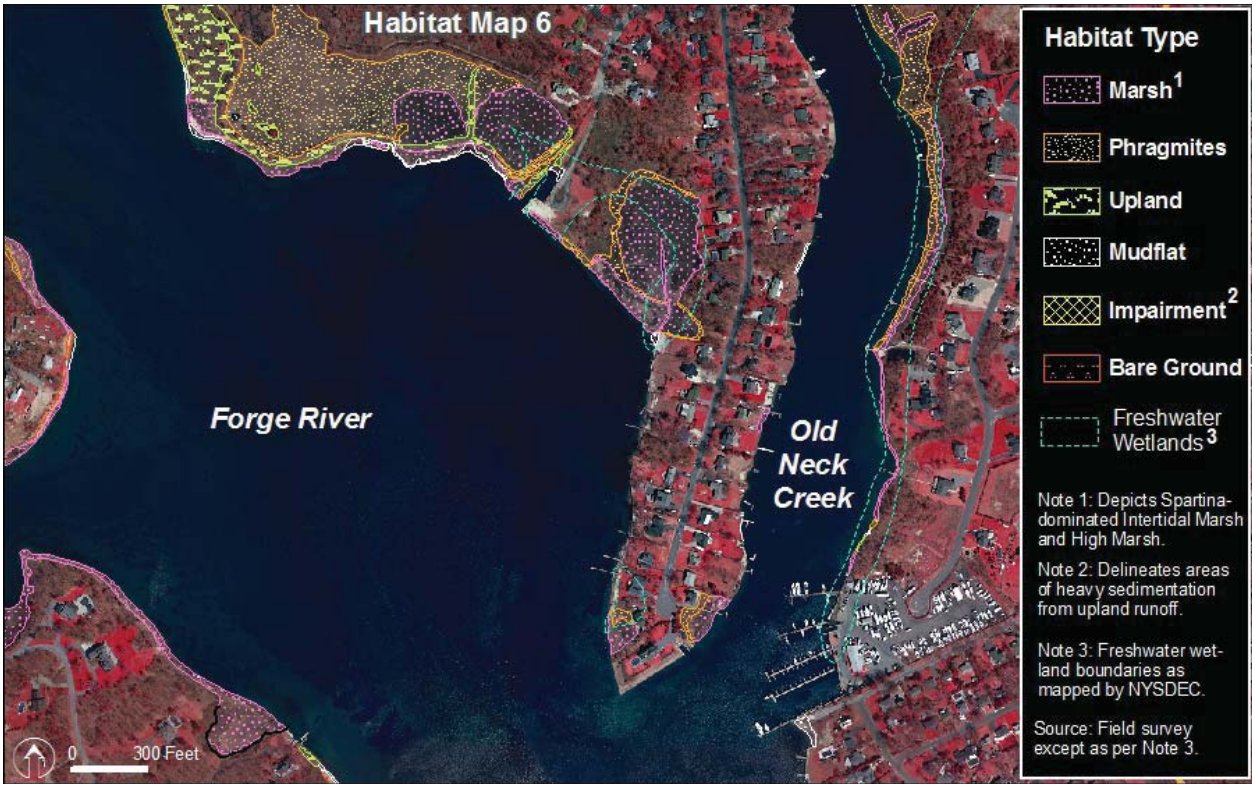
Habitat Map 1
State Hwy 27
East Millpond
West Millpond
0 300 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3 above.

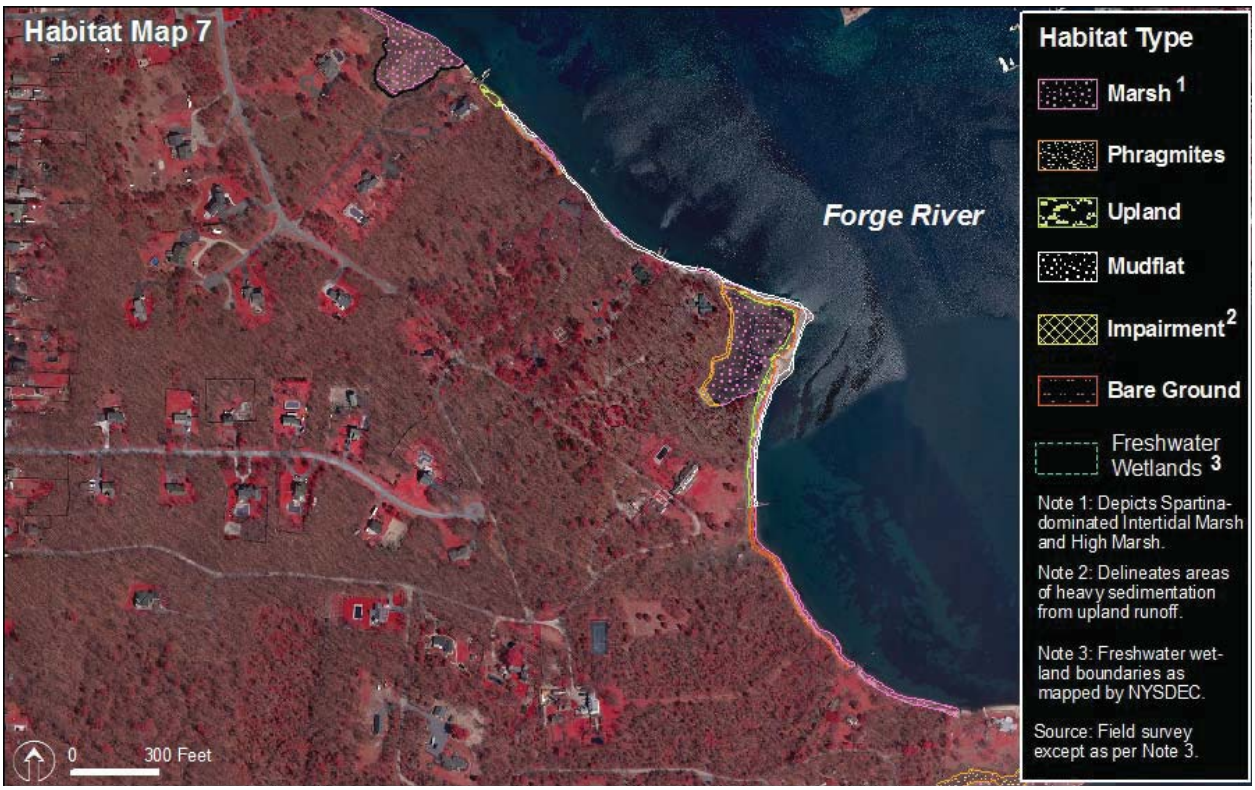

Habitat Map 2
West Millpond
East Millpond
Forge
River
0 300 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3 above.

Habitat Map 3
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3 above.
Wills Creek
Forge River
0
300 Feet


Habitat Map 4
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.
Ely Creek
Old Neck Creek
Forge River
0
300 Feet


Habitat Map 5
Forge River
Poospatuck Creek
0 300 Feet
Habitat Type
Marsh[1]
Phragmites
Upland
Mudflat
Impairment[2]
Bare Ground
Freshwater Wetlands[3]
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.

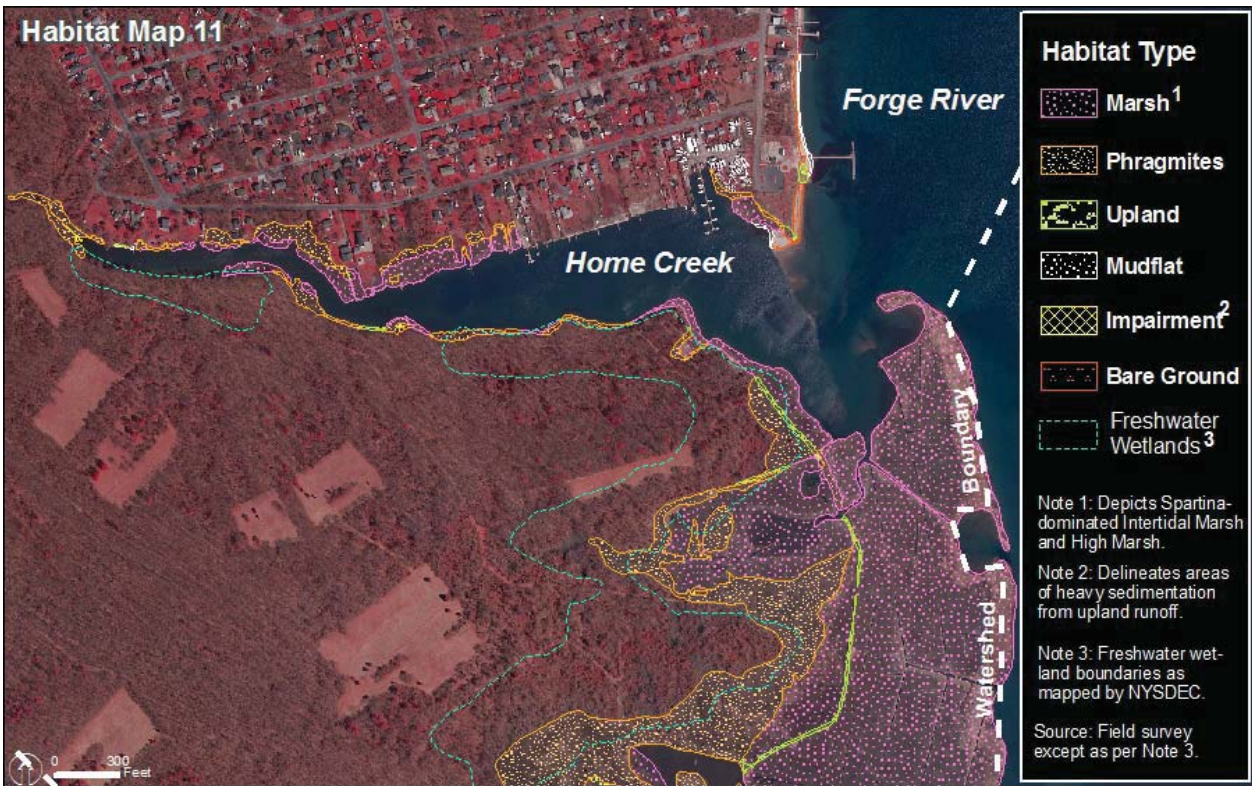

Habitat Map 6
Forge River
Old Neck Creek
0 300 Feet
Habitat Type
Marsh[1]
Phragmites
Upland
Mudflat
Impairment[2]
Bare Ground
Freshwater Wetlands[3]
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.

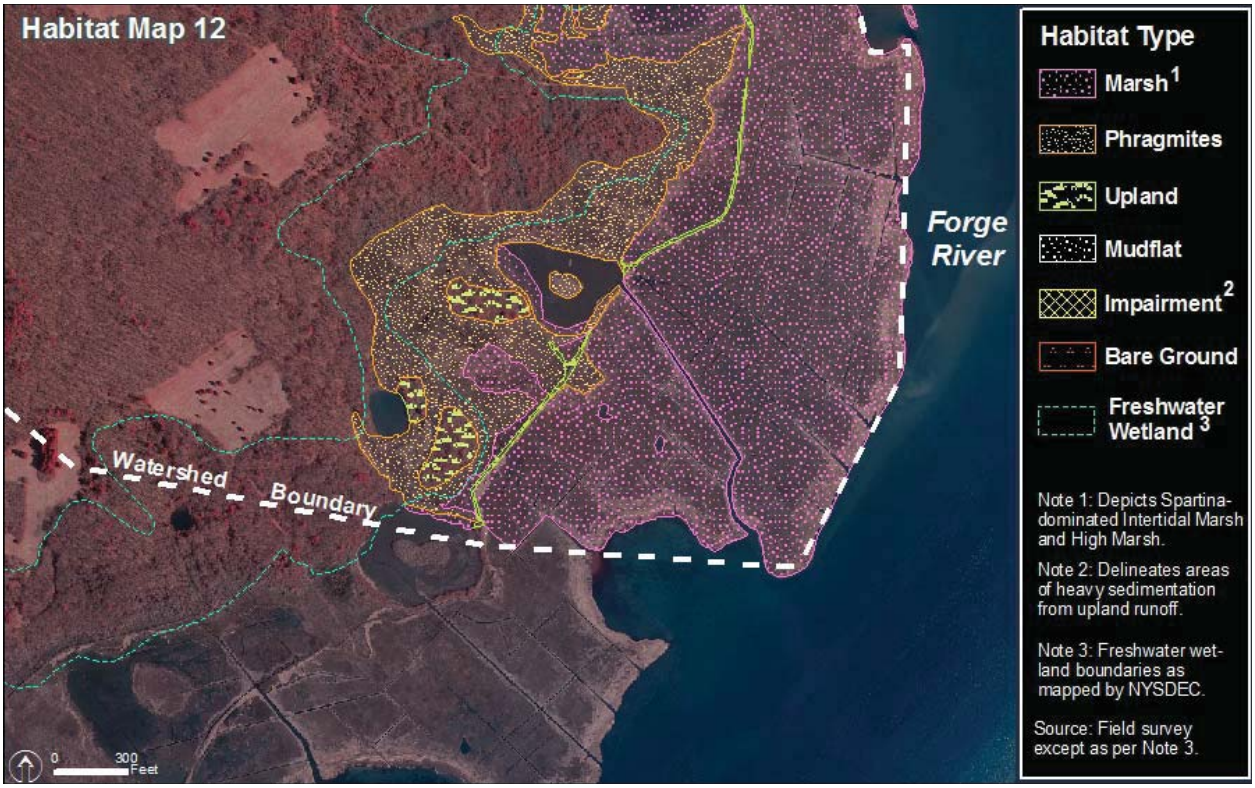

Habitat Map 7
Forge River
0 300 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.

Habitat Map 8
Forge River
Watershed Boundary
0 300 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.

Habitat Map 9
Forge River
Lons Creek
Home Creek
0 200 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.

Habitat Map 10
Watershed Boundary
Forge River
Moriches Bay
0 300 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.


Habitat Map 11
Forge River
Home Creek
Watershed Boundary
0 300 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetlands 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.


Habitat Map 12
Forge River
Watershed Boundary
0 300 Feet
Habitat Type
Marsh 1
Phragmites
Upland
Mudflat
Impairment 2
Bare Ground
Freshwater Wetland 3
Note 1: Depicts Spartina-dominated Intertidal Marsh and High Marsh.
Note 2: Delineates areas of heavy sedimentation from upland runoff.
Note 3: Freshwater wetland boundaries as mapped by NYSDEC.
Source: Field survey except as per Note 3.

