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

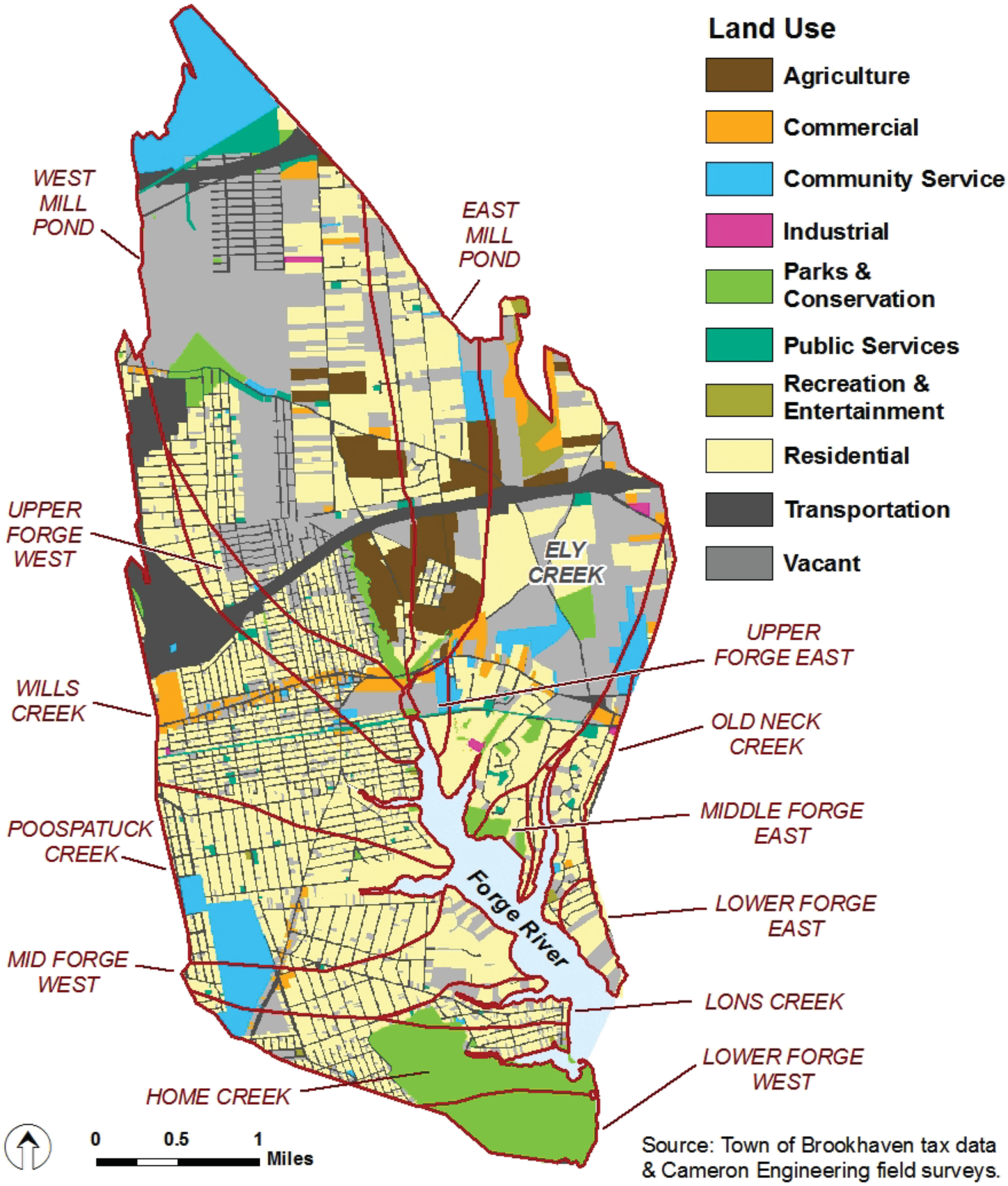


Table 6-1 provides a summary of land use for the watershed and its fourteen subwatersheds. Residential land accounts for the largest single use of land within the watershed; approximately 3,620 acres within the watershed, or 38.5 percent of the total, are dedicated to residential use. Transportation, 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

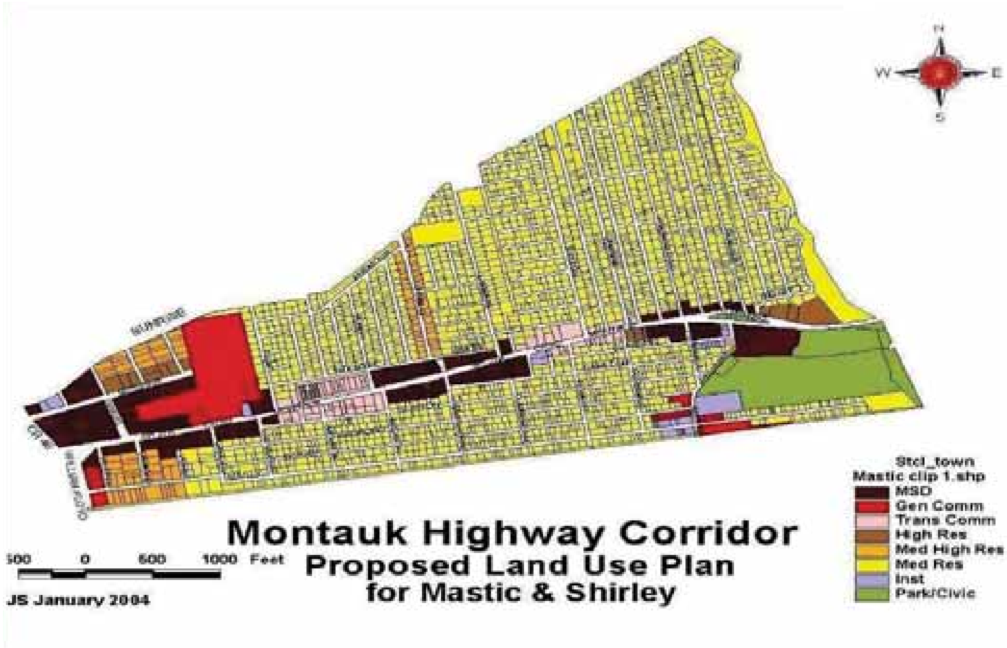


Table 6-2. Build-out Analysis Methodology and Results

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 Average Size Lots for each Zone • 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%

