STONY BROOK WATERSHED MANAGEMENT PLAN

MMI #3104-01-1

September 25, 2009

Prepared for:

Town of Waterford
15 Rope Ferry Road
Waterford, Connecticut 06385-286

Prepared by:

MILONE & MACBROOM, INC.
99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773
www.miloneandmacbroom.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Introduction

This document presents the results of Waterford's Stony Brook Watershed Management Plan. This inventory and assessment was undertaken by the Town in an effort to identify water, wetland, and upland resources within the Stony Brook Watershed and to evaluate the mechanisms by which these resources can be preserved, protected, and regulated at the local level.

This watershed management plan includes an assessment of surface water quality, benthic habitat, wetland functions and values, and unfragmented wildlife habitat. The plan formulates strategies for resource management, stormwater quality management, low impact development, and septic suitability.

Overview of Watershed

The Stony Brook watershed is approximately 2.86 square miles (1,835 acres) and is located within the southwestern part of Waterford. Stony Brook is the primary perennial watercourse within this watershed, and it discharges into Keeny Cove. The watershed is bounded to the west by the Niantic River, to the north by interstate 395, to the east by the Jordan Brook watershed, and to the south by Keeny Cove.

Land use and zoning within the Stony Brook watershed differs from north to south, with the southern portion being dominated by residential, the central section by residential and large vacant parcels, and the northern portion dominated by undeveloped mixed hardwood forests and a few commercial properties. Commercial and industrial developments are primarily located along Cross Road, I-95, and Route 1. The I-95 corridor serves as a major barrier for wetland connectivity between the north and central portions of the watershed. Motor vehicle noise and the limited number of culverts beneath I-95 limit and impede wildlife movement between wetlands. Stormwater runoff from the interstate also discharges directly into bordering wetlands and watercourses ultimately degrading water quality. Existing residential development occurs primarily south of Route 1 and along Cross Road.

According to the State of Connecticut's surficial materials GIS mapping, the Stony Brook watershed consists of approximately 1.91 square miles (1,225 acres) of till and approximately 0.95 square miles (610 acres) of stratified drift. Based on the soil types and surficial geology of the Stony Brook watershed, the soil erodibility K values can be classified as moderate. Most of the soils within the watershed have a K value less than 0.3, meaning that they are moderately susceptible to erosion. Some of the wetland soils within this watershed do not have a determined K value.

Stream Assessment

Stony Brook and its tributaries begin in red maple/alder/skunk cabbage swamps in a wide wetland complex in the upper watershed. This area is typically flat with wide, heavily vegetated floodplains and a network of many small channels full of organic material and fine sediments.

An occasional cascade over boulders is present in the upper watershed. Instream habitat is minimal in the upper watershed but, where present, appears to be of good quality. The primary disturbance in the upper watershed is road crossings consisting of culverts or dirt roads that actually travel through the stream channel.

The slope of the watershed increases further down the watershed, and as the channel travels towards the I-95 crossing, it becomes well defined and takes on a step-pool pattern. The main stem flows through large boulders and rock vanes and is thus quite stable. The smaller tributary originating to the east in the vicinity of Cross Road is also stable due to large diameter particles on the bed and banks. The water in this tributary has a distinct red color and appears to influence water quality from the confluence with the main stem and downstream. The small channels upstream of I-95 typically consist of high quality physical aquatic habitat due to good channel stability, intact riparian areas, and floodplains free of human encroachments.

Downstream of the I-95 crossing, the slope of the Stony Brook channel decreases and the channel widens. A riffle-pool pattern is present. Human alterations to the channel are more abundant in the mid to lower watershed. For example, immediately downstream of the I-95 culvert, the stream appears to have been channelized alongside a roadway and farm field. This channelization has reduced habitat quality by causing more embeddedness, decreased amount of material retained for colonization, and a general decrease in the heterogeneity of the channel bed. Signs of excess sediment deposition begin to appear at this location.

As Stony Brook and its tributaries approach Route 1, the channel flattens and takes on a dune-ripple pattern. The channel bottom is primarily sand, with some small gravels. Some point bars are evident, indicating sediment deposition and movement through the system. The aquatic habitat upstream of Route 1 is of high quality as the channels travel through large wetland complexes that are abundant in organic material and have good floodplain access unimpeded by human infrastructure. The small tributaries entering Stony Brook tend to have silty bottoms and deliver loads of fines to the channel. The small, partially breached dam immediately upstream of the Route 1 bridge appears to be holding back excessive amounts of fine sediments.

Downstream of Route 1, both water and habitat quality decline relative to upstream locations. The wetland immediately downstream appears deteriorated, containing garbage and an oily sheen on the water surface. The water has a reddish hue, indicative of iron oxide leachate that can indicate water pollution or may be due to microbial action within the soil. Once back into a well-defined channel, Stony Brook is relatively deep and wide and consists of fine substrates. The stream flows though neighborhoods where it is channelized among homes. The channel is largely disconnected from its floodplain at this location. Tidal influence is evident in the majority of the channel in this stream segment.