APPENDIX B
Atmospheric Deposition Data for the Peconics

Suffolk County Department of Health Serives - Office of Ecology
Peconic Estuary Program
National Atmospheric Deposition Program (NADP) / National Trends Network (NTN)
Annual Deposition Data for Site NY96

Year	Dates		Days	Deposition (kg/ha)												Totals			% Precip. Rep. by Field Chem.
				Ca	Mg	K	Na	NH_4	**NH_4 (lb/acre/day)**	NO_3	**NO_3 (lb/acre/day)**	Inorganic-N	CL	SO_4	H+ (Lab)	Sample Vol. (ml)	Precip (cm)	Precip (in)	
2003	11/25/03	12/30/03	35	0.17	0.44	0.14	3.68	0.04	**0.0010**	0.40	**0.0102**	0.13	6.7	1.5	0.01	5681.7	9.4	3.7	89
2004	12/30/03	12/28/04	364	1.21	2.06	0.73	17.81	1.20	**0.0029**	8.66	**0.0212**	2.89	32.2	13.8	0.24	75120.1	120.2	47.3	98
2005	12/28/04	1/3/06	371	1.65	3.50	1.14	29.88	1.14	**0.0027**	8.63	**0.0208**	2.83	53.5	16.8	0.24	66721.0	131.1	51.6	0
2006	1/3/06	1/2/07	364	1.47	2.67	0.94	22.72	1.76	**0.0043**	9.53	**0.0234**	3.53	39.2	19.8	0.32	72303.5	134.7	53.0	0
2007	1/2/07	12/31/07	363	1.67	3.34	1.11	28.28	1.83	**0.0045**	8.72	**0.0214**	3.40	47.9	18.6	0.25	59047.1	96.1	37.8	0
2008	12/31/07	12/30/08	365	1.68	2.90	0.96	24.08	1.74	**0.0043**	9.75	**0.0238**	3.55	43.9	17.4	0.26	80185.1	118.9	46.8	0
							Averages:	1.29	0.0033	7.62	0.02	2.72						47.31*	

Total Nitrogen = NH_4 + NO_3: **0.0234 lb/acre/day to groundwater from runoff/deposition on surface water**
65% removal/plant uptake rate
0.00820 lb/acre/day to groundwater that has been recharged

* Average Precipitation did not take into account the 2003 data since there was only 3.7 inches in 35 days.

APPENDIX C
Forge River Priority Waterbody Listing

Part 1 - Individual Waterbody Segments with Impairment Requiring TMDL Development (con't)

Water Index Number	Waterbody Name (WI/PWL ID)	County	Type	Class	Cause/Pollutant	Source	Year
	Atlantic Ocean/Long Island Sound Drainage Basin (con't)						
(MW5.3) LIS-62-P296	Millers Pond (1702-0013)	Suffolk	Lake	C	D.O./Oxygen Demand	Urban/Storm Runoff	2002
					Phosphorus	Urban/Storm Runoff	2002
(MW6.1d) GB..GPB-P495	Mattituck or Marratooka Pond (1701-0129)	Suffolk	Lake	A	Metals	Urb/Storm Runoff	2002
					D.O./Oxygen Demand	Urb/Storm Runoff	2002
					Pathogens	Urb/Storm Runoff	2002
					Phosphorus	Urb/Storm Runoff	2002
(MW7.2a) AO-MB-168a thru 175	Tidal Tribs to West Moriches Bay (1701-0312) [24]	Suffolk	Estuary	SC	Pathogens	Urb/Storm, Agric,OWTS	2006
					Nitrogen	Urb/Storm, Agric,OWTS	2006
					D.O./Oxygen Demand	Urb/Storm, Agric,OWTS	2006
(MW7.5) AO-GSB-185-P889	Canaan Lake (1701-0018)	Suffolk	Lake	B(T)	Phosphorus	Urb/Storm Runoff	2002
					Silt/Sediment	Urb/Storm Runoff	2002
(MW7.7) AO-GSB-193..P304	Lake Ronkonkoma (1701-0020)	Suffolk	Lake	B	Pathogens	Urb/Storm Runoff	2002
					Phosphorus	Urb/Storm Runoff	2002
(MW7.8) AO-GSB-194	Champlin Creek, Upper, and tribs (1701-0019)	Suffolk	River	C(TS)	Thermal Changes	Urb/Storm Runoff	2002
(MW8.2a) EB-224 thru 227	LI Tribs, fresh to East Bay (1701-0204)	Nassau	River	C	Silt/Sediment	Urb/Storm Runoff	2002
					Phosphorus	Urb/Storm Runoff	2002
(MW8.3a) MDB-228	East Meadow Brook, Upper, and tribs (1701-0211)	Nassau	River	C	Silt/Sediment	Urb/Storm Runoff	2002
(MW8.4) HB	Hempstead Bay (1701-0032)	Nassau	Estuary	SA	Nitrogen	Municpl, Urb/Storm Runoff	2006
(MW8.4a) HB-233-P1005..P1012	Hempstead Lake (1701-0015)	Nassau	Lake	C	Phosphorus	Urban/Storm Runoff	2002
(MW8.4a) HB-235-P1017a	Grant Park Pond (1701-0054)	Nassau	Lake	C	Phosphorus	Urban/Storm Runoff	1998
(MW8.5b) JB	Jamaica Bay, Eastern, and tribs, Queens (1701-0005)	Queens	Estuary	SB	Nitrogen	Urban/CSO,Municipl	2002
					D.O./Oxygen Demand	Urban/CSO,Municipl	2002
(MW8.5b) JB-247	Bergen Basin (1701-0009)	Queens	Estuary	I	Nitrogen	Urban/CSO,Municipl	2006
					D.O./Oxygen Demand	Urban/CSO,Municipl	2002
(MW8.6) JB-249a	Hendrix Creek (1701-0006)	Kings	Estuary	I	Nitrogen	Urban/CSO/Municipl	1998
					D.O./Oxygen Demand	Urban/CSO/Municipl	1998

[24] Includes Upper Forge River, which is the trib of primary concern. The Lower Forge River is included in *Part 2c - Shellfishing Waters* portion of the list.

Part 2c - Multiple Segment/Categorical Impaired Waterbody Segments (shellfishing)

(Might be addressed by a waterbody specific TMDL or a pollutant/source specific TMDL or other strategy to attain water quality standards)

Water Index Number	Waterbody Name (WI/PWL ID)	County	Type	Class	Cause/Pollutant	Source	Year
	Atlantic Ocean/Long Island Sound Drainage Basin						
(MW1.2) RB (portion 1)	Raritan Bay, Class SA (1701-0002)	Richmond	Estuary	SA	Pathogens	Urban/Storm/CSO	1998
(MW3.1) LIS (portion 1b)	New Rochelle Harbor (1702-0259)	Westchester	Estuary	SA	Pathogens	Urb/Storm, Municipal	2002
(MW3.1) LIS (portion 2)	Long Island Sound, Westchester Co Waters(1702-0001)	Westchester	Estuary	SA	Pathogens	Urban/CSO, Municipl	1998
(MW4.1) LIS (portion 3)	Long Island Sound, Nassau County Waters (1702-0028)	Nassau	Estuary	SA	Pathogens	Urban/CSO, Municipl	1998
(MW4.2b) LIS-MB (portion 1)	Manhasset Bay, and tidal tribs (1702-0021)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	1998
(MW4.3b) LIS-41-P145	Dosoris Pond (1702-0024)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW5.4g) LIS-FI-P1101,P1102	Beach/Island Ponds, Fishers Island (1701-0283)	Suffolk	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW6.3b) GB..GPB-122a-P652	Scallop Pond (1701-0354)	Suffolk	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW6.3g) BIS..P764	Oyster Pond/Lake Munchogue (1701-0169)	Suffolk	Estuary	SA	Pathogens	Urban/Storm Runoff	1998
(MW6.3i) AO-SB-155	Phillips Creek, Lower, and tidal tribs (1701-0299)	Suffolk	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW6.3i) AO-SB-QgC	Quogue Canal (1701-0301)	Suffolk	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW7.2a) AO-MB (portion 4)	Forge River, Lower and Cove (1701-0316)	Suffolk	Estuary	SA	Pathogens	Urban/Storm, Agric.	2002
(MW7.6) AO-GSB (portion 6)	Nicoll Bay (1701-0375)	Suffolk	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW7.8) AO-GSB (portion 7)	Great Cove (1701-0376)	Suffolk	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW8.1) SOB	South Oyster Bay (1701-0041)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	1998
(MW8.2) EB	East Bay (1701-0202)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW8.3) MDB	Middle Bay (1701-0208)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW8.3) MDB-ERI	East Rockaway Inlet (1701-0217)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW8.3) MDB-RC	Reynolds Channel, east (1701-0215)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	2002
(MW8.4) HB	Hempstead Bay (1701-0032)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	1998
(MW8.4a) HB-236	Woodmere Channel (1701-0219)	Nassau	Estuary	SA	Pathogens	Urban/Storm Runoff	2002

More Information Regarding Shellfishing

Waters impaired for shellfishing use are based on shellfishing closures issues by New York State Department of Environmental Conservation Shellfisheries Program and the National Shellfish Sanitation Program. Because the specific extent and conditions of the closures are reported more precisely and more frequently through these programs than through the Section 303(d) List, this shellfish closure information provides better delineated and more timely information regarding the support of shellfishing use in the waters of New York than does the Section 303(d) List. For the most current shellfishing closure information, refer to http://www.dec.state.ny.us/website/dfwmr/marine/shellfish/sfntsh/index.htm.

Atlantic/Long Isl. Sound Basin Priority Waterbodies List Table 1

Water Index Number	Waterbody/Segment Name (ID) Use Impairment(s)	County	Seg Size	Type	Class	W.B.Category Cause/Source Information
(MW7.1c) AO-SB-QB-157 thru 160	Tidal Tribs to Quantuck Bay/Canal (1701-0303) Recreation KNOWN to be STRESSED	Suffolk	20.0 Acre	Estuary	SC	Impacted Seg Causes: Pathogens Sources: Other Source, Urban Runoff
(MW7.1c) AO-SB-QB-QtC	Quantuck Canal/Moneybogue Bay (1701-0371) Shellfishing KNOWN to be IMPAIRED Public Bathing KNOWN to be STRESSED Recreation KNOWN to be STRESSED	Suffolk	200.0 Acre	Estuary	SA	Impacted Seg Causes: Pathogens Sources: Other Source, Urban Runoff, Storm Sewers
(MW7.2a) AO-MB (portion 1)	Moriches Bay, East (1701-0305) Shellfishing KNOWN to be STRESSED Fish Consumption KNOWN to be STRESSED	Suffolk	3120.0 Acre	Estuary	SA	Impacted Seg Causes: Priority Organics Sources: Agriculture, Urban Runoff, Other Source, Storm Sewers
(MW7.2a) AO-MB (portion 2)	Moriches Bay, West (1701-0038) Shellfishing KNOWN to be STRESSED Fish Consumption KNOWN to be STRESSED	Suffolk	3000.0 Acre	Estuary	SA	Impacted Seg Causes: Priority Organics Sources: Agriculture, Urban Runoff, Other Source, Storm Sewers
(MW7.2a) AO-MB (portion 3)	Tuthill, Harts, Seatuck Coves (1701-0309) Shellfishing KNOWN to be PRECLUDED Public Bathing KNOWN to be STRESSED Recreation KNOWN to be STRESSED	Suffolk	1500.0 Acre	Estuary	SA	Impacted Seg Causes: Pathogens Sources: Agriculture, Other Source, Urban Runoff, Storm Sewers
(MW7.2a) AO-MB (portion 4)	Forge River, Lower and Cove (1701-0316) Shellfishing KNOWN to be PRECLUDED Public Bathing KNOWN to be STRESSED Recreation KNOWN to be STRESSED	Suffolk	1500.0 Acre	Estuary	SA	Impacted Seg Causes: Pathogens Sources: Agriculture, Other Source, Urban Runoff, Storm Sewers
(MW7.2a) AO-MB-160a thru 168	Tidal Tribs to East Moriches Bay (1701-0306) Recreation KNOWN to be STRESSED	Suffolk	50.0 Acre	Estuary	SC	Impacted Seg Causes: Pathogens Sources: Agriculture, Other Source, Urban Runoff, Storm Sewers
(MW7.2a) AO-MB-168a thru 175	Tidal tribs to West Moriches Bay (1701-0312) Recreation KNOWN to be STRESSED	Suffolk	50.0 Acre	Estuary	SC	Impacted Seg Causes: Pathogens Sources: Agriculture, Other Source, Urban Runoff, Storm Sewers

APPENDIX D
Cost Information for Strategies

SHORT-TERM MANAGEMENT STRATEGY COSTS

Short-Term (1-3 Years) Management Strategy			$1-$1K	$1K-$10K	$10K-$50K	$50K-$100K	$100K- $500K	$500K- $1M	$1M- $10M	$10M- $50M	$50M- $100M	> $100M
Land Use Management Strategies												
S1	Establish a Forge River Protection Overlay District	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt			X							
		Annual Cost/Govt										
S2	Explore Dedicated Funding Sources	Initial Cost/Owner										
		Annual Cost/Owner	X									
		Initial Cost/Govt		X								
		Annual Cost/Govt										
S3	Create a Forge River Protection Fund	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
S4	Establish a Low-Interest Loan Program for OWTS Improvements	Initial Cost/Owner										
		Annual Cost/Owner	X									
		Initial Cost/Govt		X								
		Annual Cost/Govt										
S5	Identify Properties for Open Space Acquisition or Purchase of Development Rights	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt		X								
		Annual Cost/Govt										
S6	Acquire Duck Farm Properties, Conduct Environmental Assessment and Prepare Remediation Plan	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
S7	Impose Stricter Clearing Limits	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt	X									
		Annual Cost/Govt										
Stormwater Management Strategies												
S8	Replace Direct Discharges to the Estuary	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt						X				
		Annual Cost/Govt		X								
S9	Adopt a Green Streets policy	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt		X								
		Annual Cost/Govt										
S10	Develop a Low-Impact Stormwater Management Demonstration Site	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt		X								

Short-Term (1-3 Years) Management Strategy			$1-$1K	$1K-$10K	$10K-$50K	$50K-$100K	$100K- $500K	$500K- $1M	$1M- $10M	$10M- $50M	$50M- $100M	> $100M
Nitrogen Reduction Strategies												
S11	Impose Strict Limits on Nitrogen Fertilizer Use	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt		X								
		Annual Cost/Govt										
S12	Develop Installation Requirements for Replacement of OWTS	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt			X							
		Annual Cost/Govt										
S13	Require OWTS Inspections	Initial Cost/Owner										
		Annual Cost/Owner	X									
		Initial Cost/Govt										
		Annual Cost/Govt										
S14	Enact an Ordinance Requiring Pump-outs for all OWTS within the FRPOD Every Five Years	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt		X								
		Annual Cost/Govt										
S15	Require all OWTS to Meet New Responsible Party Requirements	Initial Cost/Owner	X	X								
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt										
S16	Reduce Residential Water Use	Initial Cost/Owner	X									
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt										
S17	Provide Water Conservation Kits	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt				X						
		Annual Cost/Govt										
Water Quality Improvements and Habitat Restoration												
S18	Encourage Riparian Area Restoration	Initial Cost/Owner		X								
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt										
S19	Encourage Use of Indigenous Landscape Plants	Initial Cost/Owner		X								
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt										
S20	Install Oyster Grow-Out Systems for Algal Bloom Control	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt				X						
		Annual Cost/Govt			X							
S21	Install Surface and Water-Column Creek Aerators	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt						X				
		Annual Cost/Govt		X								

Short-Term (1-3 Years) Management Strategy			$1-$1K	$1K-$10K	$10K-$50K	$50K-$100K	$100K- $500K	$500K- $1M	$1M- $10M	$10M- $50M	$50M- $100M	> $100M
Research and Data Collection												
S22	Collect Additional Groundwater Data	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt				X						
		Annual Cost/Govt				X						
S23	Continue Research on Benthic Nitrogen Flux	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt				X						
		Annual Cost/Govt										
Training, Education, and Stewardship Programs												
S24	Develop Methods to Reduce Agricultural Fertilizer Use and Stormwater Runoff	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt		X								
S25	Provide Educational Programs for Property Owners	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt			X							
		Annual Cost/Govt		X								