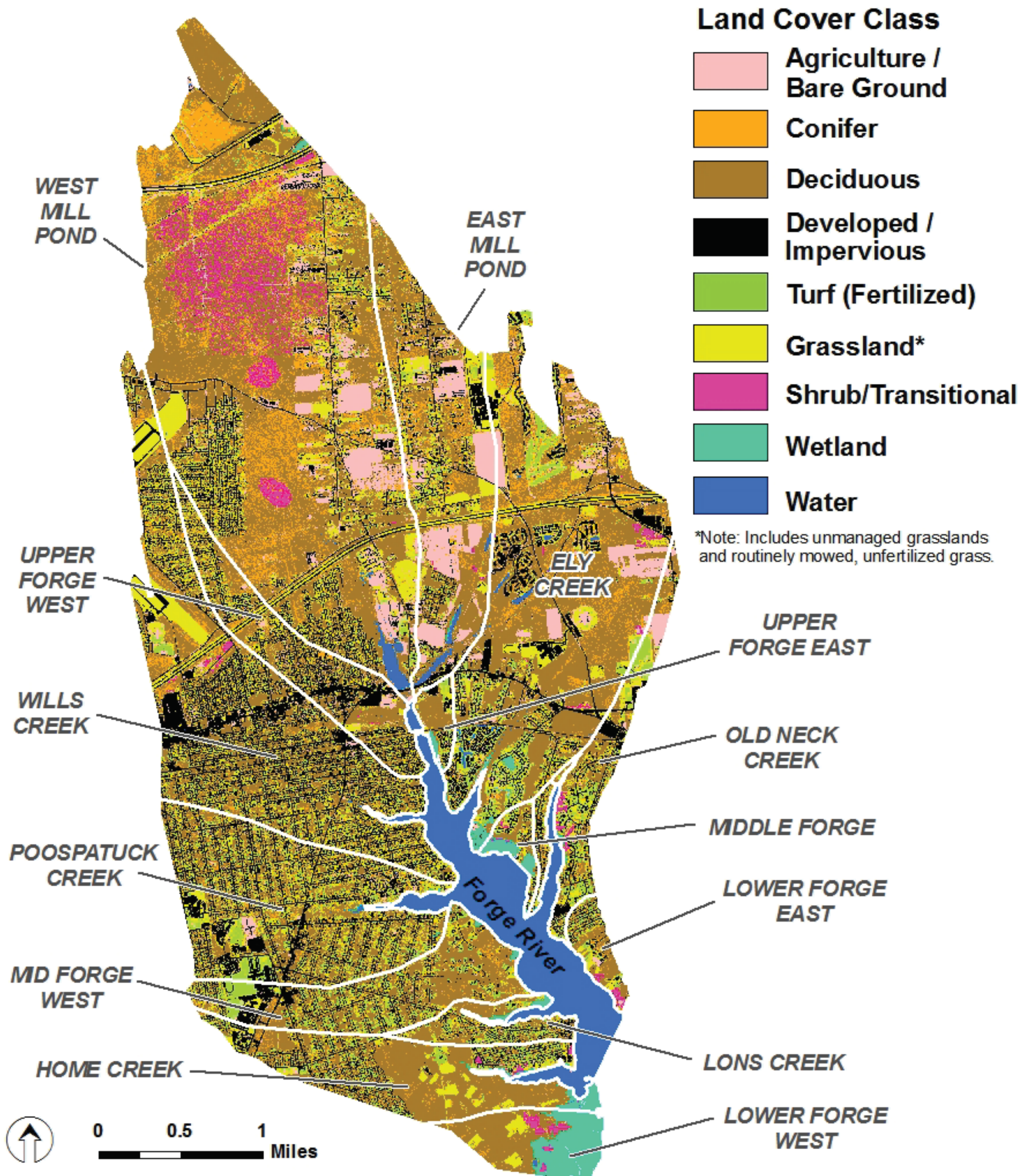
The land cover in the southern half of the watershed is markedly different from that of its northern counterpart. For example, impervious surfaces, including structures, roadways and parking areas, comprise a significant share of the southern half of the watershed, especially on the west side of the 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.

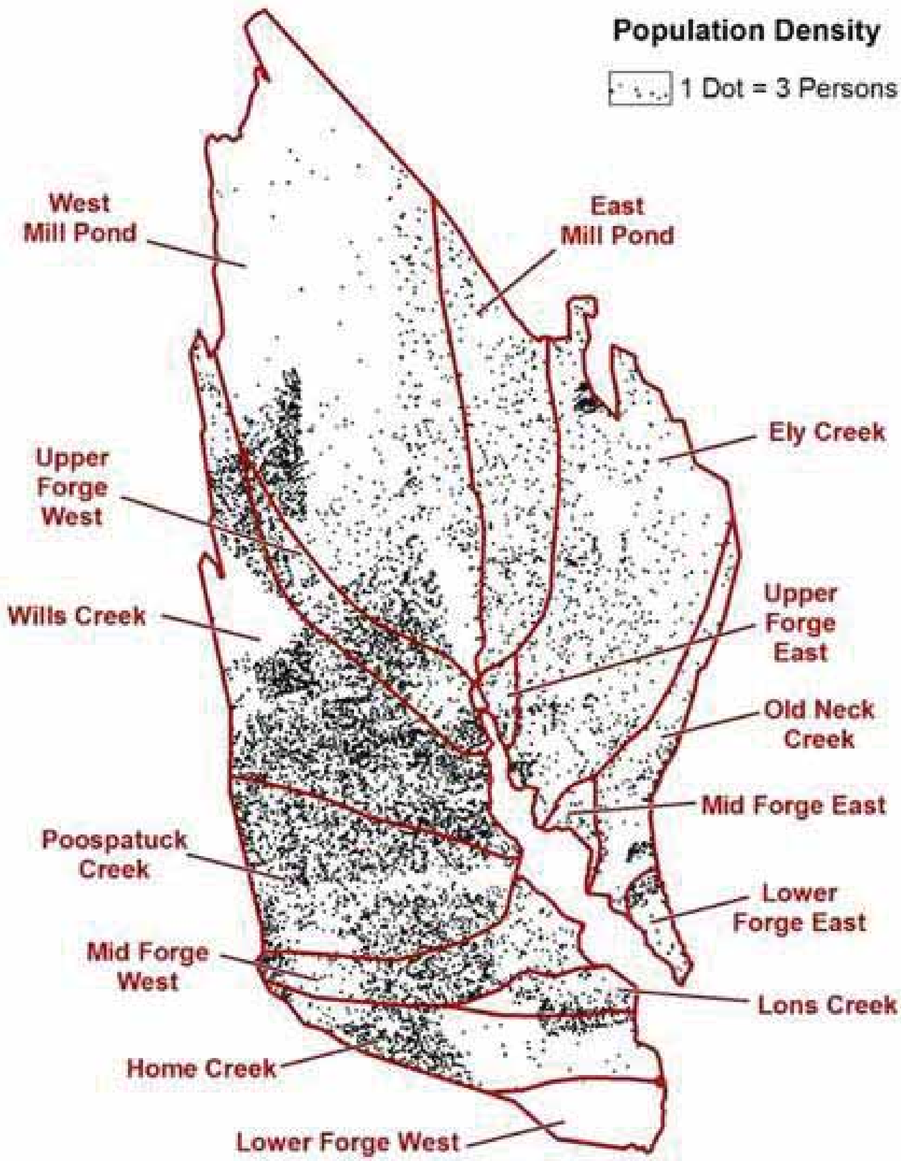
Table 8-1. Population for Years 2000 and 2010 and Build-out Scenarios

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.

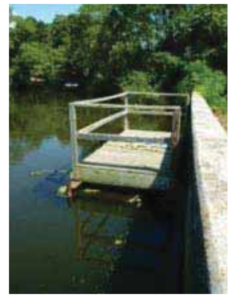
Aerials (shot in both summer and winter) of the areas that were inaccessible by land were examined to determine the dominant vegetation types. Topographic maps were examined for additional information about these areas such as the presence of berms, the extent of tidal inundation and the presence of 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 $1.31x10^6$ 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.

East Mill Pond Impairments - 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).

West Mill Pond Impairments - 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.

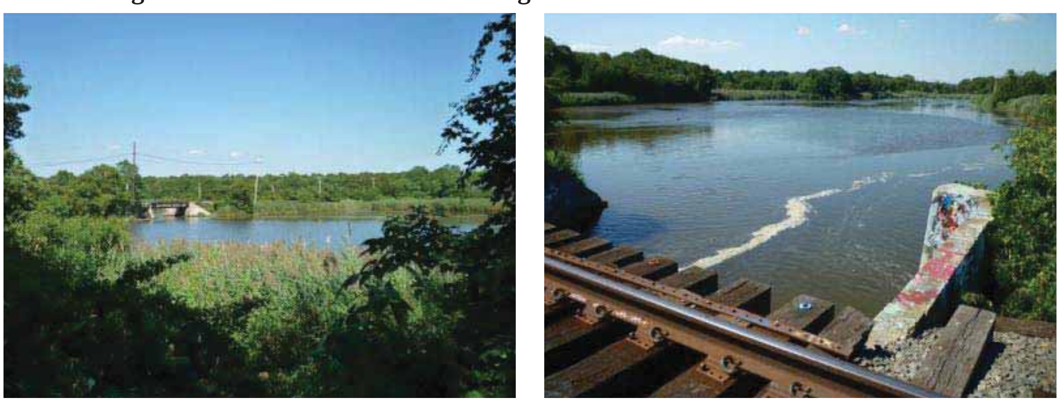
According to SoMAS researchers (Wilson, Swanson, Brownawell, Flood, & Gobler, 2009), tidal exchange in this portion of the Forge River is restricted by the railroad trestle. They suggest that freshwater is temporarily impounded during low tides by sediments accumulated under and just downstream of the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



Head of Forge River Impairments – 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.

<u>Swift Creek Impairments</u> – 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.