Stony Brook is designated as a Class A waterbody (CTDEP, 2002) from its headwaters down to Keeny Cove where it enters the Niantic River. These surface waters are designated for habitat for fish and other aquatic life and wildlife, potential drinking water supplies, recreation, navigation, and water supply for industry and agriculture.

Based on the water quality data collected by the Town of Waterford from 1999 to 2006 (summary data included in Appendix B) and the rapid field water quality assessment performed by Milone & MacBroom, Inc. in June 2007, Stony Brook appears to be mostly meeting this high water quality designation. However, data indicate some water quality issues may exist that warrant further study.

The historical water quality data typically show normal natural water quality trends for surface waters, with the following observations:

→ The water in Stony Brook is slightly acidic, with a pH near 6.5.

→ Water temperature is generally cool (< 15 degrees Celsius), with a slight increase moving down the watershed as the channel widens and the canopy opens to allow more sun to reach the water surface.

→ Specific conductivity is low (< 150 µmhos), indicative of cleaner water, with a small increase moving downstream, likely due to more dissolved particles present either due to geology or increased runoff from road crossings.

→ Chloride, a common component of stormwater runoff near roadways where salt is applied in the winter months, is low (typically < 20 mg/l), with concentrations increasing moving downstream likely due to more runoff from roads and developed areas in the lower watershed.

→ Dissolved oxygen is high (9.5 mg/l) and consistently above the 5.0 mg/l standard for Class A waters.

→ Turbidity is at normal levels for clear water (~1 NTU), with typical variability observed across data collected in different flows and in different locations.

→ *E. coli* is low and meeting the Class A standards, with some other typical coliform bacteria present in higher amounts that are usually associated with watershed geology or normal stormwater runoff.

→ Phosphorus levels are low (< 0.03 mg/l) and, as usual, the limiting nutrient for plant growth in freshwater. The measured concentrations are near the low limit where nuisance plant growth is possible, yet in flowing waters algal blooms typically occur at higher levels of total phosphorus (USEPA, 2000). The shading by the dense riparian canopy typical along Stony Brook, combined with the measured phosphorus concentrations, leads to the observed plant growth at normal levels that in turn leads to more available substrate for colonization by benthic macroinvertebrates. A normal crop of aquatic plants also reduces the likelihood of large dissolved oxygen sags during the day due to respiration.

→ Nitrogen, in the various forms measured, is present in typical concentrations, with a minor increase in nitrate moving downstream. In general, nutrient levels appear typical for a partially developed watershed such as around Stony Brook.

→ Metals data collected over the past eight years suggest the potential for both acute and chronic toxicity to aquatic life.

Wetland Assessment

The more than 306 acres of wetlands in the watershed represent several ecological categories that include palustrine open water, forested, scrub-shrub, and emergent marsh/wet meadow. The relative proportions of each are presented in Table ES-1 below.

TABLE ES-1
Wetland Types Within the Stony Brook Watershed

Wetland Type	*Acreage Within the Stony Brook Watershed*	*Percentage Within the Stony Brook Watershed*
Palustrine Open Water	4.7	<1%
Palustrine Emergent Wetland	17.4	<1%
Palustrine Scrub-Shrub Wetland	7.6	<1%
Palustrine Forested Wetland	180.0	10%
Palustrine Forested/Scrub-shrub Wetland	88.0	5%
Palustrine Scrub-shrub/Emergent Marsh Wetlands	8.0	<1%

Site-specific wetland assessment was conducted throughout the Stony Brook watershed. Wetland quality ranged from marginal to excellent, with varying degrees of prior disturbance. This assessment also included the identification of critical wetland systems. This assessment was a broad analysis and is not a substitute for site-specific analysis for proposed development projects.

Critical Wetland Systems

Through decades of well documented research, it has become clear that wetlands and watercourses provide a host of important physical and chemical functions as well as a suite of beneficial societal values. These functions and values operate at all scales, from the microscopic up to the local and regional landscape. While most wetlands perform some, or even many, of these functions and values, some wetlands, because of their geology, location, vegetation, aesthetics, prior impacts, or their history, are inherently more valuable than others. The identification of critical wetland and watercourse systems was completed to provide assistance in development of management practices and guidelines that would be applied to land-use decisions and conservation practices to protect these important resources within this watershed.

Within this management plan, these special wetlands and watercourses have been referenced as "critical wetland systems." Two objectives were established for identifying critical wetland systems within the Stony Brook watershed. These objectives included (1) establishing a network of wetland systems that fully represented a diversity of wetland types and that performed key ecological and hydrological functions on a local and regional scale; and (2) ensuring local and regional wetland biodiversity through designation and management of critical wetland systems. The critical resource areas within the Stony Brook watershed are presented in Table ES-2. In addition, Figure ES-1 illustrates the critical resource areas.