MID-TERM MANAGEMENT STRATEGY COSTS

Mid-Term (3-5 Years) Management Strategy			$1-$1K	$1K-$10K	$10K-$50K	$50K-$100K	$100K- $500K	$500K- $1M	$1M- $10M	$10M- $50M	$50M- $100M	> $100M
Land Use Management Strategies												
M1	Acquire Selected Open Space and Direct Development to Developed Areas Outside the FRPOD or to Future Sewered Areas in the Watershed	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt						X				
M2	Purchase Development Rights for Existing Farms	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt							X			
		Annual Cost/Govt										
M3	Prepare a Land Use Plan for the Duck Farm Properties and Implement Remediation Plan	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt						X				
		Annual Cost/Govt										
Stormwater Management Strategies												
M4	Provide Treatment Systems at Selected Creek Heads	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt						X				
		Annual Cost/Govt		X								
M5	Provide Treatment for Runoff into Mill Ponds	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt		X								
Nitrogen Reduction Strategies												
M6	Determine the Total Maximum Daily Load for Nitrogen	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
M7	Develop a TMDL Implementation Plan	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
M8	Evaluate Need and Locations for Regional Wastewater Treatment Plant	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt			X							
		Annual Cost/Govt										
M9	Impose Stricter Nitrogen Limits on STPs within the FRPOD	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt		X								
		Annual Cost/Govt										

Mid-Term (3-5 Years) Management Strategy			$1-$1K	$1K-$10K	$10K-$50K	$50K-$100K	$100K- $500K	$500K- $1M	$1M- $10M	$10M- $50M	$50M- $100M	> $100M
Water Quality Improvements and Habitat Restoration												
M10	Dredge Sills at Creek Mouths and at Mouth of the Forge River	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt							X			
		Annual Cost/Govt										
M11	Remove Deposits South of Montauk Highway	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt							X			
		Annual Cost/Govt										
M12	Remove Deposits by LIRR Trestle	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
M13	Deepen Ely Creek	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt							X			
		Annual Cost/Govt										
M14	Harvest and dispose of *Ulva*	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt			X							
M15	Restore Native Riparian Vegetation on Public Land	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
Research and Data Collection												
M16	Measure groundwater nitrogen removal by *Phragmites*, *Spartina*, and mudflats.	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt			X							
		Annual Cost/Govt										
M17	Test permeable reactive barriers for groundwater nitrogen removal and obtain conservation easement in priority subwatershed	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
M18	Test nitrogen reduction by septic systems Bio-Augmentation	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt				X						
		Annual Cost/Govt										
M19	Test nitrogen reduction by groundwater Bio-Augmentation	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										

LONG-TERM MANAGEMENT STRATEGY COSTS

Long-Term (5-10 Years) Management Strategy			$1-$1K	$1K-$10K	$10K-$50K	$50K-$100K	$100K- $500K	$500K- $1M	$1M- $10M	$10M- $50M	$50M- $100M	> $100M
Land Use Management Strategies												
L1	Implement the Land Use Plan for the Duck Farm Properties	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt				X	X	X	X			
		Annual Cost/Govt										
Nitrogen Reduction Strategies												
L2	Install Permeable Reactive Barriers	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt								X	X	
		Annual Cost/Govt			X							
L3	Pump groundwater to treatment location	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt								X	X	
		Annual Cost/Govt					X					
L4	Improve operation of private STPs.	Initial Cost/Owner					X					
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt										
L5	Sewer Part or all of the FRPOD **OR**	Initial Cost/Owner										
		Annual Cost/Owner		X								
		Initial Cost/Govt										
		Annual Cost/Govt										
L6	Construct advanced onsite systems for individual FRPOD parcels **OR**	Initial Cost/Owner			X							
		Annual Cost/Owner	X									
		Initial Cost/Govt										
		Annual Cost/Govt										
L7	Collect septic system effluent from all FRPOD parcels, treat at centralized community STP **OR**	Initial Cost/Owner		X								
		Annual Cost/Owner		X								
		Initial Cost/Govt										
		Annual Cost/Govt										
L8	Incorporate adjacent areas (Mastic Shirley and Center Moriches)	Initial Cost/Owner										
		Annual Cost/Owner		X								
		Initial Cost/Govt										
		Annual Cost/Govt										
Water Quality Improvements and Habitat Restoration												
L9	Pump bay water to head of Forge River and priority creeks	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt							X			
		Annual Cost/Govt				X						
L10	Dredge to Remove Accumulated Organic Material	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt					X					

Long-Term (5-10 Years) Management Strategy			$1-$1K	$1K-$10K	$10K-$50K	$50K-$100K	$100K- $500K	$500K- $1M	$1M- $10M	$10M- $50M	$50M- $100M	> $100M
L11	Fill Creek Depressions	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt					X					
		Annual Cost/Govt										
L12	Maintain Moriches Inlet	Initial Cost/Owner										
		Annual Cost/Owner										
		Initial Cost/Govt										
		Annual Cost/Govt						X	X			

APPENDIX E
Response to Comments

Responses to Comments Received

on the

FORGE RIVER WATERSHED MANAGEMENT PLAN

Prepared for

The Town of Brookhaven

February 2012

Prepared by

Cameron Engineering & Associates, LLP

In Association with

CH2MHILL

The following comments were received on the Draft Forge River Management Plan. The Town of Brookhaven and its consultant have reproduced all of the substantive comments/questions received by Monday February 6, 2012 below. Some of the comments/questions are abridged to retain just the key language – other introductory or explanatory language is deleted. No response is offered and comments are not reproduced where the comment was simply supportive of the Management Plan strategy. Comments are numbered for reference purposes only. All references to use of the Jurgielewicz Duck Farm as a potential site for a STP have been removed from the final Management Plan. The Plan does incorporate other potential sites for a sewer plant.

NYSDEC COMMENTS

Comment 1.

My comment pertains to tables 24-26, table 25-20 and 26-13 (short term, mid-term and long-term management strategies), please add footnote to each of the table to clarify that the DEC, marked as a responsible party under the Responsible Parties column is only responsible as a regulatory agency in terms of enforcement and permitting.

I don't want people to read this and think that we have authority to do many of the items outlined, as an example, take a look at S18 strategy on page 24-33, it says "encourage riparian area restoration by offering tax rebates to property owners for voluntary restoration of the wetland buffer", DEC has no mechanism to offer tax rebates, our involvement would only be in enforcement and permitting pertaining to riparian areas.

Response

Tables referenced in comment will be amended as follows:

Note: the NYSDEC is the responsible entity only in terms of its role in Environmental Conservation Law enforcement and permitting.

NYSDOS COMMENTS

Comment 2.

I do have some concerns over several of the mid-and long-term strategies that are related to dredging, and those recommendations that involve pumping and transferring water. Dredging projects at site specific locations are proposed in four mid-term recommendations, including:

- *25.4.1, Dredge Sills at Creek Mouths and at Mouth of Forge River;*
- *25.4.2, Remove Deposits South of Montauk Highway;*
- *25.4.3, Remove Deposits by LIRR Trestle; and*
- *25.4.4, Deepen Ely Creek*

Long term dredging projects include:

- *26.3.2, Dredge to Remove Accumulated Organic Material;*
- *26.3.2, Fill Creek Depressions; and*

- *26.3.4, Maintain Moriches Inlet*

*Dredging projects are not without significant issues, and all dredging projects must come into the Department of State for consistency review. That being said, we realize that dredging is an immediate solution, albeit somewhat temporary in nature. Therefore, the Town of Brookhaven may want to consider additional site specific options for reducing sediment, organic material and vegetation that could be used in conjunction with, or instead of extensive dredging. Please note that the New York State Department of State retained the consultant Woods Hole Group to compile existing information on dredging in the South Shore Estuary Reserve (SSER) as a preliminary step to a possible Dredged Material Management Plan. Reports have been completed that contain information and recommendations for improving dredging practices, and can be found at*http://www.estuary.cog.ny.us/dredging/dmmp.html

Response

The Report does recommend stormwater management measures to reduce future sediment and organic matter loading into the Estuary, particularly at the heads of several creeks, at the Montauk Highway discharge to the Forge River, and at the outfalls of all piped stormwater systems. Although these measures would reduce future inputs, water quality would be improved through the removal of historic accumulations.

Comment 3.

Recommendation 25.4.1 states that stormwater runoff and wave or wind-driven circulation likely cause creek bank erosion. Recommendations should be explored to reduce the stormwater runoff and stream bank erosion.

Response

The report suggests two strategies that are pertinent to stormwater runoff and stream bank erosion. First, the Town or County should restore degraded riparian areas that are under their ownership. Second, the Town should promote conservation easements and riparian area restoration for owners of private shoreline properties.

Comment 4.

Recommendation 25.4.2 states that winter sanding of Montauk Highway is a source of the accumulated deposits south of the highway. Recommendation 25.4.2 is to remove deposits and Phragmites south of Montauk Highway. While dredging this site may offer an immediate solution, it is also a somewhat temporary. The Town of Brookhaven may want to consider adding recommendations that target municipal practices for roads and bridges, such as:

- *Conduct road and bridge maintenance (de-icing material usage and storage, pot-hole repair, bridge washing, scraping and painting, etc.) according to best management practices;*

- *Require a percentage of roads to be tested with non-ice and non-sand de-icing;*
- *Develop and identify erosion/sediment control areas (examples include easily erodible soils, nearby sensitive areas and steep slopes) and retrofit opportunities;*
- *Review municipal practices such as street sweeping to ensure regularity.*

Response

Montauk Highway is a State roadway and thus outside the jurisdiction of the Town. The Report does suggest the installation of a sediment-capture device like a hydrodynamic separator for Montauk Highway roadway runoff.

Comment 5.

Recommendation 25.4.3 proposes to dredge deposits by the LIRR trestle. Is there any way to modify the trestle in order to increase flow and circulation, such as creating additional openings in the trestle?

Response

Although such a solution may be possible and even desirable, it may be far costlier than occasional maintenance dredging. As the train trestle may be considered a 'dam,' special permitting would be required. The bridge might need to be modified or one or more culverts installed beneath the trestle.

Comment 6.

Recommendation 25.4.4 is to deepen Ely Creek. This watershed is characterized as having gradual topography and a large contributing area, which may influence the naturally occurring shallow depth of the creek. According to the prioritization, land use and nitrogen pose the greatest threats to water quality in the Ely Creek watershed. Deepening the creek makes me very uncomfortable. If turf grass is a primary land use, where the use of fertilizers is of common practice, then site specific riparian buffers could be proposed, along with other site specific recommendations that reduce nitrogen from entering the groundwater.

Response

The report does recommend replacement of *Phragmites* with riparian buffers of native vegetation. One of the methods that are frequently used to reduce *Phragmites* populations is an increase in exposure to more saline water. Dredging Ely Creek would increase tidal exchange and the salinity of the Creek, which would reduce the growth of the reed. Increased water depths would lower water temperature and make the Creek most hospitable for marine organisms. Dredging would also remove some of the accumulated high-nitrogen sediment that contributes to the flux of nutrients from the benthos to the water column. Cutting and harvesting of *Phragmites* is also recommended as a management technique. Nitrogen reductions to the Creek are also recommended for the Forge River watershed in terms of fertilizer restrictions and wastewater treatment plant upgrades.

Comment 7.

Long term recommendations regarding the pumping or transferring of water are also of concern. The following two recommendations involve pumping and transferring water:

- *26.2.2, Pump Groundwater to Treatment Location; and*
- *26.3.1, Pump Bay Water to Head of Forge River and Priority Creeks*

While the plan states that these are not long term solutions to reduce nitrogen, but rather to move higher concentrations of nitrogen out of the system. Significant research is needed prior to conducting and investing in this type of project in order to weigh the benefits.

Response

The comment is correct in observing that these strategies require additional study. These strategies result from the recognition that even if all nitrogen loading ceased, groundwater nitrogen would continue discharge into the Forge River for decades from legacy nitrogen loading. For instance, although sewering could substantially lower nitrogen loading to groundwater, the effect of that sewering would not be realized for decades due to the travel time of groundwater to the Estuary.

These two strategies (26.2.2 and 26.3.1) were proposed as short- to mid-term mechanisms to remove the nitrogen that will continue to flow into the Forge River even if inputs are reduced. Implementing either strategy would be costly, but could be effective in lowering nitrogen inputs sufficiently to generate immediate water quality improvements. The first step would be the completion of the nitrogen TMDL to determine the required reduction in groundwater nitrogen. A preliminary evaluation of one or both of these techniques in the TMDL process could then be conducted to determine the costs and benefits of the strategies.

CITIZENS CAMPAIGN FOR THE ENVIRONMENT

Comment 8.

Upgrading of individual wastewater systems and establishing new wastewater infrastructure in communities within the identified watershed(s) should be given the highest priority…Wills Creek, Poospatuck Creek and West Mill Ponds are identified in the plan as the 3 most impaired subwatersheds entering into the Forge River. It would be advantageous for the Town to prioritize and focus efforts of either sewering or implementing more modern decentralized waste water systems within these impacted subwatersheds.

Response

The Town agrees with the comment and will seek opportunities to work with community groups to prioritize plan recommendations.

Comment 9.

It is also critical to note that several hundred homes are less than nine feet above groundwater, the minimum currently required by the County for on-site wastewater treatment systems (Figure 10-38). These low-lying homes are clustered primarily in four areas:

- *Along the northern side of Wills Creek*
- *Along the northern side of Poospatuck Creek and*
- *Most of the homes between Lons Creek and Home Creek*
- *Along both sides of the southern end of Old Neck Creek*

Suffolk County has recently identified and allocated a funding source of $2 million dollars per year to advance the use of these new residential wastewater treatment technologies. In addition, the County has now established a funding source for approximately $25- $40 million per year for upgrading existing or constructing new Sewage Treatment Plants. The Town and County need to aggressively work together to prioritize Forge River to be a recipient of these limited but valuable funds. Targeting these funds for use to repair or establish infrastructure which will prevent the worst known sources of nutrient pollution will be meaningful in the long term restoration efforts for the River.

Response

The Town continually seeks outside funding opportunities, and will continue to do so to assist with implementation of plan recommendations.

Comment 10.

The Town should implement a moratorium on septic systems within the defined watershed of the Forge River.

Response

A moratorium requires a comprehensive study of the affected area. The purpose of the Forge River Management Plan and subsequent TMDL are to gather new information and where applicable recommend further study.

Comment 11.

The Town of Brookhaven should seek to upgrade the existing 3 sewage treatment plants[Villas at Pine Hills, Pine Hills South, and Waterways at Bay Pointe] *with the possibility of expanding these STPs to include additional areas…It is unacceptable that these 3 sewage treatment plants are, on average, discharging nitrogen above drinking water standards of 10mg/1. CCE is also concerned that these samples are not taken directly from the effluent. Why not? SPDES permits require that effluent meet the state standard of 10mg/l. Once the effluent is discharged into groundwater dilution occurs and masks the actual N concentration. The average downstream monitoring wells are detecting nitrogen concentrations at 19.05, 18.325, and 17.46 mg/l. Peak concentrations are reported as 32, 58.9, and 36.3*[mg/l], *significantly above the drinking water standard of 10 mg/l. It would also be noted that surface waters have a* [nitrogen] *standard of 0.25mg/1, since nitrogen is toxic to marine life. CCE urges the town to upgrade these STPs to reduce nitrogen into groundwater and ultimately the Forge River.*

The Town should also seek to upgrade the treatment capacity of these facilities to provide for the option to expand treatment for additional properties within the watershed. Upgrading existing antiquated STPs that are clearly identified as a source of N pollution needs to be given a high priority for restoration efforts.