Impairments to Poospatuck Creek – 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.

<u>Impairments to Lons Creek</u> –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

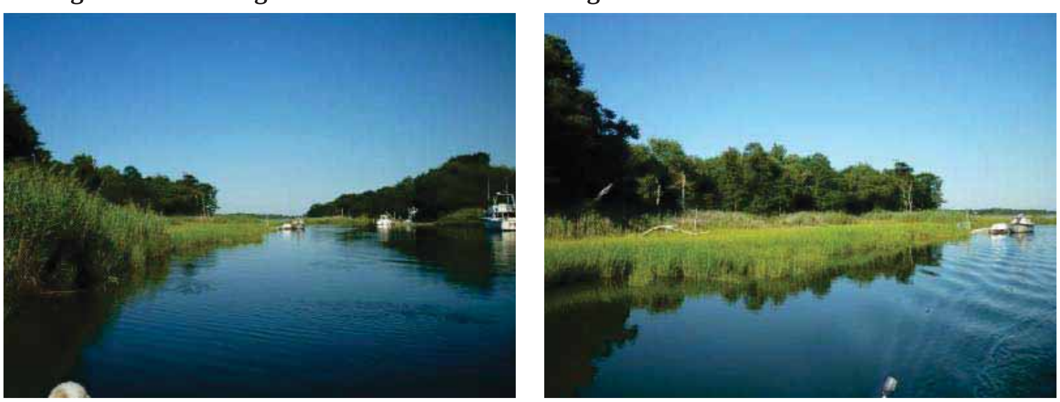


Figure 9-14. Tidal Wetlands along the Northern Shore of Lons Creek Bordered by Woodlands

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.

<u>Impairments to Home Creek</u> – 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.

<u>*Crabs*</u>

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.

<u>*Fish*</u>

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 19^{th} 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)

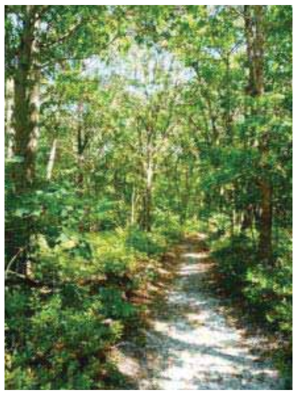
9.4 Significant Upland Adjacent to Aquatic Habitat

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.

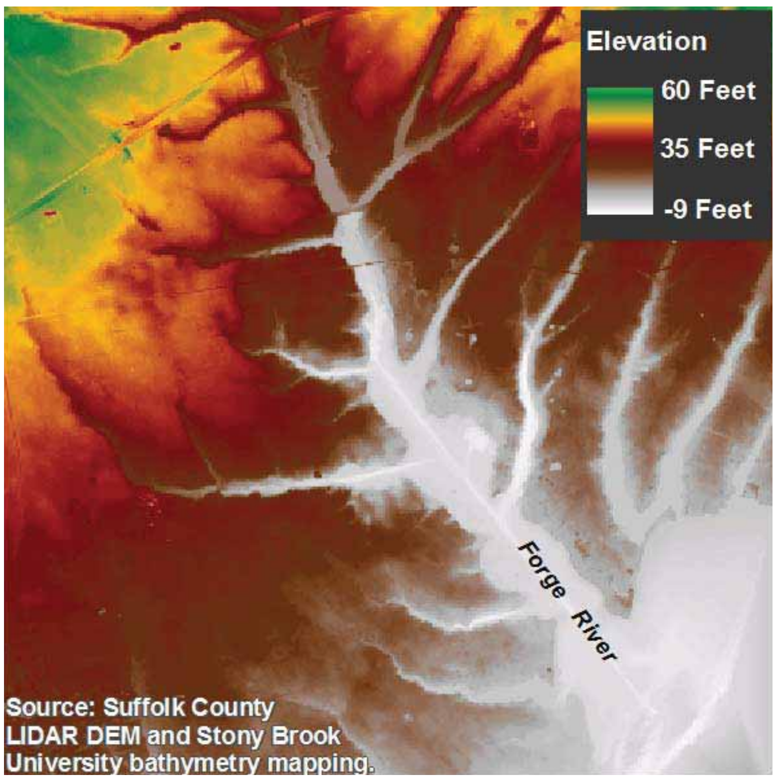
Additional dredging has been done in Moriches Bay channels and in the ocean inlet. The east-west Moriches channel was dredged from 2002 to 2003 when approximately 80,000 cubic yards of spoil were removed and placed on East Inlet Island. Researchers at Stony Brook University’s SoMAS (Wilson, Swanson, 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