TABLE ES-2
Critical Wetland Systems

Critical Wetland System	***Watershed ID***	***Size (acres)***	***Dominant Wetland Cover Types***	***Important Functions***
CWS-1	SB-70 SB-90	40.2	PFO and PSS	Biodiversity Nutrient Retention Flood Flow Alteration Production Export Fishery Habitat
CWS-2	SB-70	64.3	PFO, PSS, PEM	Biodiversity Flood Flow Alteration Nutrient Retention
CWS-3	SB-30	5.0	PFO, PSS, POW	Biodiversity Pollutant Renovation

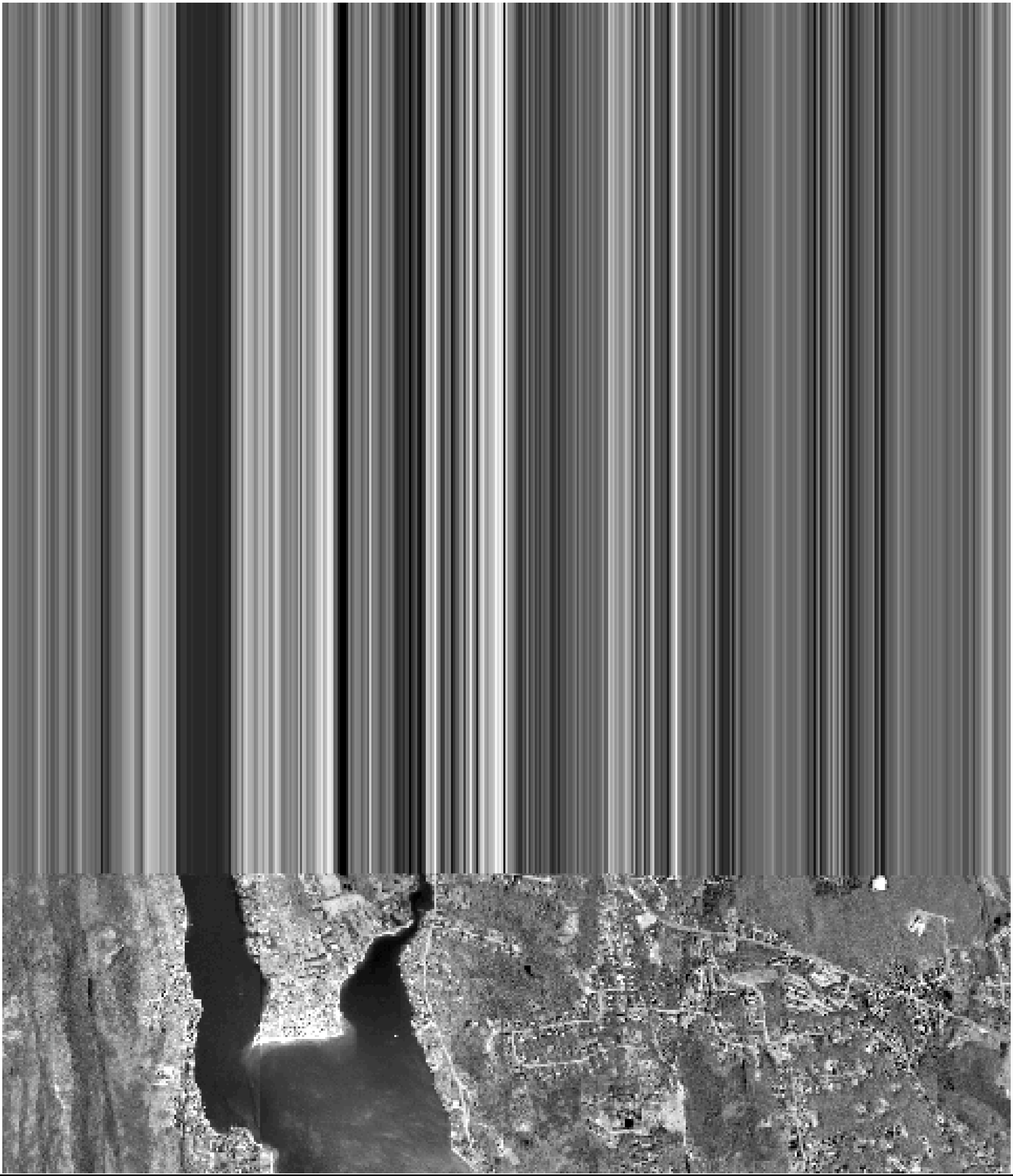
PFO = Palustrine Forested Wetlands; PSS = Palustrine Scrub-shrub Wetlands; PEM = Palustrine Emergent Marsh; POW = Palustrine Open Water

Recommendations for Upland Review Areas and Natural or Enhanced Vegetative Buffers

Recommended upland vegetated buffer distances have been developed to give the commission the ability to provide upland protection zones for wetland and watercourses. Continued application of the Town's existing 100-foot upland review area as codified in Section 6.3 of the Inland Wetlands and Watercourses regulations is recommended within the Stony Brook watershed. Where proposed land use changes are proximal to wetlands containing vernal pool habitat, a review area of 150 feet is recommended to determine if activities are likely to affect wetlands and watercourses.