Response

The County has sewering studies underway that include portions of the Forge River watershed. The Center Moriches study is examining a number of sewering options, one of which includes upgrading and expanding one of the existing three plants to serve a larger area. The study is also considering a regional wastewater treatment plant that could serve the Mastic/Shirley peninsulas. In that case, these two plants might be converted to pumping stations that would direct wastewater to the regional plant. It should be noted that the three facilities are privately owned and operated and are regulated by the SCDHS. The Town does not have any authority over their operations.

Comment 12.

Sewering the most impacted areas of the watershed should also be a priority.

Response

The nitrogen TMDL will determine the reduction in nitrogen loading required to improve water quality to meet what will be the Forge River nitrogen concentration goal. As suggested in the Prioritization Report, sewering should start with the subwatersheds with the greatest nitrogen loading from onsite systems.

Comment 13.

It is critical that the town further understand organic decomposition and benthic flux as a nitrogen source. The algae and Ulva growth in the river system are not only indicators of high nitrogen levels, but actually become a source of nitrogen contribution through benthic flux that occurs after they decay. Benthic flux, or internal recycling, represents the transport of dissolved chemical species between the water column and the underlying sediment. This phenomenon is a never-ending cycle, therefore, the presence of the algae and Ulva strengthens the case for eliminating this source as both preventative and remediation action items. The draft watershed plan offers conflicting information on benthic flux. CCE urges the town to clarify these important discrepancies:

According to the draft plan, benthic flux, the breakdown of sediments is a very large contributor to the high nitrogen levels in the Forge River, but it is unclear exactly how much, because of conflicting reports in the document. On page, 10-56, the plan states:

> *"It is estimated that the largest nitrogen input to the Forge River is from nitrogen released from microbial degradation of sediment organic matter. The majority of the organic matter is from degraded algal (Ulva and phytoplankton) blooms that have settled to the bottom. The second largest source of nitrogen is on-site wastewater treatment systems that release nitrogen to groundwater... "*

The table 10-13…shows the above statement to be correct, but it is not consistent with other statements. This table is missing critical nitrogen inputs such as stormwater runoff-stated to be 6% of the nitrogen entering into the river. Please clarify the table…On page 10-37, the draft plan states:

> *"The authors estimated that approximately 30 to 50 percent of the nitrogen in the Forge River is derived from recycling of nitrogen from organic matter deposited in the sediments. Thus, according to the SOMAS study, sediment-derived nitrogen may account for one third to almost one half of all nitrogen inputs to the system. The majority of the rest of the nitrogen input is (as described above) from groundwater. Approximately 40 to 50 percent of the nitrogen in the system is removed annually due to exchange and flushing with Moriches Bay."*

This paragraph states that 30 to 50 percent of the nitrogen in the river is from recycling from organic matter, but table 10-13 states that benthic flux is responsible for 68%. Please clarify which is correct…In table 10-6, benthic flux is not listed as an input at all, yet in the above tables it is listed as a significant input. Please clarify how benthic flux is contributing nitrogen into the Forge River…This information must be clearly stated and understandable to the public, as it is critically important for determining the priority of certain action items, particularly activities related to dredging.

Response

Section 10.9.3 of the draft Management Plan is a summary of the nitrogen budget prepared by SoMAS in May 2009, while sections 10.9.4 through 10.9.10 are based on the nitrogen budget prepared for this study. The nitrogen budget calculated for this study was prepared for each subwatershed for the four primary nitrogen sources. The contributions from each nitrogen source varied between studies because the sources were based on different estimates and were grouped

together differently. The estimates from the studies are, however, within an order of magnitude of each other: 740-1,480 lb/day (SoMAS) vs. 1,743 lb/day from this study. Management strategy S23, Continue Research on Benthic Nitrogen Flux, acknowledges that further research is needed to better quantify the contribution of benthic flux to the Forge River nitrogen budget.

Comment 14.

The final plan should place more importance on breaking the cycle of benthic flux, being it is a significant contributor of nitrogen into the system. According to the draft plan, the recycling of organic matter cycle has been in place for over six decades. Breaking this cycle needs to be a top priority. As long as the present conditions exist, the cycle will continue, and restoration will be marginalized. It is necessary to break this cycle with three main action items:

- *Remove the current nitrogen sources; sediment, algae and Ulva that are largely contributing to the cycle*
- *Prevent further nitrogen inputs from entering the system*
- *Increase the circulation between the estuary and Moriches Bay.*

These three action items should be considered high priority, and should be grouped together within the plan, currently these items are listed separately and are spread over low, medium, and high priorities.

Response

Although correctly identified as three important and related strategies, they were separated in the Management Plan because they would be implemented by different entities and at different times. For example, sediment removal might be conducted by the County or the ACOE or both and would require independent review and permitting. *Ulva* collection could be the responsibility of the Town or County, could be operated by a private entity, and could be implemented more quickly than some of the other strategies can. Preventing further nitrogen inputs from entering the system requires changes to agricultural practices, residential fertilizer restrictions, onsite sanitary system upgrades, and ultimately, sewering. A number of different Town, County, and State entities would be involved in these efforts.

Comment 15.

On page 10-56, the draft plan states that "The cycle will continue indefinitely until sediment and groundwater nitrogen sources are significantly reduced and circulation within the estuary and between the estuary and Moriches Bay is restored...." The cycle is a critical component of degraded water quality and a flow chart like the one above would help readers better understand this complex cycle.

Response

The flow chart will be incorporated into the report.

Comment 16.

CCE urges the town to incorporate navigational dredging needs into remediation needs. CCE also cautions the town NOT to rely on routine dredging to become a main component of the restoration process. This will not allow for the restoration of a healthy, thriving ecosystem.

a) Dredging Sediments should be a High Priority

CCE agrees dredging is needed and should be utilized as a mechanism to provide immediate improvement of the water body, but it should not be relied upon as a long term water quality protection plan and pollution sources need to be addressed, not just remediated. In addition, more clarification is needed to identify the depth of sediment removal needed for dredging to adequately address benthic flux.

b) Current Plan to Dredge for Navigation Should Include Water Quality Components

A comprehensive, holistic plan that includes both navigational dredging and dredging for water quality needs to move forward simultaneously. Currently, there is a plan moving forward to dredge the Forge River, tributaries, and Narrows Bay. According to Suffolk County, this project is considered to be maintenance dredging and is only being performed to improve navigation and does not incorporate a goal of environmental restoration purposes. This pending plan to dredge the river for navigational purposes needs to be recognized in the management plan. Any dredging activities that occur should not be solely for navigational purposes, but also for maximum benefit in removing sediment that is contributing to benthic flux. In the past, dredging has had beneficial effects on flushing this system and improving water quality, but were not specifically designed and implemented for this reason and, therefore, did not completely remediate the system. For example, navigational dredging would not reach critical parts of sediment deposit near the head of the river that were formed from sand and grit from runoff, this needs to be addressed.

Considering water quality in dredging plans is in accordance with the 2006 Suffolk County determination that "environmental factors and marine productivity should be added to the criteria used to determine if a dredging project is in the public interest." The navigational dredging project as-is is estimated to cost over $3 million and plans to dredge -6 feet below the plane of mean low water. According to research by Stony Brook University, the sediment in the Forge River is between 2.3 to 9.2 feet to the sand layer. It would waste large sums of tax payer money to do navigational dredging now, only to later determine that further dredging is needed for restoration of the River. This proposal should go before the Dredging Projects Screening Committee to be considered with the current dredging project.

Response

The following paragraph will be added to section 25.4:

> The County is currently developing a plan to dredge the Forge River and its tributaries for maintenance ‘navigational’ purposes. Suffolk County includes environmental factors and marine productivity among the criteria it uses to determine if a dredging project is in the public interest.

> The County's plan should therefore be expanded to recognize the importance of dredging to Forge River water quality. Dredging will not only improve navigation, but tidal circulation as well. The dredging plan should be reviewed by the County's Dredging Projects Screening Committee and should include the following several strategies to improve Forge River water quality.

Similarly, the following will be added to section 26.3.2:

> The County is planning to dredge the Forge River and its tributaries for 'navigational' purposes. The County's dredging plan for the Forge River should include long-term removal accumulated nitrogen-rich sediments if future benthic flux studies demonstrate that such an initiative could lower water-column nitrogen.

Comment 17.

Include updated information in the Final plan since 2011 closure and lawsuit [related to the Jurgielewicz Duck Farm]. *The Draft Plan cites that "The Jurgielewicz Duck Farm, located directly adjacent to West Mill Pond (Figure 10-40), represents the largest nitrogen point source, at 195 lbs N/day." It is necessary to clarify whether these numbers are still accurate considering that the Jurgielewicz Duck Farm shut down operations in summer of 2011. Language used in the plan infers that the Duck Farm is still in operation. If these numbers have not yet been updated, the final plan should identify what are the daily projections of nitrogen input moving forward now that there are no new sources at the farm location.*

Response

The following footnote will be inserted in the Report:

> The Jurgielewicz Duck Farm ceased operations just prior to the publication of this report. Nitrogen loading will be re-calculated as part of the formulation of the TMDL without the input from the duck farm.

Comment 18.

Immediate remediation of the Duck Farm should be of extremely high priority and expedited due to the extremely high nitrogen contribution from the farm. During operations, the farm contributed 195 pounds of nitrogen into the river every day; this is equivalent to nitrogen input from 4,000 households with properly functioning onsite wastewater treatment systems. The duck farm treatment plant's total effluent nitrogen concentration is similar to the influent concentration at a typical human wastewater treatment plant. Because "groundwater travels slowly to the estuary, nitrogen entering the Forge River through groundwater today may have been released many years or even decades ago." It is necessary to prevent further nitrogen inputs by the swift remediation of duck waste before it leaches into groundwater.

Carryout strict enforcement against the previous owners of the Duck Farm. Enforcement action must be taken by the responsible entity; the DEC. The short term timeline regarding owner responsibility that has been identified by the DEC must be strictly followed and enforced. The DEC originally

requested that the owners of the Farm be fined $600,000 but ultimately suspended $450,000 and reduced the fine to $150,000 after consideration of the owners filing of bankruptcy. The DEC also required them to submit a closure plan, which must address all parts of the wastewater system, including the removal of stockpiled duck manure. According to the DEC, the closure plan shall establish milestone dates for the implementation and completion of closure and remedial activities at the duck farm, identify any environmental consulting firms that would be assisting respondents in closing the duck farm, and provide access to Department staff to oversee the closure and remedial activities. The DEC is not responsible for this closure plan and the respondents must submit this plan 60 days from December 9, 2011. This plan is due on February 6. The final Forge River Watershed Management Plan should lay out this closure plan and use it as a reference for action items. The plan should also identify where the penalty of $150,000 has gone, and for what purposes it will be used. It should also be noted that if the $150,000 and the plan are not submitted on deadline, the fine will go back up to $600,000.

Response

The closure plan is not yet available. The following paragraph will be added to section 24.1.6:

> The acquisition of the Duck Farm properties and the associated environmental assessment and remediation plan is a short-term strategy, but would likely follow the closure plan required by the NYSDEC and would be subject to NYSDEC approval. The closure plan should be coordinated with the Town and/or County if it is publicly acquired. Cleanup of the Jurgielewicz Duck Farm property as soon as possible following acquisition could improve water quality relatively quickly. Because accumulated duck waste continues to leach into groundwater and West Mill Pond, its quick removal would be immediately beneficial. Similarly, restoration of the riparian areas of the property even before a land use plan is prepared would benefit Forge River water quality and provide wildlife habitat for a variety of aquatic and terrestrial organisms. Preparation of a land use plan in the mid-term is recommended subsequent to the cleanup and riparian restoration (see strategy M3) followed by its implementation in the long-term (see strategy L1).

Comment 19.

The draft plan states that the property will likely be auctioned off by the bankruptcy court before a cleanup takes place. The plan recommends that the Town of Brookhaven or Suffolk County should acquire the property from the court either individually or in partnership. CCE strongly opposes the auctioning of the land before full remediation and questions the market value of severely contaminated farmland whose development rights are owned by the County. CCE urges the Town of Brookhaven and/or Suffolk County to review and evaluate the feasibility of purchasing the land for use as a site of a regional Waste Water Treatment Plant. An environmental site assessment should be conducted to determine the scope of the work necessary for site remediation: An estimated cost should be associated with the cleanup of the property.

Response

The management Plan recommends such a site assessment prior to conducting any actions associated with acquisition of the properties by the Town or the County.

Comment 20.

Page 4-14 states "The Barnes Road Duck Farm is comprised of four lined lagoons and has a 'zero-discharge' SDPES permit. Because the SPDES permit requires no discharge, there is no effluent data collected or available. The presumption is that waste from the Duck Farm's lined effluent lagoons is removed and taken off-site for disposal." The plan should recommend testing at this location. Real solutions require real data. Assuming that a duck farm has zero discharge and basing our remediation plan on this assumption seems naive at best and downright foolish at worst:

Response

Section 24.1.6 notes that the "Jurgielewicz Duck Farm absorbed the adjacent Barnes Road Duck Farm." As such, all strategies for the 'duck farm properties' apply to both properties.

Comment 21.

There are several action items on the master list that have to do with the Duck Farm properties. They are located in the short, medium, and long term sections. It would be beneficial to have a single place where all action items having to do with the duck farm are located so that these items are not looked at individually, but holistically. The action items are:

- *24.1.6 Acquire Duck Farm Properties, Conduct Environmental Assessment and Prepare Remediation Plan (S6)*
- *25.1.3 Prepare a Land Use Plan for the Duck Farm Properties (M3)*
- *26.1.1. Implement the Land Use Plan for the Duck Farm Properties (L1)*

Response

See response to Comment 19.

Comment 22.

Conduct Stormwater Education, specifically in the surrounding watersheds of East Mill Pond and West Mill Pond...The Ely Creek area should also be included in targeted education because of the golf courses and ball fields. Many residents remain unaware that hundreds of household products contain contaminants that contribute to the degradation of nearby rivers and streams. An education campaign should be conducted letting residents know about local sources of nitrogen pollution into the Forge River and tributaries. A comprehensive education campaign would be spearheaded and implemented in partnership with the Town and County, and motivate members of the public to become active environmental stewards to prevent further degradation…Things residents can do:

1. *Maintain septic systems*
2. *Use rain barrels and items like permeable pavement to reduce storm water runoff*
3. *Reduce or eliminate chemical fertilizer application - compost*
4. *Use natural vegetation and barrier vegetation along properties*
5. *Conserve water usage*
6. *Refrain from feeding wildlife along waterways*
7. *Don't put improper materials down the drain - chemicals, oils, garbage, etc.*
8. *Properly dispose of boating waste*

9. *Clean up after pet waste*
10. *Prevent litter from entering storm drains, which often go unfiltered into waterways*

Response

Section 24.7.2 of the Management Plan proposes both broad and targeted community outreach and education programs. The goals of the outreach programs are to: 1) raise public awareness of the management strategies, 2) educate the public on the importance of their implementation, 3) encourage behavioral changes in support of the strategies, and 4)coordinate with the stakeholders and elected officials for the promotion and support of goals 1) through 3).