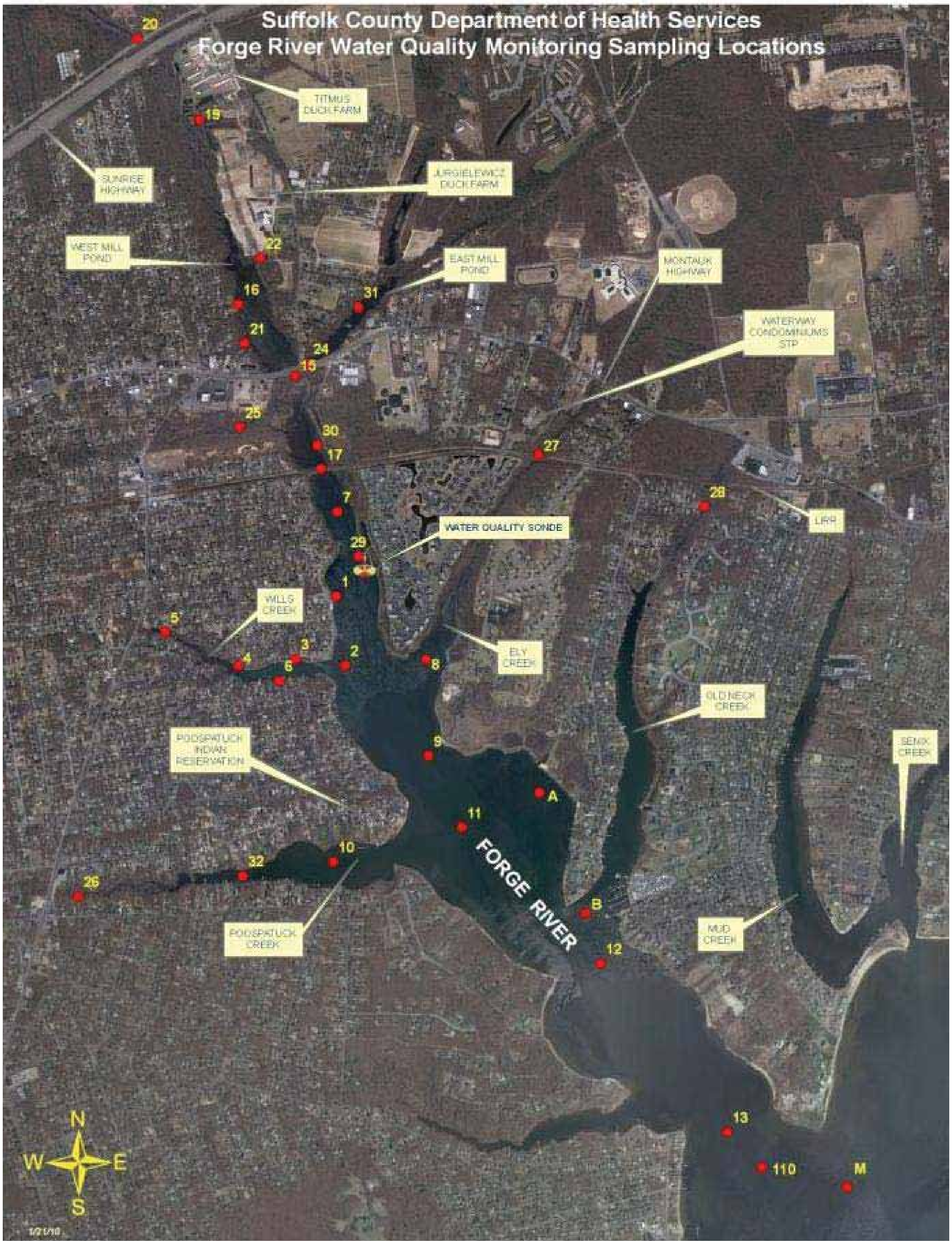


Table 11-2. Forge River SCDHS Monitoring Stations

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

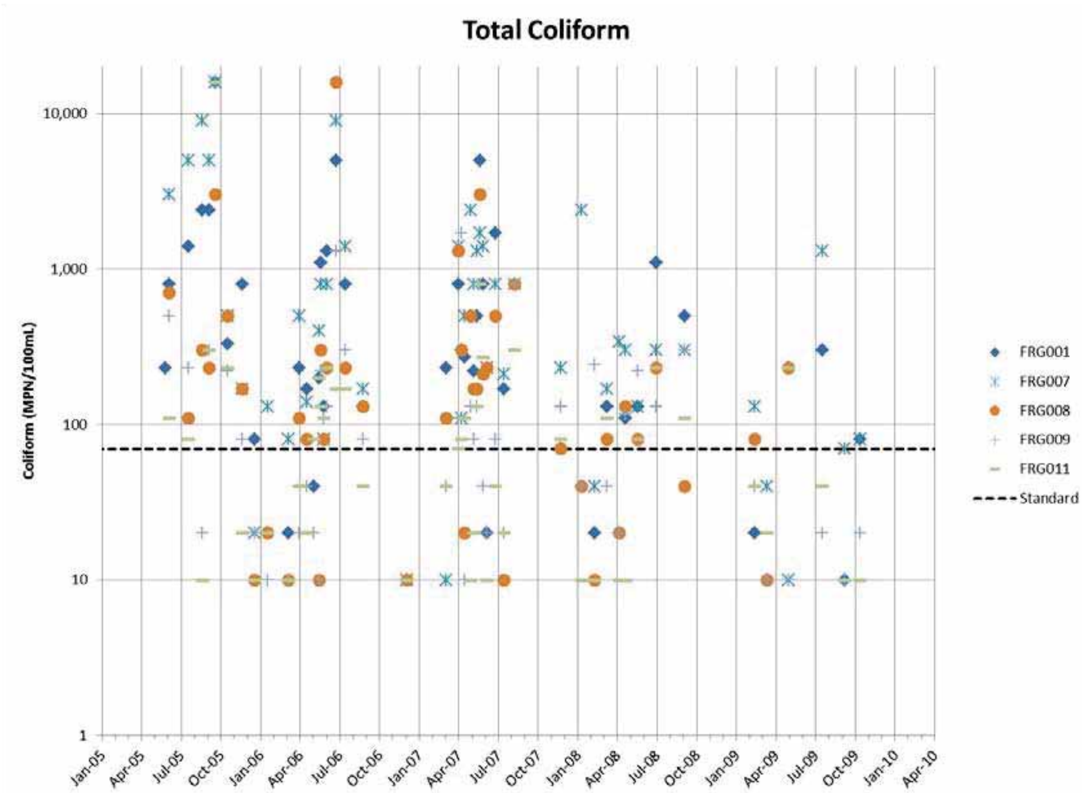


Figure 11-4. Total Coliform Time Series for the Lower Forge River