Maintenance of a vegetated buffer area between proposed development and the edge of a wetland is recommended to protect the diversity of wetland plant communities, integrity of in-stream habitats and channel characteristics, and to preserve water quality features including turbidity, dissolved oxygen and temperature. The width of this vegetated buffer area ranges between 50 and 100 feet, based upon the following factors:

→ the quality of the wetland or watercourse, i.e., the functions and values it provides
→ water quality features
→ fishery resources



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

LOCATION:				
MMI#:		DATE:	SHEET:	
MXD:		SCALE:		
SOURCE:				

→ critical wetland habitats
→ the sensitivity of the wetland to potential impacts from development
→ the merits, benefits, and particular risks of the proposal, including alternatives to the suggested action and available remedial measures

There may be specific property constraints and/or site development objectives that limit the availability or opportunity to provide these recommended vegetated upland buffer areas. In these circumstances, it is recommended that the commission carefully evaluate the potential direct and indirect impacts of the proposed land use change on the receiving wetland and watercourse and require both structural and nonstructural measures to protect the water quality, habitat, and functions of the wetland resources.

The suggested upland vegetated buffers for protecting the Stony Brook watershed wetlands and watercourses are summarized in Table ES-3.

TABLE ES-3
Upland Vegetated Buffers

	Recommended Upland Review Area (feet)	**Recommended Upland Vegetated Buffer (feet)**	**Recommended Conditions and Goals**
Stony Brook Main Stem & Riparian Zone	100	100	Densely vegetated buffers see Section 5.9.2 for specifications
Critical Wetland Systems	100	100	
Vernal Pools and other Amphibian Breeding Areas	150	100 to 150	
First Order Streams	100	50 to 100	
Intermittent watercourses and/or wetlands without watercourses, vernal pools, and/or critical wetland systems	100	50	

Upland vegetated buffer widths are but one important measure for protecting wetlands and watercourses from adverse impacts associated with changes in adjacent land use. Other important measures for protecting wetlands and watercourses that should be considered include the following:

→ appropriate site planning given existing landscape variables

→ design, installation, monitoring, and maintenance of proper sediment and erosion control measures

→ design, installation, monitoring, and maintenance of stormwater control and treatment measures in keeping with the state's Stormwater Quality Manual and use of appropriate low impact development (LID) design practices

Watershed Management and Low Impact Development (LID)

In broad classification, typical impacts to wetlands and water resources due to the alteration of hydrologic conditions associated with land development and other activities include degraded water quality, unnatural stream channel geomorphic changes, and increased frequency and severity of flooding. All of these potential impacts may also impact aquatic systems and can result in habitat loss and degradation and decreased biodiversity.

The practice of stormwater management is intended to mitigate hydrologic impacts resulting from changes to the land's surface. Stormwater management can occur at a watershed scale or at the site scale. At the watershed management scale land use controls, source controls and treatment controls are three common methods of stormwater management.

At a site scale, LID is currently the preferred method of managing stormwater. LID design practices make use of creative site planning and design tools that are intended to preserve or reduce the changes to a site's hydrology rather than simply providing "end of pipe" treatment or highly engineered management systems. The use of these planning and design tools can often times reduce or even eliminate the requirement for more costly and sometimes obtrusive storage, infiltration, or end-of-pipe structural practices for the management of stormwater runoff. They can also result in development proposals that better fit the existing characteristics of a site, are aesthetically pleasing, and protect the environment.

The following site design elements incorporate LID:

1. Reduce paved areas to the extent possible. This may include reducing the width of paved roadways and cul-de-sac diameters, eliminating on-street parking, promoting use of common driveways, or using narrower driveway widths (perhaps nine or 10 feet).

2. Use permeable pavement materials such as grass pavers whenever possible.

3. Avoid compaction of high permeability soils.

4. Minimize the area dedicated for construction easements and stockpile areas.

5. To the extent possible, plan site activities to limit the removal of trees and vegetation.

6. Disconnect impervious areas. Do not connect roof drains and footing drains into a piped drainage system (consider drywells or other infiltration devices). Provide curbless roads to allow sheet flow.

7. Maintain existing topography to the extent possible. The intent is to maintain runoff travel distances, slopes, roughness, and channel shapes whenever possible.

8. Maximize the use of open drainage systems such as grass swales.

9. Alter front yard setbacks to move houses forward on a lot to reduce driveway lengths.

Table ES-3 presents a listing of preferred best management practices (BMPs), specific to different zoning designations and land uses.

TABLE ES-3
Preferred Best Management Practices

Residential	*Retail/Industrial*	*Both*
Rain Gardens or Barrels	Pervious Parking	Grass Swales
Infiltration Basins or Trenches	Green Roof Storage	Deep sump catch basins in roads and parking areas
Dry Wells	Single Sidewalks	Hydrodynamic Separators
	Reduction in Building Footprint	Oil/water separators
	Parking Lot Storage	Created wetland systems
	Decentralized Parking	Bioretention facilities
	Bioretention at Parking Lot Islands	Detention Basins

LID practices can be incorporated into proposed developments in any zone, provided soil types and other site conditions are favorable for the proposed LID application. The most important consideration is the ability to capture and collect pollutants in the event of a release. For this reason, the use of infiltration in business and industrial zones needs to be carefully considered based on the proposed use of the property.