Comment 23.

There needs to be more clarification as to what is considered direct runoff. Some items (i.e. Farms, golf courses, duck lagoons, etc.) can be considered both stormwater and groundwater contributors. Stormwater on lawns, streets can be washed directly into rivers, and can leach into groundwater which eventually makes its way to rivers. How is this distinction made? Does the nitrogen budget account for this? Direct runoff (stormwater) is listed in table 10-6 as contributing 2.2%, but is not listed at all in table 10-13.

Response

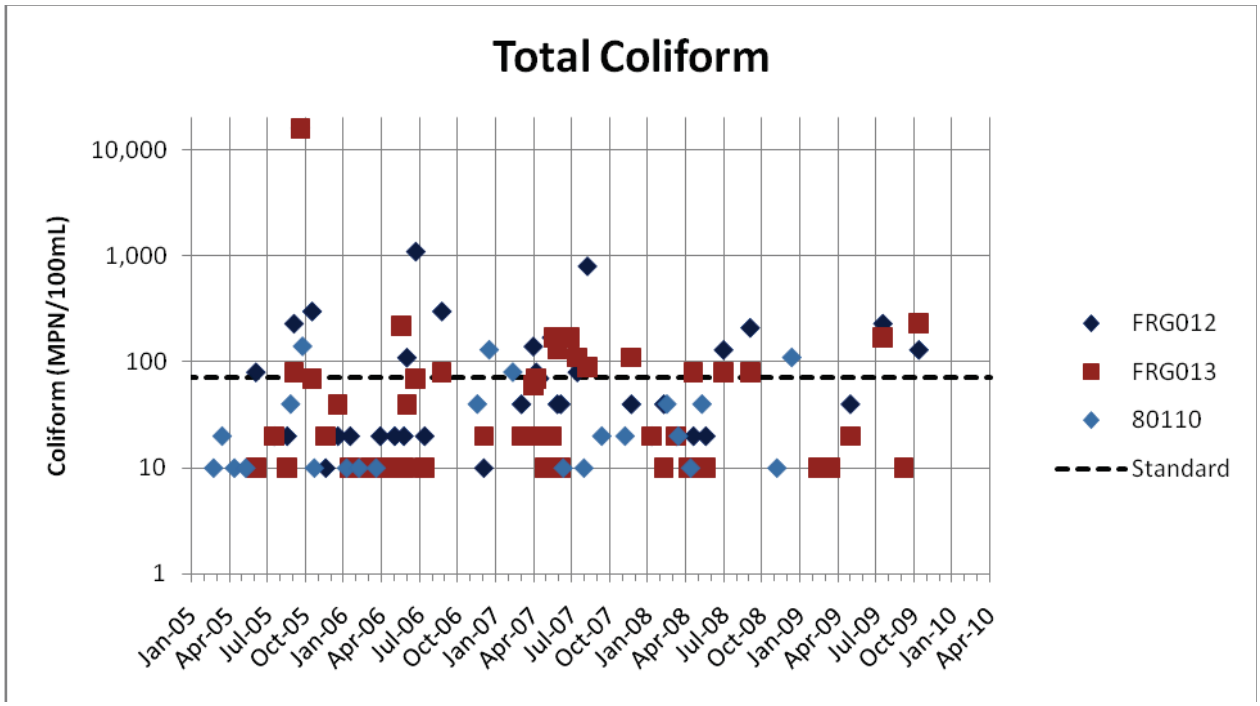
Stormwater (precipitation) that does not pass through the soil to groundwater is considered direct runoff. Stormwater runoff occurs over approximately 590 acres of the watershed (see Figure 3-3 in the Characterization Report). Nitrogen from atmospheric deposition accounted for a greater portion of the nitrogen load for parcels in the 590-acre direct runoff zone than in the remainder of the watershed. In the remainder of the watershed, approximately 8860 acres, rainfall passes into the ground where a portion of the nitrogen and other contaminants are removed by plants and soil bacteria. Stormwater runoff to the Forge River carries a higher concentration of nitrogen to the Estuary than the precipitation passing into the soil.

Comment 24.

CCE is requesting that the Town clarify the graphs regarding Coliform on pages 10-9 to 10-11, 10-14 to 10-15, 10-24 to 10-27, 10-32 to 10-35. The Coliform graphs cover several years but show different months every year. This does not paint a clear or usable picture of the annual cycles and in some cases is misleading.

Response

The graphs will be replaced with a series of new graphs such as the one below. The graphs clarify when samples were taken and indicate which values were higher than the standard.



Comment 25.

The town of Brookhaven should work with stakeholders and the Forge River Task Force to prioritize action items. CCE believes the following projects should be given top priority:

Short-term priority management projects:

- *S5 - Identify properties for acquisition or purchase of development rights. CCE urges the Town to work with the County and environmental groups that have maps of open parcels in Suffolk County.*
- *S6- Acquire Duck Farm Properties, Conduct Environmental Assessment and Prepare Remediation Plan*
- *S8 - Replace direct discharge stormwater systems with vegetated swales, rain gardens, and other green treatments.*
- *S11 - Impose strict limits on nitrogen fertilizer to the month of April. The draft plan states that 66.7 lbs of nitrogen enter into groundwater from residential and commercial fertilizer use, which is 87% of the total fertilizer contribution. CCE would urge the town to be aggressive and implement a ban on nitrogen fertilizers within the watershed.*
- *S13 - Require inspections of all OWTS at no cost to the properly owners. CCE believes it is important to adequately understand to the full extent the problem of failing septic systems*

and how many cesspools are still in operation. These can be mapped and allow for a targeted approach in deciding what areas should be prioritized for the county funds.

- *S20-Install an Oyster grow-out system for algal bloom control. Oysters feeding on plankton are capable of filtering 10 liters of seawater an hour. There are already aquaculture oyster projects within the South Shore Estuary Reserve. An initial project could act as demonstration for future projects throughout the Reserve.*
- *S23 - Continue research on benthic nitrogen flux. The Watershed Management Plan states that benthic flux is a significant source of nitrogen into the Forge River. Further research is needed to address this issue to remediate the existing conditions and prevent them from reestablishing in the future.*
- *S24-Develop methods to reduce agricultural fertilizer use and stormwater run-off. There are approximately 400 acres of farmland within the watershed and as much as 40-50% of applied nitrogen enters groundwater. Improved management of the farms can help to improve the river. Farmers should be encouraged or mandated to use organic practices, and at a minimum, be required to use slow release or natural fertilizers.*
- *S25 - Provide educational programs for property owners on implementation of Forge River Management strategies. Public acceptance and participation improve with increased outreach to the community.*

Mid-term Management Strategies

- *M1 - Acquire selected open space and direct development to developed areas outside the FROD or to future sewered areas.*
- *M3-Prepare land use plans for the duck farm properties and include consideration of the properties for a regional sewage treatment plant.*
- *M5- Provide stormwater treatment for run-off into the East and West Mill Ponds and the Forge River from Montauk Highway. Stormwater should be treated to remove sediments and contaminants. CCE urges the town to utilize green infrastructure where possible.*
- *M6-Determine the Total Maximum Daily Load (TMDL) for nitrogen. This is a project that the Town has already taken initial steps to move forward and should continue to pursue. A TMDL can take several years to complete and CCE would urge the Town to continue to reduce nitrogen inputs to the Forge River, while the TMDL is in development. The town should NOT put all efforts on hold while the TMDL is developed.*
- *M8- Evaluate the need and locations for a regional wastewater treatment plant*
- *M14-Harvest and dispose of Ulva to remove assimilated nitrogen and its associated water quality problems.*

- *M18-Test Nitrogen reduction by septic system bio-augmentation to improve OWTS efficiency. The management plan states that injection of selected bacteria into a septic system has been shown to improve their effectiveness at reducing nitrogen.*

Long Term Management Strategies

- *LI - Implement the Land Use Plan for the Duck Farm Properties. CCE urges the Town of Brookhaven and/or Suffolk County to review and evaluate the feasibility of purchasing the land for use as a site of a regional Waste Water Treatment Plant.*
- *L4-Improve the operation of private STPs.*
- *L5-L8- Sewer part or all of the FROD.*
- *L10-Institute long term dredging operations to remove accumulated organic matter from estuary. (However, CCE would alter this to dredging as needed).*

Response

The Town recognizes the need to prioritize management plan recommendations and will continue to work with community groups to develop implementation plans.

Comment 26.

CCE strongly urges the town to re-evaluate and potentially eliminate the following recommendations:

- *M2-Purchase development rights for existing farms in the Forge River watershed. Allow greenhouse farming with lot coverage limits as less fertilizer and pesticide is released from greenhouse farming than open field farming.*

This statement is not true and is harmful. Greenhouses can and have left a legacy of contamination on Long Island and in our groundwater. One such example, a superfund site, entitled the Bianchi/Weiss Greenhouse site in East Patchogue, housed a greenhouse. The site is now highly contaminated with lead and chlordane. The contamination extends 2,900 feet down gradient of the site with said contamination in both in soil and groundwater. The pesticide Imidacloprid, one of the top 3 most frequently detected pesticides in Long Island's drinking water, is widely used to control white flies in greenhouses. The pesticide is highly likely to leach into groundwater and a recent report released by NYS DEC found it was detected 890 times throughout Suffolk County's groundwater supply. ***CCE would urge the town to encourage organic farms that do not use pesticides or chemical fertilizers. We are strongly opposed to a blanket statement allowing and encouraging greenhouses, unless specified that they adhere to the SC local pesticide phase out law. This successful legislation bans the use of pesticides from county owed greenhouses, and only exceptions can be made with an emergency request application.***

Response

Section 25.1.2 and the associated strategies will be rewritten as follows:

> In addition to the permanent protection of farmland through purchase of development rights, the Town could consider provisions to support local farmers while reducing nitrogen runoff associated with fertilizer applications. The Town should work with representatives of the agricultural industry and researchers from Cornell Cooperative Extension to select crops and management methodologies that require less nitrogen fertilizer. Similarly, farmers should be encouraged to utilize organic farming techniques and integrated pest management that reduce or eliminate the use of pesticides. Greenhouse farming, can, when well-managed, exert greater control over fertilizer applications (with drip 'fertigation' and recirculation), which can thereby reduce total application rates. The potential for visual impacts from greenhouse farming, however, should be reduced using lot coverage limits and a requirement for buffers.
>
> **ACTION ITEM**
>
> - Purchase development rights for existing farms.

Comment 27.

[With regard to L2- Install permeable reactive barriers], CCE would urge the town to further research this option before advancing this highly questionable procedure. Perhaps first provide a computer model to start with.

Response

Strategy L2 would only be implemented (as stated in the Report) if strategy M17 (Test Permeable Reactive Barriers for Groundwater Nitrogen Removal) proves successful.

Comment 28.

L3-Pump groundwater to treatment locations such as wetlands or denitritfication reactors and L-9 - Pump bay water to head of the Forge River and into priority creeks. CCE's position is that these are not long-term treatment and restoration tools for the Forge River. A pump and treat system can be costly and masks the true problems of contamination into the river. It does not remedy the source of the pollution and masks the problem. It needs to be taken off the table. Pumping groundwater to treatment locations is the same "quick fix" mentality and only allows for business as usual without addressing the core of the problems. The town should not invest money into projects that are simply a Band-Aid masking true problems of the river.

Response

See response to Comment 7.

SAVETHE FORGE RIVER

Comment 29.

Moriches Inlet has been shown to have an impact on Forge River tidal flushing. We support the continued maintenance of the Inlet.

Response

Work by the SoMAS at Stony Brook supported the assertion that inlet capacity had a direct relationship on tidal exchange in the Bay and the Forge River. Keeping the Moriches Inlet open and well-maintained is important to improved water quality in the Forge River. The Army Corps of Engineers is the agency that maintains the Inlet.

Comment 30.

Save the Forge River supports the preservation of open space. We believe, however, that not all public land acquisitions should be for preservation alone. Land acquisitions can be for other public benefits including active recreation and in some cases, for public utilities, such as treatment plants. Acquisition of the duck farm property is a good idea. Use of the property for a treatment plant may make sense, though further study would be needed of this and other locations before a determination could be made.

Response

Suffolk County has studies underway that will look at different sewering options for the Mastic Shirley area and potential locations for one or more treatment plants.

PECONIC BAY BAYKEEPER

Comment 31.

(S6) Acquire and remediate the duck farm properties - What remains a questionable decision, the TOB in 2006 purchased the development rights on the Jurgielewicz duck farm. The legacy of duck farming in this watershed is well established and although discontinued on this parcel, the future agricultural use has uncertain environmental ramifications. The optimal management action is to restore this property to native riparian habitat that will benefit water quality while providing the community with an area for passive recreational use. The other land-use options identified in 26.1.1 must be secondary to habitat restoration and thoroughly analyzed before any further consideration.

Response

The Management Plan recommends a cleanup, followed by a remediation and land use plan. The Management Plan recognizes the importance of and recommends riparian restoration. For the long term, the Management Plan recommends the preparation of a land use plan that identifies the best use of the properties.

Comment 32.

(S11) Impose strict limits of nitrogen fertilizer use - If this strategy recommends the adoption of Suffolk County's residential fertilizer restriction (November 1 through April 1), the restrictions are already in place and because the restrictive window of time occurs during the cold weather months the benefits to water quality are questionable. If fertilizer restrictions are considered they should include the growing season.

Response

The Management Plan recommends that the Town restrict the use of fertilizer to the month of April only.

Comment 33.

(S12) Develop installation requirements for the replacement of OWTS - Deferring to Suffolk County sanitary health code standards is woefully inadequate for the protection of surface waters. Installation requirements (for nitrogen reduction) need to be directly linked to performance standards for the treatment of effluent. The Nitrex system, which has been recently approved by Suffolk County, can effectively reduce nitrogen concentrations in sanitary wastewater effluent in the range of 3-4 mg/L. Installation of the best available technologies for de-nitrification should be the requirement.

Response

Although installation of the "best available technology" is a good idea, *requiring* its installation would be problematic. The systems are relatively expensive for homeowners, in the range of $15,000-$30,000 per unit. Most advanced systems also require routine servicing that would likely be beyond the capability of most homeowners and would add additional annual cost. Community-based,

area-wide, or regional wastewater collection and treatment would be more cost-effective than widespread use of individual systems. A key next step is the development of the TMDL. It will help determine the reduction in nitrogen loading to groundwater required to generate in improvement in Forge River water quality. From this information, decisions can be made on the extent of the sewering effect necessary to achieve water quality goals.

Comment 34.

(S13) Require inspections of all OWTS – I support the first element of this management action (identifying and documenting the status of existing systems). However, the requirement for upgrades needs to be more clearly defined. If the recommendation is that upgrades meet the current code pursuant to Suffolk County Department of Health Services (SCDHS) standards, negligible water quality improvements relative to nitrogen loadings will be realized. The term "upgrade" needs to be directly linked to nitrogen reduction performance standards and be modified (more restrictive) as the available technologies improve. Use of this term in the current context (SCDHS) is misleading to the public and is inconsequential as a nitrogen reduction strategy.