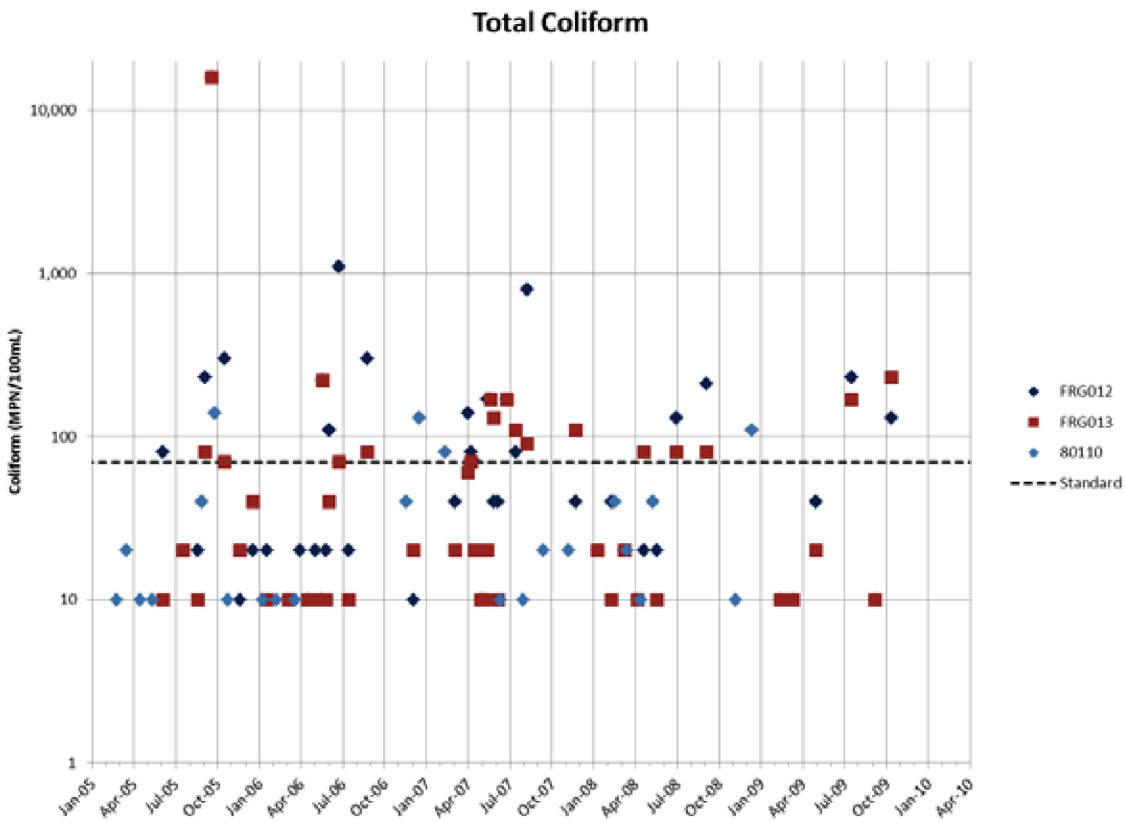


Figure 11-5. Total Coliform Time Series for Forge River creeks

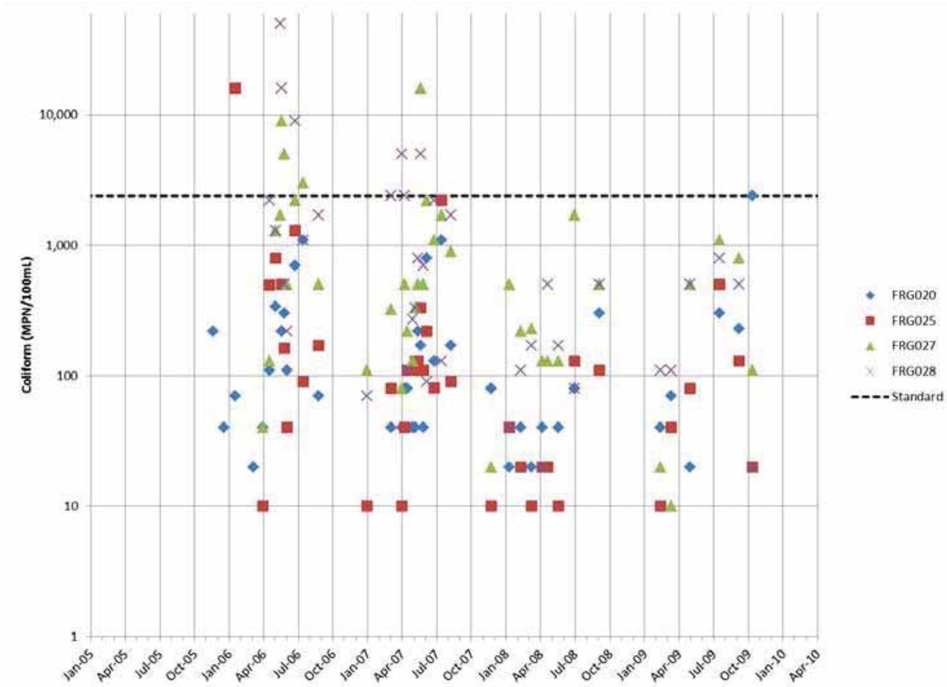


Figure 11-6. Total Coliform Time Series for Wills Creek

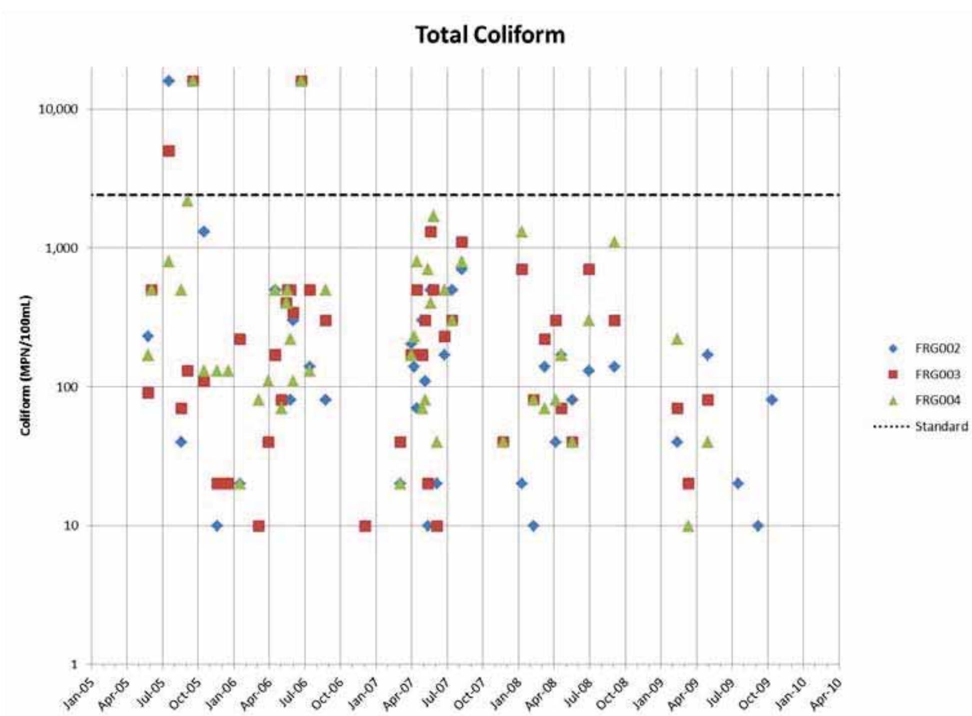