In many communities across Connecticut, the application of LID principles in the design of development plans is hindered by language in the land use regulations that seemingly prohibits their use. The Town of Waterford may wish to incorporate additional LID principles into their existing land-use regulations.

Summary of Findings

1. The Town of Waterford has placed a high priority on identifying, protecting, and managing its natural resources within the Stony Brook watershed. The Stony Brook watershed includes several large valuable wetland and watercourse systems. The more than 306 acres of wetlands in the watershed represent several ecological categories including palustrine open water, forested, scrub-shrub, and emergent marsh/wet meadow systems. These wetland systems, in conjunction with their neighboring uplands, are critical in maintaining a clean and adequate supply of surface and ground water.

   The Stony Brook watershed is unusual in that the northern portion of the watershed is relatively undeveloped with large wetland systems that are natural and unfragmented while the central and southern portions of the watershed are more disturbed, developed, and fragmented. These differences in land use influence wetland cover types, water quality/quantity, and wetland functions and values such as flood control, pollutant renovation, aesthetics, recreational opportunities, and wildlife habitat among others.

Wetland cover types north of the interstate are predominantly forested and scrub-shrub wetlands. South of the interstate, where anthropogenic disturbances are numerous, wetland cover types diversify from forested and scrub-shrub wetlands to include wet meadow, emergent marsh, and some open water wetlands. With the exception of a few wetlands such as (CWS-3) and Stony Brook itself, Milone & MacBroom, Inc. (MMI) observed that the overall wetland quality declines south of the interstate. Evidence of more recent disturbances (particularly commercial and residential development), invasive species colonization, and lower water quality all contribute to the decline of these wetlands. However, that is not to say that the wetlands south of the interstate do not still provide important functions and values that merit continued protection.

2. Based on the water quality data collected by the Town of Waterford from 1999 to 2006 and the rapid field water quality assessment performed by MMI in June 2007, Stony Brook appears, for the most part, to be meeting its Class A water quality designation. However, some data and field observations indicate that some water quality issues exist that warrant further investigation. In summary, Stony Brook has:

   a. Cool water temperatures
   b. Slightly acidic pH
   c. Low specific conductivity
   d. Low chloride concentrations
   e. High dissolved oxygen
   f. Low *E. Coli* concentrations
   g. Low phosphorus and nitrogen concentrations
   h. Metals data suggest the potential for both acute and chronic toxicity to aquatic life due to high lead and copper concentrations. However, the data may be inaccurate due to the use of nonstandardized techniques with high detection limits. Further testing, after inspections, is likely warranted.

   Our field observations indicate some areas of departure from the Class A water quality. For example, the instream bioassessment data indicates a limited abundance and diversity of macroinvertebrates within Stony Brook. MMI also noted strong, red-colored surface waters within the upper eastern subwatersheds (tributaries T2 and T3) that appear to be excessive given the underlying watershed geology. Thus, there may be sources of contamination. These few instances of potential water quality problems warrant further study because Stony Brook is a high quality watercourse and provides an important fishery resource. It should be carefully protected and maintained through appropriate watershed management and careful land use planning.

3. It is critical that management efforts extend beyond the banks and flowing water of Stony Brooks. Upstream land uses can have significant hydrologic impacts such as increases or decreases in runoff volumes and peak discharge rates as well as nonpoint source pollution. Based on our field observations, Stony Brook does experience low-flow impairments, and it is important to maintain recharge capabilities within its watershed. Wetland filling that reduces the detention/retention capability in the watershed can increase water surface elevations at

upstream properties and increase erosion downstream as water velocities increase in direct response to the loss in conveyance area. Loss of riparian buffers and/or wetlands can impact habitat quality and also increase water temperatures as shade-providing vegetation is removed as was observed south of I-95.

4. This study provides important mapping and analysis tools of critical environmental resources in the Stony Brook watershed. It provides a baseline of information from which good planning can follow. This is true for individual sites and projects as well as for broad-scale planning at the municipal, regional, or statewide level. It is difficult for planning boards, regulatory commissions, and local officials to fully evaluate the merit and/or potential impact of an action when it is out of the context of the broader environment in which it is to take place.

5. MMI identified three critical wetland systems (CWS) within the Stony Brook watershed. These wetland systems include forested, scrub-shrub, and emergent wetlands, which provide important functions including preservation of biodiversity, flood flow alteration, and water quality protection and renovation. The critical resource areas within the Stony Brook watershed are described further in Section 5.8.1.

6. The Stony Brook watershed includes several large tracts of land that have been classified in this report as unfragmented natural areas. Each area is described in Section 5.8.2. Unfragmented natural areas are a critical component in the conservation of biodiversity on a local and regional scale, and they provide and protect essential water supplies. Virtually the entire Stony Brook watershed north of I-95 can be viewed as an unfragmented area of high resource value. Only narrow strips of development exist and these are, for the most part, closely confined to Cross Road and the access road north of the highway.