Response

The term 'upgrade' in the relevant sections of the Management Plan will be replaced with 'bring into compliance with County and new Town requirements.' Water quality improvements could be realized by bringing into compliance the numerous OWTS constructed prior to current County requirements. Many of these, constructed too close to groundwater, are less effective than they would be if built according to County requirements. Other OWTS systems are simple cesspools that become clogged more quickly than septic systems that have solids collection capability and proper detention time. Clogging reduces the capacity of soils to support the bacteria that degrade OWTS effluent prior to its recharge to groundwater. Presently, SCDHS is the agency charged with regulating the design and installation of OWTS. Modifying current regulations and standards may be a mid- or long-term objective. In the meanwhile, non-compliant installations should be brought into compliance.

Comment 35.

(S14) Enact ordinance requiring pump-outs for all OWTS every five years- From a maintenance standpoint; periodic pump-outs can be beneficial to the functionality and longevity of a system. Relative to nitrogen reduction (both individually and cumulatively), pump-outs, even when performed on an annual basis have minimal effect on nitrogen loadings emanating from OWTS. This assertion is based on the findings of the Buzzards Bay National Estuary Program, the body that conducted an analysis to determine the magnitude of nitrogen reduction if this is a cost effective approach. The conclusion is that it's not and should be omitted as a viable nitrogen reduction strategy.

Response

Onsite systems must be maintained to keep them functioning properly. Drainage fields will clog if septic tanks are not pumped out periodically. Clogged drainage fields reduce the capacity of soil bacteria to degrade nitrogen and other contaminants of OWTS effluent. System backups and overflows can occur if maintenance is not provided leading to public health hazards and possibly to stormwater systems and even receiving waters.

The PBK is correct, however, that the same dollars spent on sewering instead of OWTS pump outs can achieve much greater nitrogen reduction. The following will be added to this section:

> The Buzzards Bay National Estuary Program recommends and the Chesapeake Bay Preservation Act requires onsite wastewater systems pump outs every five years for system maintenance. Although regular OWTS pump outs will help these systems function effectively and will help avoid public health problems, sewering is ultimately the more effective choice for nitrogen reduction. On average, OWTS effluent contains 50 mg/l total nitrogen, whereas an advanced treatment plant can discharge effluent with nitrogen concentrations less than 10 mg/l.

Comment 36.

(S15) Require all OWTS meet Town requirements at time of sale - What are the specifics of new TOB requirements the Plan is referring to? In 2010, PBK provided the TOB with the specific legal citations that supports enacting municipal sanitary codes that are more restrictive than State or County codes (see Carmen River Study Group). To my knowledge, the TOB retains the position that Suffolk County is "the" only authority that can regulate sanitary wastewater. Is the Plan recommending that the TOB exercise their authority and enact more restrictive wastewater discharge policies that provide greater protection to surface waters? S15 requires further explanation.

Response

The Town has been investigating this issue and is committed to working with its agency partners to develop more restrictive waste water policies.

Comment 37.

(S17) Provide water conservation kits-Although water conservation is a laudable strategy for a host of reasons, it's a conflicting strategy as it pertains to nitrogen reduction. It is well documented that water conservation in wastewater apparatus strengthens the concentration of nitrogen in effluent. This strategy requires scientific justification or stricken from the nitrogen reduction section.

Response

Water conservation will not *directly* reduce nitrogen. It will, however, improve system efficiency by extending residence time and will reduce the likelihood of system failures due to hydraulic overload. The following will be added to this section of the Management Plan:

> The USEPA states that "*minimizing wastewater volumes can improve the efficiency of onsite treatment and lessen the risk of hydraulic or treatment failure*" (USEPA, 1995*). The USEPA reports the most common OWTS failure is from hydraulic overloading. Detention is reduced,

which decreases pollutant removal and overloads the infiltration field. The USEPA recommends reducing water use to decrease hydraulic loading and improve system performance.

*U.S. Environmental Protection Agency (USEPA). 1995. Clean Water Through Conservation. EPA 841-B-95-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Comment 38.

(M6&M7) TMDL development and implementation - PBK's primary objective in petitioning the DEC to classify the FR as Impaired Waters (303d) remains the implementation of an effective nutrient reduction strategy best achieved through a TMDL. We're pleased that the TOB is committed to this endeavor. That, being said, the pending TMDL will only succeed if there is the political will to implement the appropriate regulatory policies and the financing required to install the necessary wastewater and stormwater infrastructure. At this juncture in time the TOB should recognize which management actions are essential components of the TMDL and begin discussions on implementation in advance of the draft TMDL.

Response

Implementing TMDL-related management actions in advance of the TMDL is premature.

AFFILIATED BROOKHAVEN CIVIC ORGANIZATION INC. (ABCO)

Comment 39.

The report repeatedly incorrectly identifies and characterizes locations, conditions and water quality present at the headwaters of the Forge River. For the record, the headwaters of the Forge River are located north of Sunrise Highway east and west of Barnes Road and are the major sources of fresh water input to the River.

The report identifies alternately the Long Island Railroad (MTA) trestle crossing as either the headwaters or alternately the northern limits of salt water circulation. The report incorrectly states at the same time "the Forge River contains no fresh water as in the Peconic and Carmans Rivers." This glaring error resulted in a recommended strategy to pump salt water into the upper reaches of the Forge River to "increase circulation." There is no scientific evidence that pumping salt water into fresh water habitats is either warranted or even environmentally sound. Perhaps the consultant would have secured more accurate information, reached more reasonable conclusions and developed a clearer picture of the watershed if it had used a marine professional familiar with the Forge River for the tours mentioned in the Plan. Clearly there were several available with long-term expertise on the river that could have been used.

Response

Management Plan references to the Forge River 'headwaters' will be clarified. The section on pumping will be revised as follows:

> Pumping bay water to the head of the *intertidal portion of the* Forge River *between Montauk Highway and the railroad trestle* and to the priority creeks would increase circulation and oxygen concentrations, while reducing temperatures and nitrogen concentrations.

Comment 40.

The report identifies the recently closed Duck Farm, at the West Mill Pond, south of Sunrise Highway, as a possible location for a Regional Sewer Plant. The County and the Town own only the development rights to the now closed duck farm. These rights were purchased in 2006 using open space and farmland preservation funds and as such, the parcel cannot and should not be considered or used for other than parkland or agricultural purposes. The inherent difficulties in acquiring the fee simple title to the site for such a purpose were not even remotely covered in the recommendation of the site for such an intense purpose along a 303d impaired waterway cannot be underestimated.

Response

References to use of the Jurgielewicz Duck Farm for a regional sewer plant have been removed from the Management Plan.

Comment 41.

The Mid-term strategy for use of this site as a potential `regional' STP was at best poorly researched and offered little more than a speculative off-hand suggestion, endlessly repeated and a limited and cursory view of the environmental adverse impacts for such a use of this location site for a major infrastructure construction. Unfortunately, the consultant failed to realistically research the ownership, purchase terms, bankruptcy status, or previous litigation regarding the location of another STP at the headwaters and along the Forge River that eventually was dropped and the site acquired as open space. The previous plan was litigated, contested and ultimately resulted in a purchase of the 154-acre Mastic Woods, just north of the duck farm, for some $16,000,000 dollars as preserved open space.

Response

See response to comment 40 regarding the Jurgieliwicz Duck Farm.

Comment 42.

The plan is supposed to be aimed to develop objectives for a Forge River Management Plan, but seems to have morphed mid-way into yet another forum for discussion of plans for regional sewer treatment. Although, such a discussion is necessary and already underway at taxpayer expense, this Plan was supposed to address conditions in the watershed and mythologies [sic] *to address remediation and restoration of the waterway and its watershed.*

Response

The major conclusion of the Management Plan is that nitrogen reduction should be the number one management priority. Sewering is the strategy that will achieve the greatest reduction in nitrogen. The Management Plan offers sewering options other than a regional treatment plant, such as community sewering. The economics of public sewering, however, favor larger regional plants where the costs can be distributed over a larger number of users. Another alternative, proposed in early 2012 by the Suffolk County legislature, may be the establishment of a Suffolk County sewer district, where presumably all residents of the County would contribute to the costs of sewering as all residents benefit from clean drinking water and surface water. If the County were to pursue such a course of action, smaller community-sized treatment plants might become more cost effective.

Comment 43.

However, pointedly, several of the strategies recommended and discussed as part of the FRMP included previous feasibility plans developed by the County for regional sewering that included areas outside the Forge River Watershed. The inclusion of these previous plans seems off-base as these plans were rejected as too costly by both county government and the Mastic-Shirley community at large. Although conditions in the Forge have been used as a repeatedly as a poster for implementation of sewering, none of these plans purpose was to remediate conditions in the Forge River. In fact, they never indicated any of the plans could actually deliver meaningful or

demonstrable improvements to the nitrogen loads or hypoxic conditions as much of the areas proposed for sewering were completely outside the boundaries of the Forge River watershed, while large areas within the watershed were completely ignored. Furthermore, these plans focused and included largely business areas along Rt 27A, CR46 and Neighborhood Road with little residential sewering. Residence and failing cesspool are one of the main remaining sources of nitrogen pollution to the river. Absent plans to remediate the environmental conditions in the Forge Rive these three plans were simply a wholly unproductive discussion.

Response

The comment is correct in stating that sewering of the business districts alone would have a relatively small impact on Forge River water quality. However, sewering of the Forge River watershed could in fact lead to substantial improvements. The County study for the Mastic Shirley peninsulas found that sewering would substantially reduce nitrogen loading to the Forge River and Moriches Bay/Narrows Bay. The report states "*the abandonment of onsite systems which at most can remove 40% of the conventional pollutants and minimal concentrations of nitrogen and phosphorus would be replaced by the state of the art technology with nitrogen of* [sic] *concentrations less than 4 mg/l and conventional pollutants in the single digits."*

Comment 44.

We found the discussion of a strategy for a transfer of development rights program too vague and ill-defined to be a useful tool for protection and or restoration of the Forge River. The report failed to even identify 'receiving or sending areas.' Little date was presented for consideration that such a TDR program would be workable. We find it an unavailing in the fully built-out communities of the Mastic Peninsular we find their inclusion to be uninformative at best. When one considers that a similar TDR program is presently being considered for the Carmans River data is essential to know how much Transfer of development is reasonable, can be accomplished, and what is the additional realistic carrying capacity of the Town to absorb such increases to development in other non-stressed areas of the town. The TDR strategy is possibly useful in the northern reaches of the Forge river Watershed to preserve those areas intact, but research shows those areas have been identified as TDR receiving areas for the transfer of DR in the Carmans River. Obviously, this is a mutually exclusive concept and is unworkable for the Town to implement two TDR programs that transfer development to other equally if not more environmentally stressed communities.

Response

TDRs are just one tool. Further analysis is required before a TDR program can be considered, including a full investigation of potential sending and receiving sites.

Comment 45.

The Forge River has been a distressed estuary since the early part of the 20th century. Extensive duck farming in the 20th century along the banks of the Forge River and high density residential development contributed to the high-nitrogen content sediment load that remains. Residential development booms in

Mastic Beach area in the early and on the peninsula in the mid- twentieth century added thousands of onsite wastewater treatment systems (cesspools and septic systems) inside the Forge River watershed.

Response

Report text will be modified as suggested.

Comment 46.

(S2) - Explore potential dedicated funding sources such as a FRPOD fee to provide water quality improvement services to property owners based on water usage and assessed value. Such a fee could be added to property owners' tax bills. Property owners already connected to private STPs would be assessed a lower fee. - What formula would be implemented to address the inequities of the watershed geographic communities? Since areas within the watershed FRPOD would be subject to the "fee," an inequity arises since the watershed pollution is not contributed equally from all parts of the watershed, and areas more densely populated have historically imposed greater impacts, but have lower assessed valuations than those areas to the north with less density, less impacts and higher assessed valuations.

Response

All residential properties within the watershed contribute to the nitrogen loading of groundwater. Nitrogen from properties located further from the estuary simply takes longer to reach the estuary. Property owners would be assessed a fee based on both water usage and assessed value. The exact formula has yet to be determined, but it is likely that water usage would be weighted more heavily than assessed value as it is more directly related to nitrogen loading.

Comment 47.

(S3) - Create a Forge River Protection (FRP) Fund for program expenditures, green infrastructure, and loans to property owners for eligible improvements. - The sources for this fund should be considered from a variety of town wide fees and assessments, not merely attached to the residents. The pollution has occurred over decades and many have benefited from the permitted higher densities that resulted in deterioration of the ground and surface waters of the river.

Response

The Town will explore all possible revenue sources.

Comment 48.

(S4) - Establish a low-interest loan program for property owners for onsite wastewater treatment system (OWTS) improvements with initial funding potentially from the FRP Fund. Property owners could repay the loans through their tax bill. Loans would survive changes in property ownership and stay with the property. - Consider bundling OWTS for residences located in neighborhoods, identify as sub-districts, and establish routine fees per household for regular maintenance costs associated with such systems.

Response

Community-based sewering is in fact one of the strategies presented in the Management Plan.

Comment 49.

(S5) - Identify properties for acquisition or purchase of development rights based on location and environmental resources. Reducing future development opportunities can lower future nitrogen generation and release. - Additionally and alternatively, identify and up zone undeveloped watershed areas to reduce future development opportunities; which will lower future nitrogen generation and release.

Response

The Town agrees with the comment and recognizes that this is yet another tool to aid in the reduction of nitrogen loading to the watershed.

Comment 50.

(S6) - Acquire and remediate the duck farm properties and consider their use for temporary dredge material management. - Any consideration for future use as a temporary dredge material management site must be fully explored for adverse impacts on adjacent communities.

Response

Such a use would likely require a permit from the NYSDEC, where potentially adverse environmental impacts would be evaluated.

Comment 51.

(S7) *- Impose stricter clearing limits and fertilizer applications inside the FRPOD watershed retain existing native, non- fertilizer dependent vegetation, towards maximizing natural groundwater filtration systems.*

Response

Fertilizer limits are addressed elsewhere.

Comment 52.

(S8) - Replace direct discharge stormwater systems, modernize catch basins with new technology systems with end of pipe equipment that removes pollution before entering the water, include where reasonable and possible new vegetated swales, rain gardens and other "green" treatments. Systems that discharge directly to the estuary can do not capture stormwater contaminants and nutrients prior to their release to the estuary. Green alternatives increase infiltration and degradation by soil bacteria.

Response

Management Plan language will be modified as follows:

(S8) - Replace direct discharge stormwater systems by incorporating new technology including, where appropriate, catch basin inserts and end-of-pipe equipment that removes pollutants before they are discharged to the estuary. Utilize preferentially and where possible vegetated swales, rain gardens and other 'green' treatments. Green alternatives increase infiltration and degradation by soil bacteria.

Comment 53.

(S9) - Adopt a 'Green Streets' policy('Green Streets, application requires details, and (needs explanation and definition) to improve roadway design for capturing, treating and or improving stormwater management~~, and improve „walk ability" and lower vehicle miles traveled~~.

Response

Management Plan language will be modified as follows:

(S9) - Adopt a 'Green Streets' policy to improve roadway design to capture, treat, and improve stormwater management.

Comment 54.

(S10) - Develop a demonstration low-impact stormwater management site to demonstrate to builders and homeowners methods for improved stormwater management. Intent remains unclear, applicability and cost must be better developed.