Figure 11-7. Total Coliform Time Series for Poospatuck Creek

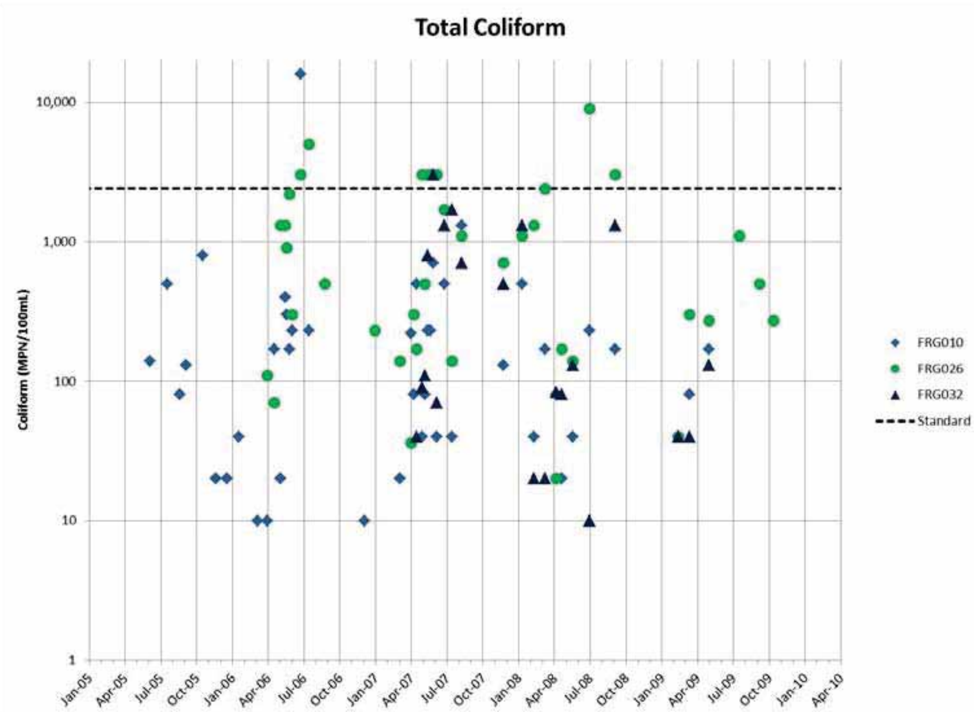


Figure 11-8. Total Coliform Time Series Near and Below the Duck Farms

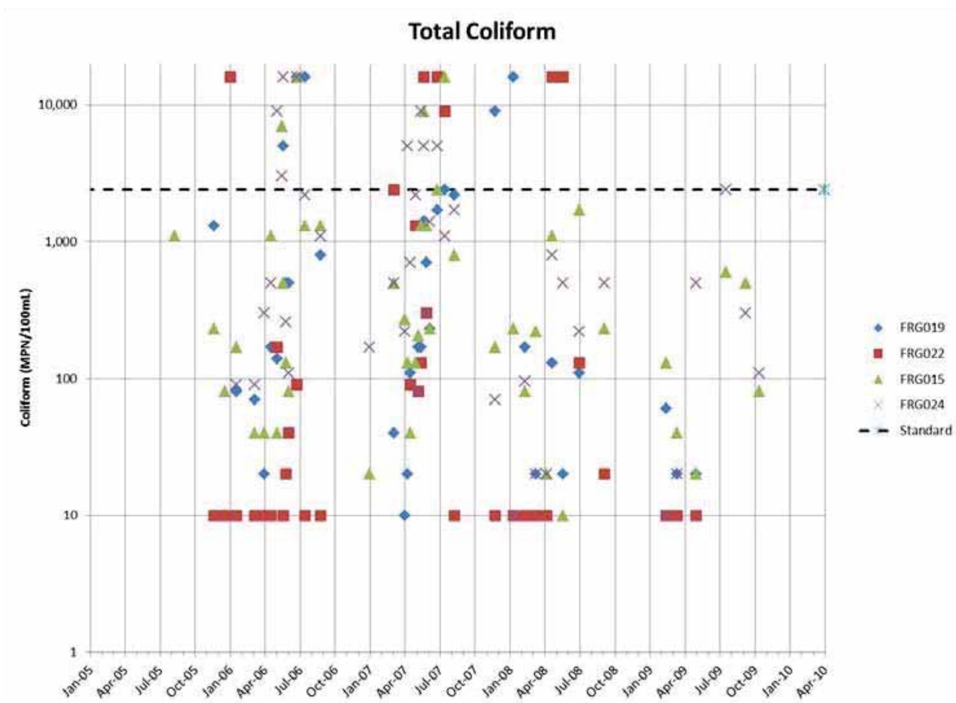
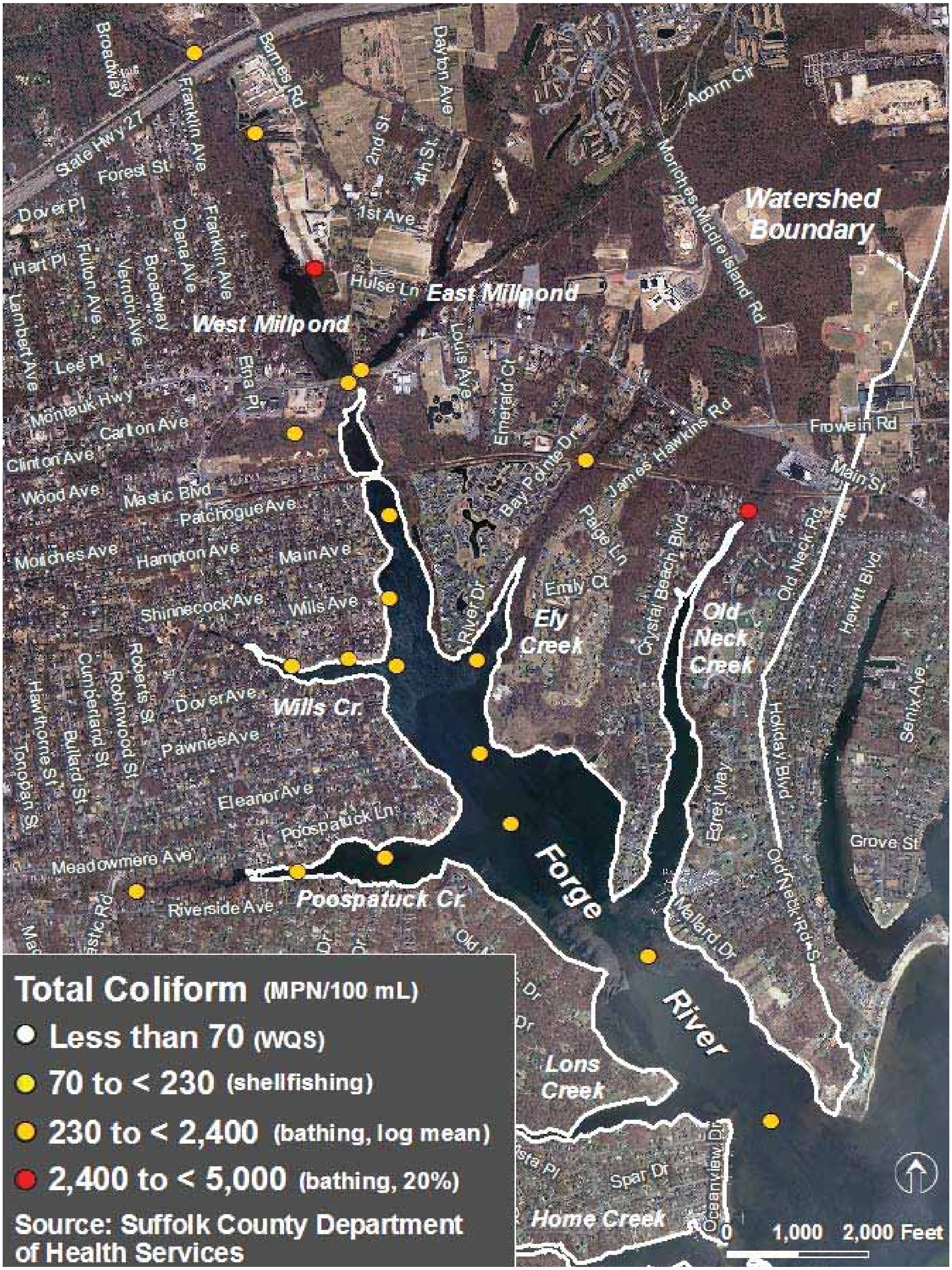