   Similarly, the lands south of I-95 and north of the Post Road are largely undeveloped. As viewed here, the "natural" state of the fallow farm fields, farm ponds, and wooded hedgerows adds diversity to the landscape and provides opportunities for wildlife not found in the forested sections of the watershed. Additionally, they offer easier access and vantage points for public enjoyment.

   On a smaller scale, valuable undeveloped lands occur south of the Post Road. These include the high resource value wetlands near Oswegatchie School and beyond Fulmore Drive. The undeveloped woodlands that border these two wetland systems greatly increase the overall resource value, although on a more local scale than areas to the north.

7. Vernal pool obligate species such as spotted salamanders and wood frogs were found within numerous wetlands in the Stony Brook watershed. Based on the field investigations, there is a higher concentrations of breeding habitat north of I-95. This is most likely attributed to the fact that the wetland and upland habitats north of the interstate have remained natural and unfragmented. South of I-95, the occurrence of amphibian breeding habitat lessens, due to the overall change in land use which is predominantly agricultural, residential, and commercial.

8. Effective watershed management within the Stony Brook watershed involves a multifaceted approach that encompasses land uses (past, present, and future); stream and wetland buffers; responsible development through adequate site selection, design, and maintenance; stormwater BMPs; control of nonstormwater discharges; and control of destructive and unnatural erosion and sedimentation.

9. Unchecked or unregulated development within a watershed like Stony Brook can have profound negative impacts on the surrounding environment in the form of changes to stream flow, flooding, erosion and sedimentation, and deteriorated water quality in streams, ponds, and wetlands. Many communities have attempted to address these issues through local zoning or subdivision regulations that prohibit increases in peak stormwater runoff rates. However, regulation is only one aspect of the zero-extra runoff concept. Of equal importance is consideration of the individual watershed(s) in which stormwater detention is proposed. Depending on the specific hydrology, detention could actually be detrimental to the watershed and even exacerbate downstream flooding impacts.

10. In low impact development, land development design practices for stormwater management make use of creative site planning and design tools that are intended to preserve or reduce the changes to a site's hydrology rather than simply providing "end of pipe" treatment or highly engineered management systems. Low impact development techniques and practices are intended to preserve natural systems and protect resources and their buffer areas through design of drainage systems that mimic natural systems. The selection of specific BMPs varies from site to site. Some applications, such as infiltration systems, may not be appropriate for all land uses or all sites.

Summary of Recommendations

1. Based on field investigations and the fact that the Stony Brook main stem is predominantly underlain by stratified drift, the watercourse is susceptible to low flow impairment and should be managed to increase infiltration. Fortunately, the main stem has a significant extent of stratified drift deposits along the watercourse, such that infiltration and recharge of the aquifers would be relatively easy. The Town may wish to require an assessment by developers of the feasibility of incorporating infiltration and recharge into the design of new development in areas underlain by stratified drift.

2. Any future regulations that control the quantity and timing of stormwater runoff should be carefully crafted to account for the complex hydrologic and hydraulic processes occurring in the watershed in question. In watersheds with alluvial streams, a zero increase in peak flow does not preclude channel erosion. Sensitive streams are also stressed by increased stormwater volume and flow duration, even if peak flows are equalized. Accordingly, each of these components should be considered in the development and application of stormwater management regulations.

3. The inventory, mapping, and habitat analysis conducted under this Watershed Management Plan should be utilized by town leaders and regulatory review boards to help serve as an

active reference tool in reviewing applications, to provide the basis for comparison in the review of the applicability and adequacy of current zoning designations, and to distinguish a hierarchy of protection for natural resources based on their function and value in their respective ecological communities.

4. This plan supports the Town's existing 100-foot upland review area along all wetlands and watercourses that have not been identified as having vernal pools and/or other amphibian breeding habitat. For wetland areas designated as having vernal pools and/or other amphibian breeding habitat, a 150-foot upland review area is recommended from the edge of the pool and/or breeding habitat.

   Maintain an upland vegetated buffer between proposed development and the edge of a wetland. Suggested buffer widths range between 50 and 100 feet, based upon the quality of the wetland resource, the functions and values the resource provides, water quality and vulnerability to land use changes, fishery resources, critical wetland habitats, and the resource sensitivity to proposed development.

5. The Town may wish to consider a program to protect its unfragmented natural areas within the Stony Brook watershed through land acquisition, where possible, and through its land use planning processes. There are many benefits to maintaining unfragmented natural areas. Healthy, ecologically diverse systems that are unfragmented perform important natural, abiotic processes such as decomposition of organic matter, soil and sediment creation, filtration of ground and surface water, air cleansing, pollutant renovation, and nutrient retention. In addition, these unfragmented lands provide educational and recreational opportunities to the public such as bird watching, hiking, skiing, hunting, and fishing.

6. Guidance and suggestions are included in this plan for the promotion of LID in the Stony Brook watershed. The type and scope of LID techniques used may vary from subwatershed to subwatershed and site to site depending, not only on the proposed land use, but on the geology and topography of the site. Other factors such as depth to water and depth to bedrock are also considerations when evaluating LID application.