Response

The Town is already considering this recommendation, Town-wide. Management Plan language will be modified as follows:

(S10) - Develop a low-impact stormwater management demonstration at a Town-owned facility to demonstrate to builders and homeowners methods for improved stormwater management.

Comment 55.

(S11) - Impose strict limits of nitrogen fertilizer use, impose a no fertilizer zone within 1000 feet of the river and permit fertilizer applications only to the month of April for all land uses except agriculture; encourage natural applications for farmland with tools for measuring success.

Response

A portion of the fertilizer applied anywhere in the watershed will reach groundwater. Consequently, fertilizer use should be restricted throughout the watershed. A stated in the Management Plan, its use should be restricted just to the month of April.

Comment 56.

(S12) - Develop installation requirements for replacement OWTS using SCDHS standards as guidelines. pre-1972 and post 1973 septic and cesspool systems with OWTS using newly approved systems identified

by SCDHS and develop lower nitrogen release standards measured "at end of the pipe", with guidelines and standards designed to limit nitrogen and phosphorous loads.

Response

The intent of this measure is to impose the same requirements for replacement systems as those imposed on new systems.

Comment 57.

(S13) - Require inspections of all OWTS at no cost to the property owner. (Do not limit inspections to FRPOD phase should apply to entire town). Property owners would be required to upgrade systems that do not meet new Town requirements within three years of the initial inspection. A FRPOD town wide fee would cover the cost of the inspection. (Establish a seven year phase-in period). Utilize low interest loans from the FRP Fund for replacement systems. Improvements might include replacement of cesspools with modern septic systems, installation of leaching fields for properties with high groundwater and other improvements required through inspections of self-contained closed systems.

Response

Comment noted. All funding opportunities will be considered.

Comment 58.

(S15) - Require all OWTS to meet new Town requirements on sale of property. Require inspections of all OWTS prior to the sale of property with fee paid by seller. Systems that do not meet new Town OWTS requirements would need to be upgraded prior to sale of the property (similar to existing Wetland and Waterways requirement for building extensions. Add code similar to in sewered areas requiring sewer hookup for residences located in areas that have capacity to connect) Require any new development provide flow volumes to accommodate a % of the surrounding build environment as condition for approvals.

Response

The Town does not have the authority to require hook ups.

Comment 59.

(S16) - Reduce residential water use to reduce wastewater volume and increase residency time and treatment efficiency in OWTS. Require dual flush toilets for all new bathroom installations or remodels. Require low flow faucets for all new or remodeled bathrooms and kitchens. Update accessory apartment and home rental rules mandating such fixtures be installed upon granting and/or renewal of any rental permit.

Response

Comment noted.

Comment 60.

(S23) - Continue research on benthic nitrogen flux to determine the flux of nitrogen from sediments into the water column. A better estimate of the contribution of sediment nitrogen is necessary to will help determine the value of extensive long-term dredging in the Forge River; before such long-term dredging is contemplated, funded, or undertaken.

Response

Management Plan language will be modified as follows:

> (S23) - Continue research on benthic nitrogen flux to determine the flux of nitrogen from sediments into the water column. A better estimate of the contribution of sediment nitrogen is necessary to determine the value of extensive long-term dredging in the Forge River before such long-term dredging is funded and undertaken.

Comment 61.

(M1) - Acquire selected open space and direct development to developed areas outside the FRPOD or to ~~future sewered~~ areas in the watershed through the Town wide Transfer of Development Rights (TDR) program. Utilize the FRPOD as a 'Sending Area,' and designate selected hamlets and commercial areas outside the FRPOD as 'Receiving Areas.' The Town's long-term land use strategy encourages development in hamlet centers and commercial areas to preserve green space and the character of single-family neighborhoods. The TDR program provides a mechanism to incentivize development in designated mixed-use centers.

Significant problems exist with this TDR 'cookie cutter' approach. The Town is already approaching build-out and now exceeds carrying capacity as evidenced by all recent data on ground and surface waters. TDR's, if practical at all need to be implemented and addressed in concert with all other applicable TDR and sanitary flow credit plans and programs. We do not believe there are sufficient available residential, industrial or wooded undeveloped areas left in TOB to accommodate the volume of TDR programs presently being proposed. Re-zonings to higher densities simply compound the problems inherent in restoring and protection of our natural environment and vital aquifers. In fact, some of the areas that are proposed in this plan proposed as sending areas have been already been designated as receiving areas under the pending Carmans River TDR program. This is not a likely to prove a useful tool for the undeveloped areas of the watershed, where regulatory changes to these areas that require up-zoning to simply make the changes necessary to sustain the environment and the wooded areas providing fresh water to the river. Unless an owner is deprived of all rights to use the land, it does not constitute a taking, and will not require significant payment, much like the re-zonings resultant from the 208 study. No mixed use centers exist in FROD nor has the draft 2030 Comprehensive Plan been adopted.

Response

See response to comment 44.

Comment 62.

(M2) - Purchase development rights for existing farms in the Forge River watershed. The Town and County recognize the value of existing farms to Long Island and have purchased the development rights for thousands of acres of existing farms, including the duck farm properties of the Forge River. Allow for purchase of farms in watershed less than seven acres. Acquire and permit greenhouse farms within watershed. Allow greenhouse farming with lot coverage limits as less fertilizer and pesticide is released from greenhouse farming than open field farming. Farm lot coverage should restrict greenhouse flooring to natural surfaces, while buffer zones should be implemented and lot coverage restricted. Lot coverage should be restricted to maintain the aesthetic appeal of open space acquired through the purchase of development rights program.

Response

See response to Comment 26.

Comment 63.

(M3) - Prepare land use plans for the duck farm properties and include consideration of the properties for a regional sewage treatment plant (STP. Site may not be developed or used for STP, open space parkland will not require sewerage.

Response

See response to comment 40 regarding the Jurgieliwicz Duck Farm.

Comment 64.

(M5) - Provide stormwater treatment for runoff into the East and West Mill Ponds and the Forge River *from Montauk Highway. Treat stormwater to remove sediments and associated contaminants prior to its release into the waterbodies.* ***(M5a) Require LI Railroad to remodel the 100 year old artificial bermed land bridge train track crossing south of Montauk Highway to install via larger water conduits that permit better water flow from both the west and east Mill Ponds.***

Response

See response to Comment 5.

Comment 65.

(M7) - Develop a TMDL implementation plan based on the preferred allocation scenario. The Town should have an implementation plan prepared for the selected allocation scenario that provides preliminary engineering/phasing plans that detail how each of the reductions could be implemented and where. The implementation plan would include the extent with actual cost estimates, locations, and type of sewering, if any, required within the FRPOD and Watershed.

Response

Management Plan language will be modified as follows:

(M7) - Develop a TMDL implementation plan based on the preferred allocation scenario. The Town should have an implementation plan prepared for the selected allocation scenario that provides preliminary engineering/phasing plans that detail how each of the reductions could be implemented and where. The implementation plan would include cost estimates, locations, and type of sewering, if any, required within the FRPOD.

Comment 66.

(M8) - Evaluate the need and locations for a regional wastewater treatment plant. If the Town or County determines that regional sewering is the best option for meeting the nitrogen TMDL, then a suitable location must be identified. ~~The duck farm may be a good candidate as it is centrally located, sufficiently large, already disturbed, and has few residential neighbors. The property is sufficiently large to permit a substantial riparian restoration and open space set aside. Other potential sites might include Brookhaven Airport and an expansion of the Town's Sewer District #2. Regionalization may include the adjacent hamlet of Center Moriches.~~ The duck farm may not be used for such a project as it was acquired with county and town funds for farmland preservation and may not now or ever be developed. The property should have riparian restoration and be set aside as parkland open space connected by trails to the recently acquired 154-acre Mastic Woods. It is not a candidate or site suitable for a sewer plant. The airport also may not be legally used for purposes disconnected from airport use; see 1961 NYS site transfer statute.) The remaining possibility is an expansion of the Town's Sewer District #2.Regionalization may include the adjacent hamlet of Center Moriches. Not related to study of Forge River and is beyond scope of the DFRMP.

Response

See response to comment 40 concerning the Jurgieliwicz Duck Farm. All potential sites for a sewer plant and proposed sewering actions must undergo environmental impact reviews and conform to zoning and other land use restrictions.

Comment 67.

(M9) Impose stricter nitrogen limits on STPs presently or proposed for location within the FRPOD based on the nitrogen TMDL. The nitrogen discharge limit for new and existing STPs should be lowered from current County requirements if required by the TMDL. Permit no new subdivisions without "closed system" or surface water Nitrogen standard limits.

Response

The strategy is adequate as written in the Management Plan as it calls for lower nitrogen discharge limits within the FRPOD. New subdivisions that do not meet the SCDHS sanitary requirements for this groundwater zone would require a treatment plant, which would then be covered by the new nitrogen limit.

Comment 68.

(M10) - Dredge sills at mouths of creeks and accumulation at the mouth of the Forge River. Removal of the deposits at the mouths of selected creeks will increase circulation in the creeks and improve water quality. Will the creeks be dredged at taxpayer cost?

Response

If Suffolk County conducts the dredging, then funding would ultimately be derived from County taxes. Alternatively, dredging may be conducted by the Army Corps of Engineers, in which case funding would come from the federal government.

Comment 69.

(M11) - Remove deposits south of Montauk Highway including Phragmites*. Removal of the substantial deposits at the head of the Forge River will increase circulation in this portion of the estuary. Removal of the invasive reed Phragmites will increase available open water and tidal wetland habitat. (What deposits, and what location(s) have been identified as the headwaters).*

Response

Management Plan language will be modified as follows:

> (M11) - Remove stormwater-borne sediments in the waters just south of Montauk Highway including *Phragmites*. Removal of these deposits will increase circulation in this portion of the estuary. Removal of the invasive reed *Phragmites* will increase available open water and tidal wetland habitat.

Comment 70.

(L1) *Develop and Implement a* ~~**the**~~ ***land use plan for the duck farm properties*** *for the uses determined by the Town and community to be most appropriate for the restoration of the estuary. The duck farm land use plan must be consistent with its public purposes attendant to its original acquisition and may only be used for such farmland or open space as delineated by county and town funds for farmland preservation and may not now or in the future be developed apart from the action of the state legislature. The property should have riparian restoration and be set aside as parkland open space connected by trails to the recently acquired 154-acre Mastic Woods. It is not now subject to subdivision or development inconsistent with the original purchase. It is adjacent to open space to the north, east, and south.*

Response

See response to comment 40 concerning the Jurgieliwicz Duck Farm.

Comment 71.

(L3) - Pump groundwater to treatment locations such as wetlands or denitritfication reactors. The cost and feasibility of moving and treating large volumes of water would need to be measured against the costs of other treatment options. This is an unrealistic and totally cost prohibitive recommendation and should be discarded without further consideration.

Response

See response to Comment 7.

Comment 72.

(L4) - Improve the operation of private STPs. The three existing wastewater treatment plants in the Forge River watershed could be upgraded for additional nitrogen removal or could be converted to pump stations connected to a future regional STP. If feasible economically, legally and environmentally the possibility of conversion to public pump stations connected to a regional STP must be fully and completely explored. Two of these STPs are located on the eastern edge of the watershed, far removed from the main areas contributing pollution to the ground and surface waters of the Forge River.

Response

All three of these STPs contribute nitrogen to the Forge River estuary. Consolidation of these facilities into a larger regional facility is being evaluated by the County.

Comment 73.

L5-L8) - Sewer part or all of the FRPOD. Engineering studies in progress now will help determine the most advisable sewering strategy for the Forge River watershed and or adjacent communities. Since the TMDL implementation plan will identify the need for and extent of sewering needed, design plans for reaching the TMDL will be required and may include the following options: a) construct a conventional collection system and treatment plant, or b) construct advanced onsite systems for individual FRPOD parcels to avoid collection system cost, or c) collect septic system effluent from all FRPOD parcels and treat it at a centralized community STP, or d) incorporate adjacent areas also within the groundwater contribution areas of the watershed in Mastic and Shirley and parts of Center Moriches into the sewer district to include areas contributing to the nitrogen load and to reduce per parcel cost and expand environmental benefits.

Response

Management Plan language will be modified as follows:

> L5-L8 - Sewer part or all of the FRPOD. Engineering studies in progress now will help determine the most advisable sewering strategy for the Forge River watershed and or adjacent communities. Since the TMDL implementation plan will identify the need for and extent of sewering needed, design plans for reaching the TMDL will be required and may include the following options: a) construct a conventional collection system and treatment plant, or b) construct advanced onsite systems for individual FRPOD parcels to avoid collection system cost, or c) collect septic system effluent from all FRPOD parcels and treat it at a centralized community STP, or d) incorporate adjacent areas in the Mastic and Shirley peninsulas and parts of Center Moriches into the sewer district as these all contribute nitrogen to Moriches Bay and their inclusion could reduce per parcel cost and expand environmental benefits.

Comment 74.

(L9) - Pump bay water to head of the Forge River and into priority creeks to increase circulation and increase dissolved oxygen to support marine life. Increased circulation can improve water quality for aquatic organisms, but will require a substantial investment in pumping equipment and operational costs. The headwaters of the river are fresh waters, not salt water. Why pump salt water into fresh waters? What is the impact on those areas if such a practice were to be employed?

Response

See response to Comment 7.

Comment 75.

(L10) - Dredge to remove accumulated organic matter from estuary. *Institute a long- term dredging operation provided that benthic flux studies determine that the strategy could be effective over the long term. Many feet of duck farm waste and decaying algal blooms have accumulated in the Forge River and ~~will~~ may contribute substantial nitrogen to the water column.*

Response

See response to Comments13, 14, and 16.

Comment 76.

The Forge River is a partially mixed estuary that discharges to Moriches Bay. The upland area of the Forge River, i.e., the watershed area, is situated in the southeastern portion of the Town of Brookhaven and encompasses the hamlets of Mastic and Moriches and the Poospatuck Reservation. Portions of the hamlets of Manorville, Shirley and Center Moriches (Center Moriches is located outside the boundaries of the Forge River watershed see Figure 4-1) and the Village of Mastic Beach also comprise the watershed. Figure 4-1 provides a location map for the Forge River watershed communities and adjacent areas.

Response

The Plan correctly states that *portions* of the hamlets of Manorville, Shirley, and Center Moriches are included in the Forge River watershed.

Comment 77.

The Forge River is a partially-mixed estuary that discharges to Moriches Bay. The Forge River contributing area has moderately sloping terrain with greater relief in the upland part of the basin. Hydrology is dominated by groundwater due to highly permeable soils and shallow depth to groundwater in the lower portion, depth to groundwater in the northern portion exceeds 90 feet.

Response

Management Plan language will be modified as follows:

> The Forge River is a partially-mixed estuary that discharges to Moriches Bay. The Forge River contributing area has moderately sloping terrain with greater relief in the upland part of the basin. Hydrology is dominated by groundwater due to highly permeable soils and shallow depth to groundwater in the lower portion of the watershed.

Comment 78.