Figure 11-9. Spatial Distribution of Total Coliform in the Forge River



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

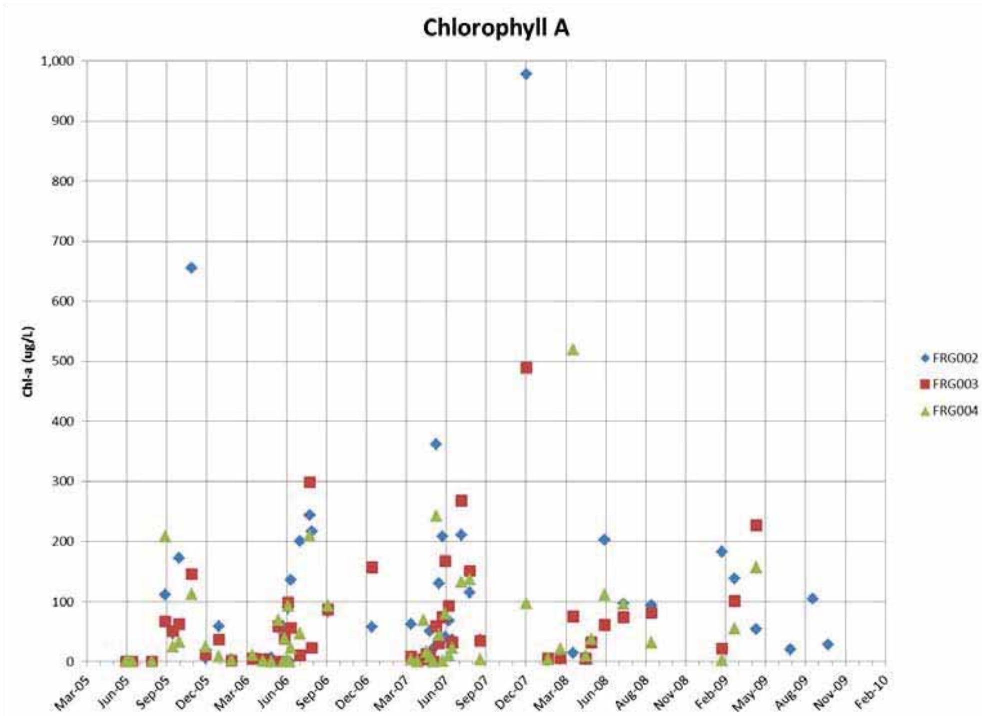


Figure 11-11. Chlorophyll-a Time Series for Poospatuck Creek

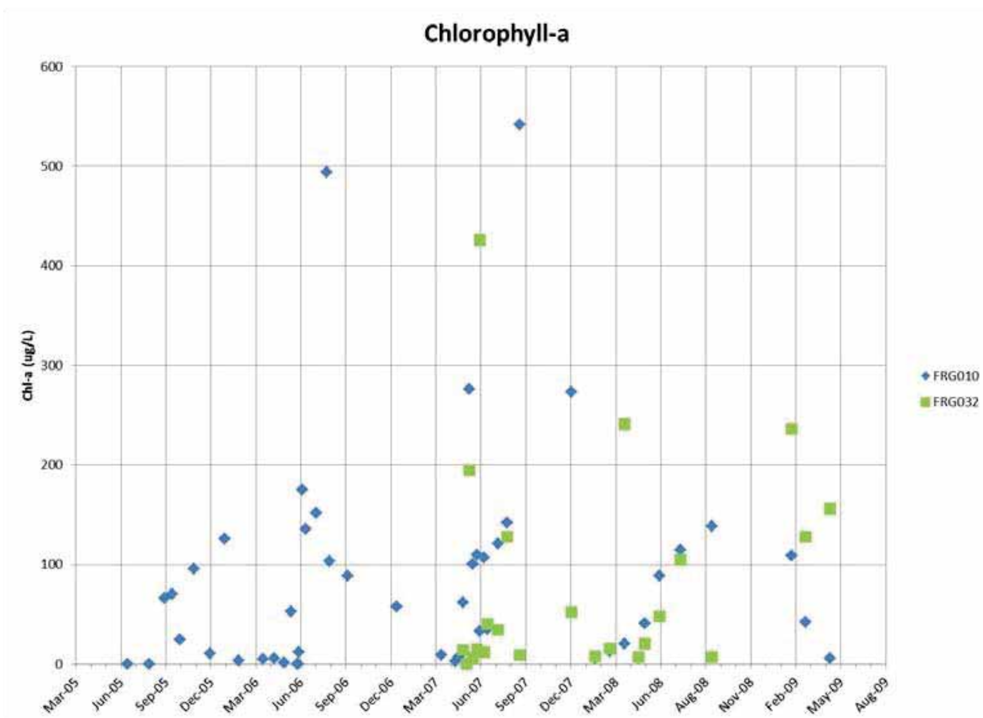


Figure 11-12. Chlorophyll-a Time Series for Middle Forge River

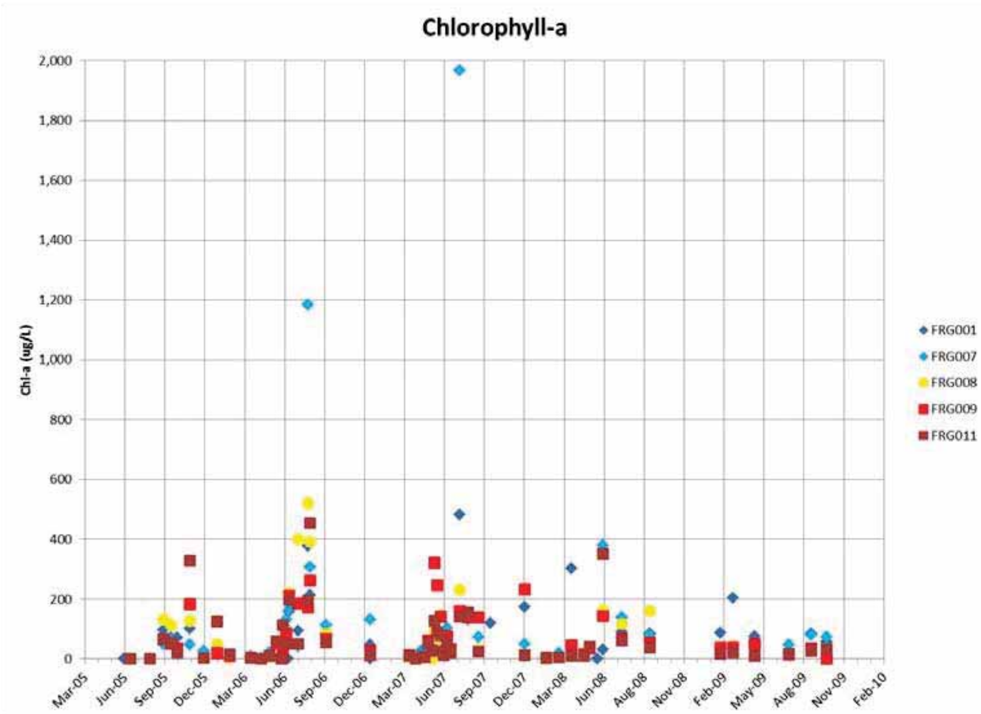
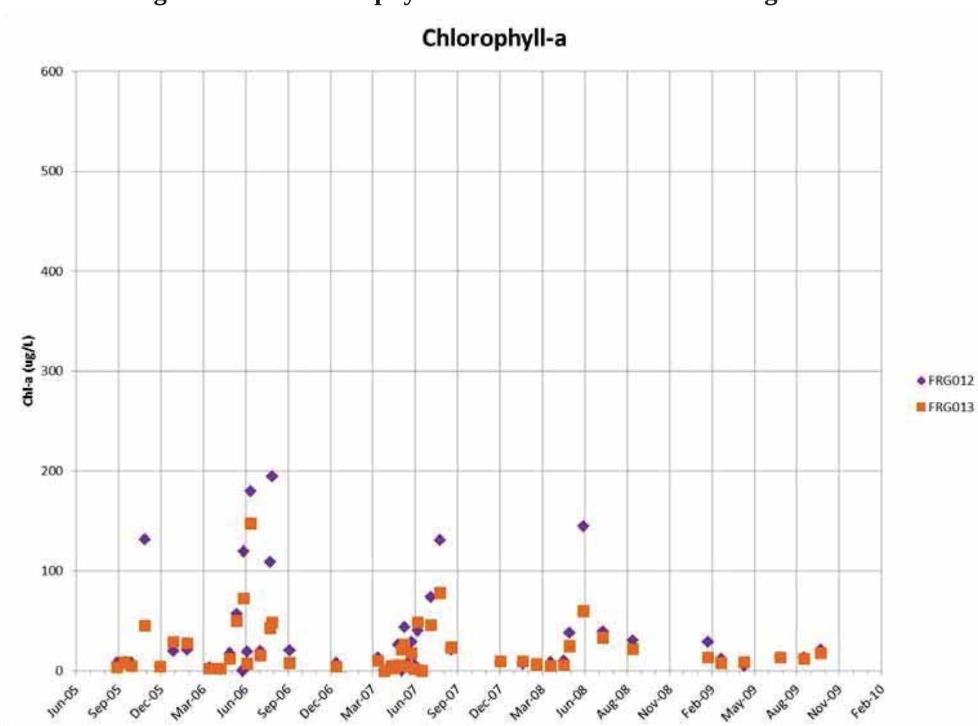