1.0 INTRODUCTION

1.1 Purpose of the Plan

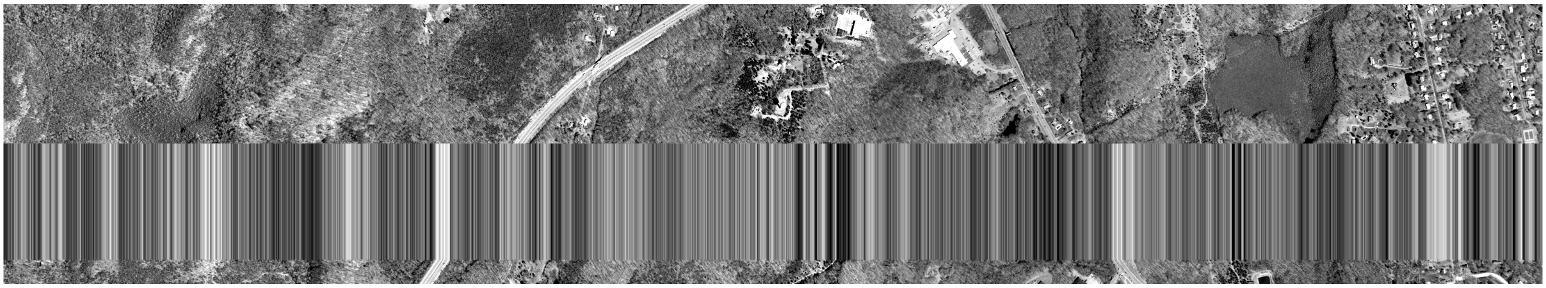
The Town of Waterford (the Town) has adopted a multifaceted approach to environmental planning in its community. The Town has retained Milone & MacBroom, Inc. (MMI) to conduct a comprehensive inventory and analysis of the water, wetland, and upland resources in the Stony Brook watershed and to evaluate the mechanisms by which these resources can be preserved, protected, and regulated at the local level. The Town recognizes that not all resources warrant the same level of protection and that higher quality resources and unfragmented habitat should logically take priority over low quality, isolated features. The Stony Brook Watershed Management Plan is intended to serve as a guidance document to be used for land use planning and decision-making purposes. Figure 1-1 is a location plan showing the geographic limits of the Stony Brook watershed.

1.2 Data Collection Resources

Numerous resources have been accessed to develop a database of information for the subject Watershed Management Plan. The following list provides the principal data resources:

- Selected geographic information system (GIS) mapping data sets for the Town of Waterford and Stony Brook watershed, available through the MAGIC web site, including orthophoto coverage, topography, soil types, surficial materials, mapped aquifer recharge areas, and Natural Diversity Data Base (NDDB) sensitive areas

- Town of Waterford Plan of Preservation, Conservation and Development, dated August 1998



Engineering, Landscape Architecture and Environmental Science MILONE & MACBROOM®		LOCATION:	
99 Realty Drive Cheshire, Connecticut 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com	MMI#: MXD: SOURCE:	DATE: SCALE:	SHEET:

- Town of Waterford Regulations for Zoning and Subdivision dated October 2006 and Inland Wetlands and Watercourses Regulations dated August 2005

- Town of Waterford Zoning District Map dated October 2006

- Electronic GIS mapping depicting land use, zoning, parcels, soils, watershed boundaries, and other coverages available through the Town of Waterford

- Electronic townwide two-foot contour topographic mapping, based on a 1995 aerial flight

- Information available through the Department of Environmental Protection (DEP) Natural Resources Center regarding the mapped resources within the Stony Brook watershed

- Stormwater system mapping

- Water quality data for Stony Brook, available from the Town

- Natural Resources Conservation Service (NRCS, formerly Soil Conservation Service, SCS) soils mapping

- Niantic Quadrangle Coastal Resource Map dated 1970

In addition to the above data, mapping, and reports, field data collection was undertaken to perform a stream assessment, vernal pool study, wetland reconnaissance, and visual inspection of general watershed features (land uses, drainage systems, vegetation, etc.). The analysis and recommendations in this document are based upon a combination of available data in combination with these field efforts.

1.3 Organization of Report

The subject Watershed Management Plan has been organized as follows:

Section 1.0 of this plan describes the scope and purpose of the plan; summarizes the sources of information, data, reports, and resource mapping; and describes the overall organization of the document.

Section 2.0 presents existing watershed conditions, including an overview of environmental and natural resources, topography, soils, land uses, and zoning.

Section 3.0 describes watershed hydrology and hydraulics.

Section 4.0 presents the results of the Stony Brook stream assessment and evaluates existing and historic water quality.

Section 5.0 is a detailed review of wetlands and vernal pools within the watershed, along with classification and mapping of significant representative systems.

Section 6.0 explores watershed management and potential application of low impact development within the Stony Brook watershed under existing and potential future conditions.

Section 7.0 is a summary of findings and recommendations.