The SCDHS requires 1.0 acre for the sewage flow from each single-family home (300 gpd) and 0.5 acres for the flow from each Planned Retirement Community (PRC) residential unit (150 gpd). Consequently, for the non-sewered scenario, residential parcels less than 1.0 acre and PRC parcels less than 0.5 acre were not included. Vacant and agricultural parcels within the watershed are zoned residential and were built out based on their zoning and the above SCDHS regulations. The parcels that are part of the Montauk Highway Corridor Study and Land Use Plan for Mastic and Shirley (Figure 5-2) were incorporated into the build-out analysis according to the proposed zoning. Some of the notable changes from the existing conditions are the preservation of vacant parcels for parks, new multi-family zoning, and additional B, C and J6 zoning. The assumptions made in the build-out analysis are shown in Table 5-2 and the results displayed in Table 5-3. Most of the Montauk Highway Study includes areas beyond the boundaries of the Watershed as delineated in this report. Clearly, any build-out analysis that includes areas outside the watershed is inappropriate for determinations of build-out scenarios within the watershed. These projections are deeply flawed as a result.

Response

The Management Plan acknowledges that the Montauk Highway Corridor Study and Land Use Plan include only a portion of the Forge River watershed. Only parcels within the groundwater contributing areas of the Forge River were included in the build out analysis.

Comment 79.

One open space area that is particularly close to the open water of the Forge River is the oak forest north of the West Mill Pond. It is relatively free of exotics and invasives (Figure 8-20) and connects to a well-preserved freshwater wetland that drains to West Mill Pond. This area was recently acquired and preserved as open space, 154 acres to protect the swales that feed fresh water into the Forge River.

Response

Management Plan language will be modified as follows:

> One open space area that is particularly close to the open water of the Forge River is the oak forest north of the West Mill Pond. It is relatively free of exotics and invasives (Figure 8-20) and connects to a well-preserved freshwater wetland that drains to West Mill Pond. This area is part of the 154 acres recently placed into public ownership as open space to protect some of the freshwater sources of the Forge River.

Comment 80.

The Town of Brookhaven might consider developing a Forge River zoning overlay district. Additional restrictions on new development would be imposed within such an overlay district. These might include:

- *More stringent requirements for onsite wastewater treatment systems.*
- *Additional development limits to help protect riparian and wetland areas.*
- *Limits on nitrogen concentrations leaving the site.*
- *Up-zone areas to the north to continue minimal development.*

Response

Up zoning is not applicable here. An overlay district adds more stringent standards to existing zoning.

Comment 81.

Because the Forge River empties into Moriches Bay, it may be technically feasible to discharge the effluent from a wastewater treatment plant directly to surface water via a point source discharge (Really…you're got to be kidding…this suggestion is outrageous and unacceptable.). Since the Forge River is an impaired surface water(i.e., on the NYSDEC 303d list) and may ultimately be subject to a Total Maximum Daily Load (TMDL) for nitrogen, a new point source discharge to the Forge River would likely have more strict effluent restrictions than that for a non-impaired surface water.

Response

A modern advanced treatment plant that would collect wastewater that is currently discharged from onsite sanitary systems at a concentration of approximately 50 mg/l nitrogen and would treat and discharge an effluent having a nitrogen concentration of less than 10 mg/l would reduce nitrogen loading to the estuary by approximately 80 percent.

Comment 82.

Sewering of the Forge River Study Area would ~~likely~~ be considered a Type I action.

THE FOLLOWING STUDIES ARE OLD, HAVE BEEN REJECTED BY THECOMMUNITY AND THE COUNTY DUE TO COST AND AS SUCH ARE NOT USEFULFOR DEVELOPING A FORGE RIVER MANAGEMENT PLAN

Mastic - Mastic Beach - Shirley Alternative #1; Mastic - Mastic Beach - Shirley Alternative #2; Mastic - Mastic Beach - Shirley Alternative #3

Response

See response to Comment 73. The studies were referenced in the Forge River Management Plan solely as a basis for a cost estimate. Capital and operating costs for relatively small sewer districts are high. The cost per property for sewering decreases as more properties are connected to the same treatment plant. In most cases, sewering is only 'affordable' when there is a large user base or it receives some form of public grant funding.

Comment 83.

ACTION ITEM

Establish a Forge River Protection Overlay District (FRPOD) for properties inside the 50(?)- year contributing area to implement special regulations and improve water quality in the estuary.

Response

Properties inside the 50-year travel time for groundwater contribute to Forge River water quality.

Comment 84.

ACTION ITEMS

- *Explore potential dedicated funding sources such as a FRP Fund to provide water quality improvement services to property owners based on water usage and assessed value.*
- *Add fee to property owners' tax bills.*
- *Assess lower fee for property owners connected to private STPs provided the STP can demonstrate long term compliance with health discharge standards.*

Response

Management Plan language will be modified as follows:

- Assess lower fee for property owners connected to private STPs provided the STP complies with its SPDES permit discharge requirements.

Comment 85.

…a significant portion of these farm parcels have been permanently protected through the purchase of development rights; these include the duck farm parcels and several active farm parcels to the east. The Town should consider the acquisition of the remaining farming rights of the duck farm parcels which, given their proximity to the upper reaches of the Forge River, could continue to impact the estuary through future agricultural operations. There still remain a number of unprotected farmland parcels within the watershed, most of which are located north of Montauk Highway.

Response

Management Plan language will be modified as follows:

A significant portion of these farm parcels have been permanently protected through the purchase of development rights including the Jurgieliwicz Duck Farm and several active farm parcels to the east.

Comment 86.

Not workable for area to be sewered as it is already built out.

The Town of Brookhaven has identified areas within the township that are most suitable for future development. The Town has, in some cases, revised the zoning in existing or proposed hamlets to encourage mixed use development. These are also the areas that are or will be sewered. Developers can purchase Transfer of Development Rights (TDR) credits to make development in the selected compact hamlets more economically attractive. Those TDRs come from 'sending areas' identified by the Town. Sending areas are typically places that the Town or County has identified for preservation as open space, as environmentally sensitive, or important to the public in some other way and therefore less appropriate for development. Those hamlets that the Town has identified for TDR redemption are referred to as 'receiving areas.' Incredibly unrealistic and lacks sufficient data to warrant implementation at this time.

Response

A full assessment will be conducted prior to any action.

Comment 87.

ACTION ITEMS

- *Identify properties for acquisition or purchase of development rights based on location and environmental resources.*
- *Develop property acquisition list based on location and environmental sensitivity.*
- *Consider acquiring the development rights for additional agricultural acreage.*
- *Develop a strategy to permit limited and controlled greenhouse farming on properties where development rights have been acquired. Limit lot coverage by greenhouses on these parcels. Better idea is to include greenhouse farming that does not have permanent structures, but also does not use fertilizers that create run-off from concrete. Require treed buffer of natural areas to shield non-retail greenhouse operations.*

Response

See response to Comment 26.

Comment 88.

ACTION ITEMS

- *Acquire duck farm properties. Perform site assessment and cleanup. Restore riparian area of the properties. Restore adjacent stream system.*
- *Utilize the property initially for dredged material dewatering and treatment.*
- *Reserve a 5-10 acre portion of the site for possible use as a regional wastewater treatment plant serving the Mastic and Moriches peninsulas.*

ABSOLUTELY NOT! We did not fight to close a polluter to put a different one in its place. Can't tell you how disturbing this recommendation is. We will not permit alienation of these lands for such a use.

Response

See response to Comment 40 regarding the Jurgieliwicz Duck Farm.

Comment 89.

24.2.2 Adopt a Green Streets Policy (S9)

With very significant reservations…most of the area retains the right to remain rural and is not in favor of the unilateral adoption of a green street policy and all that is part of that plan.

ACTION ITEM

Adopt a 'Green Streets' policy *to improve roadway design, capture and treat stormwater~~, improve 'walk ability,' and lower vehicle miles traveled~~.*

Response

Most Green Streets designs are readily adapted to 'rural' areas. See also response to Comment 51.

Comment 90.

25.1.3 Prepare a Land Use Plan for the Duck Farm Properties (M3)

Following acquisition and remediation, the Town may wish to establish a new use for the former duck farm, i.e., one that supports the restoration and long-term protection of the estuary. Three potential uses of the former duck farm that are worthy of further study and consideration are as follows: ~~1) utilize the former duck farm parcels for the management (e.g., de-watering) of dredge materials from the Forge River, 2) dedicate the site for a regional wastewater treatment plant following the sewering of all or portions of the watershed or~~ 3) restore the duck farm – as appropriate and feasible – to its original condition comprising wetlands, floodplain forest and upland forest habitats. The first potential use has short- to mid-term application. The second and third concepts – which represent long-term or permanent uses of the former duck farm – could be combined, in varying degrees, to accomplish both water quality improvement and ecosystem restoration goals. These options are discussed in greater detail below.

~~*The upland area of the duck farm could be very useful as a temporary dredged material dewatering and storage area. Dredging the creeks and main channel of the Forge River is recommended and discussed below. The operation would likely involve hydraulic (suction) dredging where the dredged material is pumped as a slurry to an area where it can be dewatered prior to trucking and off-site disposal. Alternatively, it may be possible to compost the dredged material with yard waste, duck waste, or other organic materials (such as harvested Ulva – see below). The duck farm site is large enough to accommodate both a dewatering operation and a composting facility on a temporary basis. The leachate from these operations could be properly contained and treated prior to discharge to the Forge River. The location is ideal for both its proximity to potential dredging and its considerable distance from residential uses.*~~

~~*Ultimately, the duck farm property should be considered as a location for a regional wastewater treatment plant. It is centrally located between the Mastic and Moriches peninsulas. The groundwater from both of these areas accepts effluent from thousands of onsite wastewater disposal systems and then discharges to Moriches Bay. Regional sewering is one option that could reduce the nitrogen discharged to groundwater and the Bay. Regional sewering is discussed below. Collection and pumping costs to a centrally- located treatment plant would be lower than if the plant were located at the periphery of the sewered area. It would be prudent therefore to reserve a significant portion of the duck farm property (e.g., 5-10 acres) for possible construction by the Town or the County of a regional wastewater treatment plant.*~~

In addition, the duck farm property is in an important location at the headwaters of the Forge River. The property across the stream from the duck farm is in public ownership and forested. Restoring the riparian area and the stream itself along the duck farm properties would help protect the water that flows into West Mill Pond and from there into the Forge River. The duck farm borders the eastern side of these waters but is highly disturbed. The riparian area should be restored to a condition similar to the western side where forested wetlands support wildlife and protect the headwaters of the Forge River. The restored area would also serve as a substantial buffer for whatever the final upland land use may be. There will be none!

The development of the land use plan must be integrated with the requirements of the TMDL, which may require the sewering of a portion of the watershed. ~~As mentioned above, the former duck farm properties may offer the most favorable site for a wastewater treatment plant. The sizing of the wastewater treatment plant would depend upon the adopted allocation strategies of the TMDL which, in turn, will drive the amount of land necessary to accommodate the wastewater treatment plant.~~

NOT AN STP AT THIS LOCATION OR THE PRESERVED LANDS TO THE NORTH, EAST, SOUTH OR WEST. ENOUGH WITH THE MORPHING OF THIS FRMP INTO A REGIONAL SEWER DEAL…MAKES ME THINK PERHAPS JURGEILWICZ WOULD BE INTERESTED IN GETTING THE FULL VALUE OF HIS LAND NOW THAT IT IS NOT GOING TO BE LIMITED TO AGRICULTURE OR OPEN SPACE AND PASSIVE PARKLAND. SEEMS A REALLY BAD WAY TO BETRAY THE PUBLIC'S CONFIDENCE IN THE PDR PROGRAM.

ACTION ITEMS:

- Prepare land use and engineering plans for the restoration of the duck farm properties.
- ~~Consider the properties for a regional sewage treatment plant (STP).~~ REJECTED

Response

See response to comment 40 concerning the Jurgieliwicz Duck Farm.

Comment 91.

25.3.3 Evaluate Need and Locations for Regional Wastewater Treatment Plant (M8)

If the Town or County determines that regional sewering is the best option for meeting the nitrogen TMDL, then a suitable location must be identified. Why consider just sewering for the watershed, rather than continuing to endorse regionalization including areas that are removed and apart from the watershed that will be growth inducing to the area, providing additional environmental stresses to the existent communities;

Comments are premature. …may include the adjacent hamlet of Center Moriches or the entire adjacent Moriches peninsula. The County is currently conducting a sewering feasibility study for the downtown area of this adjacent hamlet. The County's Center Moriches Study includes both the Forge River and Moriches Bay groundwater contributing areas. The size and location of a treatment plant required will be determined by many factors including current ownership and the site preparation required. The technology required and discharge location (either groundwater or surface water), would be determined in part by the results of the TMDL Study.

~~Should the DEC approve the STP for surface water discharge, the agency would likely require that it meet a discharge limit lower than the current standard of 10 mg/L of total nitrogen.~~

If groundwater discharge is permitted, the new STP would be required to follow the SPDES limits as determined by the NYSDEC as part of the final allocation scenario of the TMDL Study. A groundwater discharge would be either in the form of recharge basins or subsurface leaching pools, which both have setback requirements. An STP with groundwater discharge would require a larger site than an STP with surface water discharge.

Surface water discharge is another option for an STP. A surface water discharge could help flushing in the head of the estuary. Where is the data to support this assertion, I have been involved with the FR for 7 years and have never heard such a proposal.

ENOUGH this is NOT happening… The duck farm, if acquired as part of the short term strategies, may be a good location for an STP, as it is centrally located, sufficiently large, already disturbed, and has few residential neighbors. Depending on the size of the STP required, the property may also be large enough to permit a substantial riparian restoration that could be utilized for further polishing of the facility's effluent.

Very old plan…Ed Hennessey is long gone and this has been denied by the FAA and is significantly upland from the Mastic and Mastic Beach communities.

Two other potential sites for an STP include the Brookhaven Airport and the Town of Brookhaven's Sewer District #2 STP. A portion of the Brookhaven Airport is currently being considered for a regional STP with groundwater discharge located in the 10-25 year groundwater contributing area of the Forge River. Really? This is the first time this has been mentioned. I sit on the Airport Advisory Board and no such proposal is presently under consideration in any legal forum, nor has anyone contacted the adjacent communities for input to this idea. The Town's Sewer District #2 STP located adjacent to the LIE (in the vicinity of the William Floyd Parkway), is located in the…requires a total change to the legislation and approvals that accompanied construction of this STP.25-50 year groundwater contributing area of the Carman's River. There is currently an STP at this location, however expansion of the STP may be considered.

ACTION ITEMS

Evaluate the need for a regional wastewater treatment plant to serve the FRPOD ~~as well as the adjacent communities of Center Moriches and Mastic. Consider locations including the duck farm, Brookhaven Airport, and an expansion of the Town's Sewer District #2.~~

Response

It is premature to rule out any area locations for a treatment plant (or plants) whether on publicly or privately owned parcels. Treatment plants must discharge to groundwater or surface water. In either case, if the discharge is inside the watershed, the nitrogen will reach the estuary. Discharging treatment plant effluent directly into the estuary could aid in its flushing. The former duck farm is just one potential location for a treatment plant. The others discussed in the Management Plan remain viable options. Acquisition and expansion of a private plant is also possible. Treatment plants can be located virtually any distance from the wastewater generators they serve. Plants located closer to the users have lower collection system capital and operating costs. County studies currently underway are also examining the feasibility and cost of sewering the commercial areas of the Mastic Shirley peninsulas for social, economic, and environmental reasons. Once all the sewer studies have been completed, a determination can be made as to the best location for a treatment plant and the extent of the district it would serve.