Figure 11-13. Chlorophyll-a Time Series for Lower Forge River



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

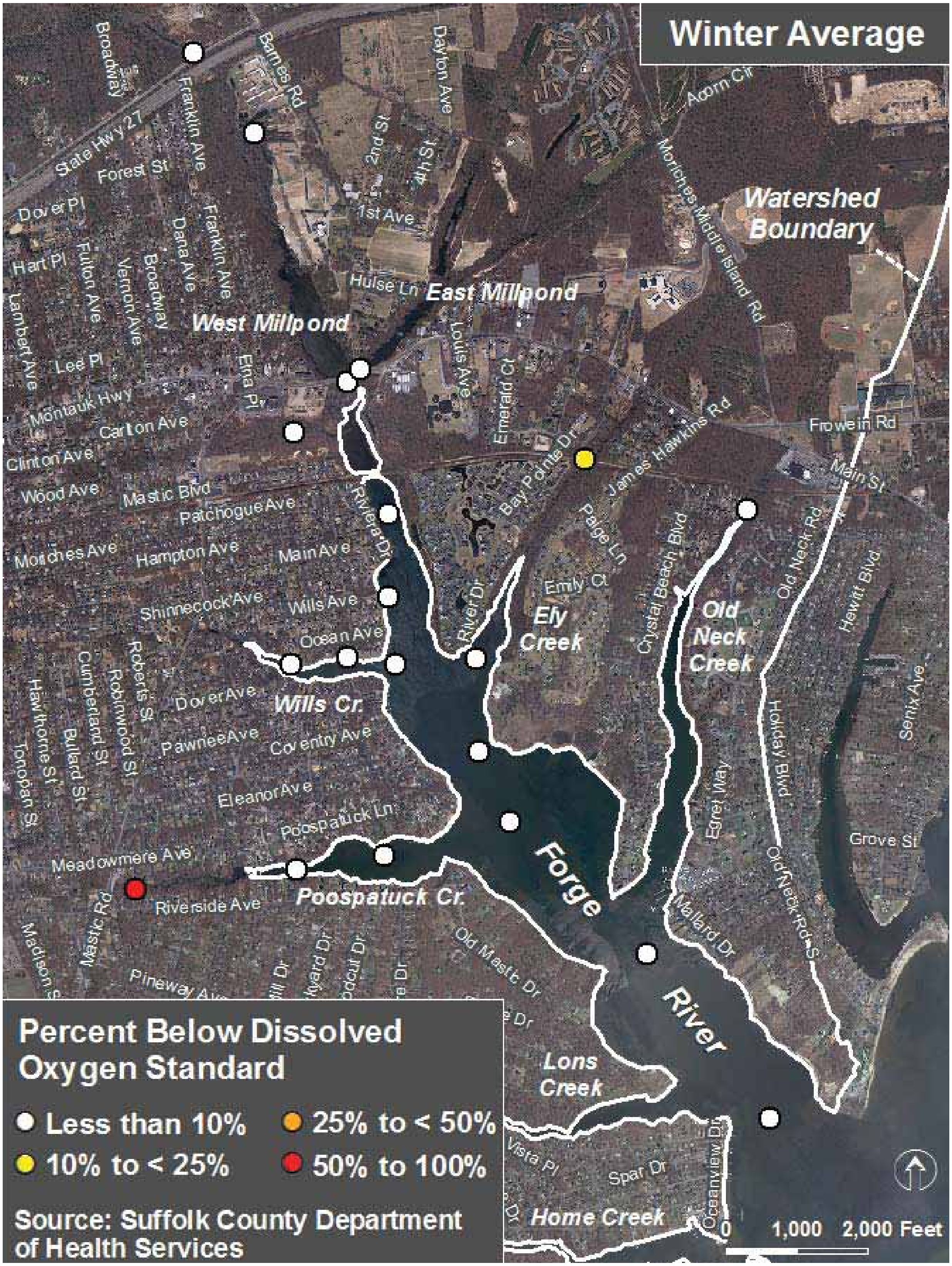


Figure 11-15. Percent of Average Spring Dissolved Oxygen below 4.8 mg/L Standard

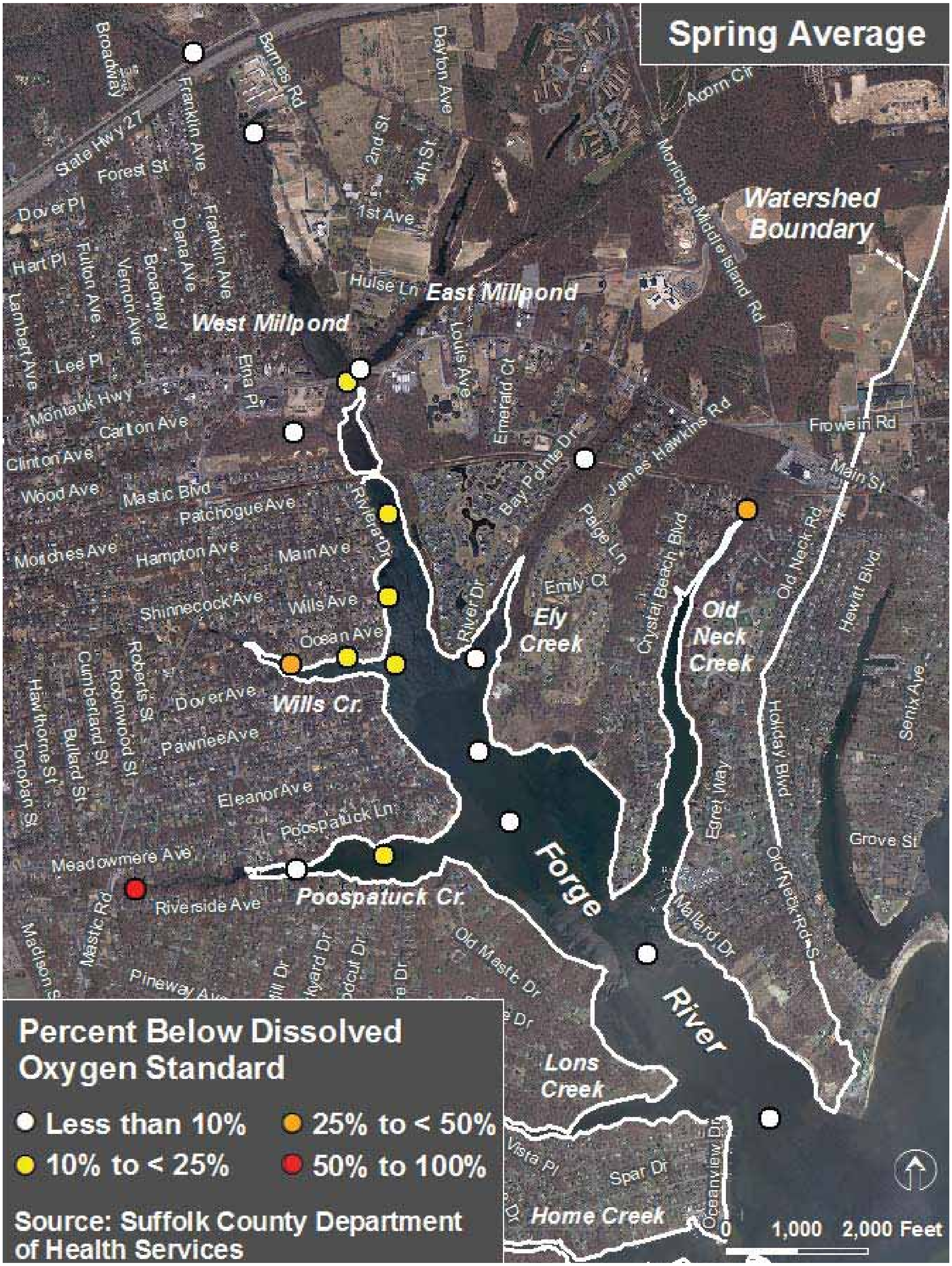


Figure 11-16. Percent of Average Summer Dissolved Oxygen below 4.8 mg/L Standard

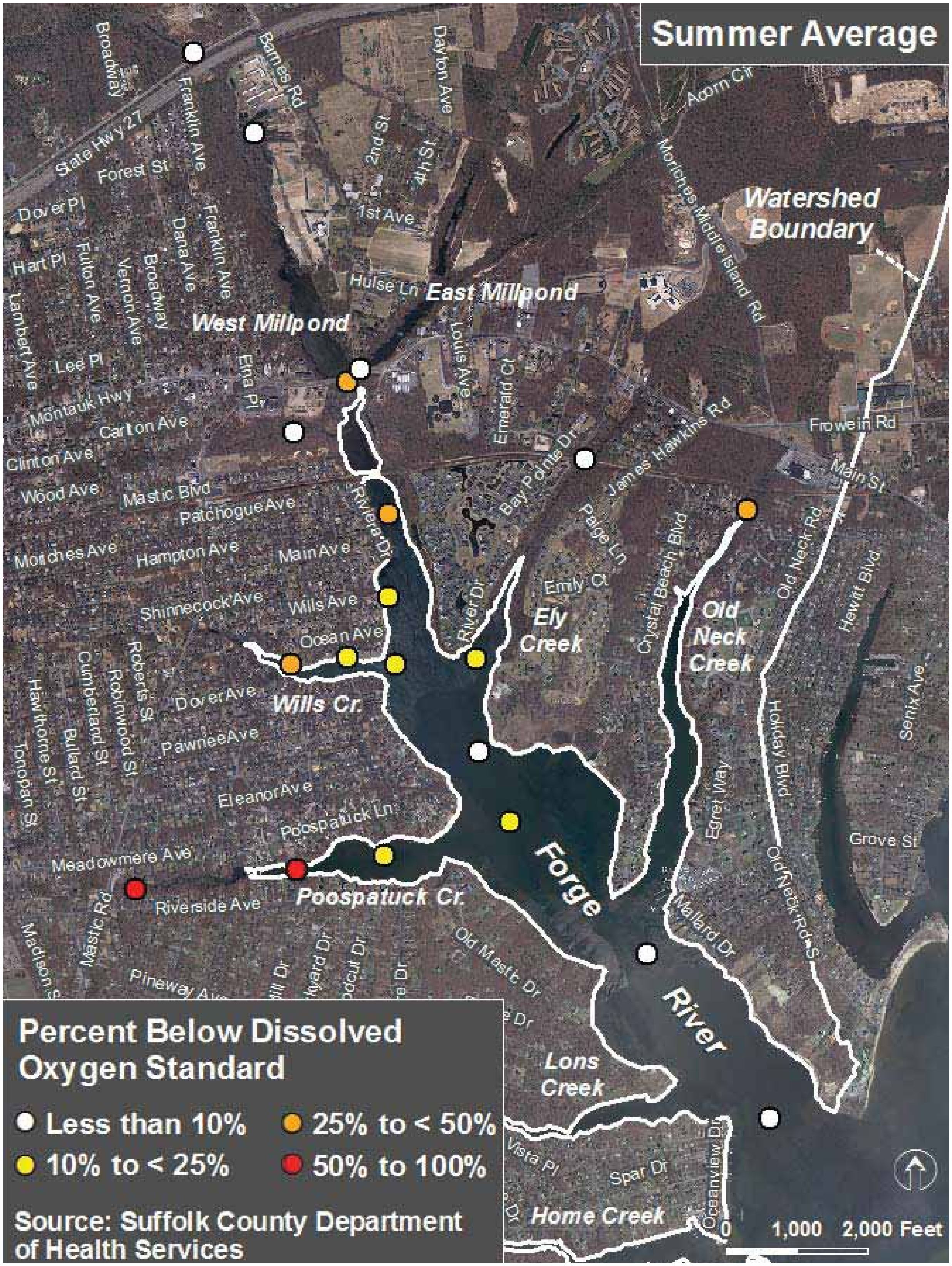


Figure 11-17. Percent of Average Fall Dissolved Oxygen below 4.8 mg/L Standard