Section 8.0 is a listing of references.

As a complement to the plan narrative, an interactive GIS database has been developed whereby the system can be queried by parcel or wetland area to provide data on the subwatershed unit, existing land use, zoning, wetland quality, soil types, and other relevant information. This tool is available to municipal staff, the Conservation Commission, and prospective developers.

2.0 EXISTING WATERSHED CONDITIONS

2.1 Watershed Boundaries

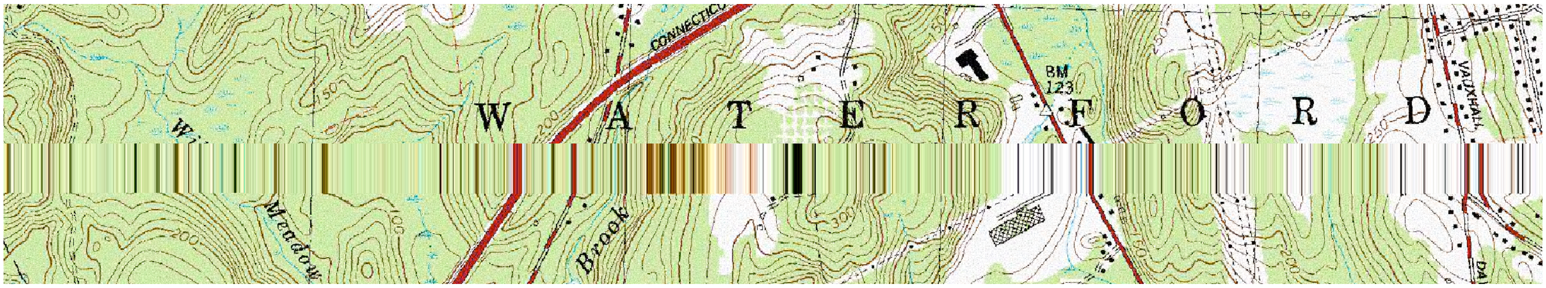
The Stony Brook watershed encompasses approximately 2.86 square miles (1,835 acres) and is located within the southwestern part of Waterford. The Stony Brook watershed is part of the Southeast Coast major basin and the Southeast Western Complex regional basin. The watershed is located within the Niantic River subregional basin number 2204. The watershed is illustrated on Figure 2-1.

Stony Brook is the primary perennial watercourse within this watershed and it discharges into Keeny Cove. The watershed is bounded to the west by the Niantic River, to the north by Interstate 395, to the east by the Jordan Brook watershed, and to the south by Keeny Cove.

2.2 Land Use and Zoning

Land use within the Stony Brook watershed is represented on Figure 2-2. Zoning is represented on Figure 2-3. Land use and zoning within the Stony Brook watershed differs from north to south with the southern portion being dominated by residential, the central section by residential and large vacant parcels, and the northern portion dominated by undeveloped mixed hardwood forests and a few commercial properties. Commercial and industrial development are primarily located along Cross Road, I-95, and Route 1.

The I-95 corridor serves as a major barrier for wetland connectivity between the north and central portions of the watershed. Motor vehicle noise and the limited number of culverts beneath I-95 limit and impede wildlife movement between wetlands. Stormwater runoff from the interstate also discharges directly into bordering wetlands and watercourses, ultimately degrading water quality.



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

LOCATION:

MMI#:
MXD:
SOURCE:

DATE:
SHEET:
SCALE:

Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

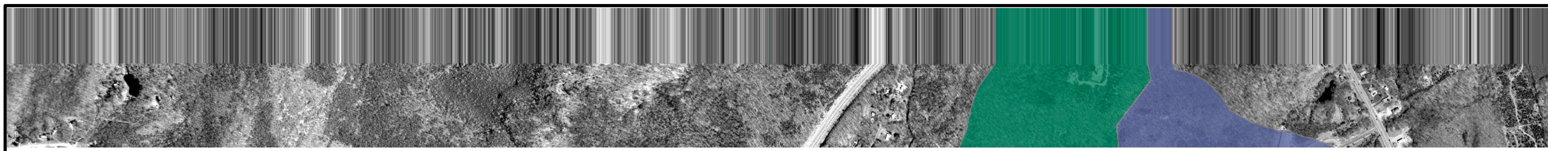
LOCATION:

MMI#:
MXD:
SOURCE:

DATE:

SCALE:

SHEET:



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

			LOCATION:	
MMI#: **MXD:** **SOURCE:**			**DATE:** **SCALE:**	**SHEET:**

Existing residential development occurs primarily south of Route 1 and along Cross Road. Geographically, land use and zoning within the watershed have been subdivided into the following sections: (1) parcels located north of I-95; (2) parcels located south of I-95 and north of Route 1; and (3) parcels located south of Route 1. Each is described below.

The network of roads is a dominant land use throughout the watershed, with a general trend of declining stream health as the density of the local transportation system increases. The decline of habitat and water quality with more roads is an important consideration as development pressure increases in the watershed and road expansion is likely. Efforts should be made to site roads away from channels, minimize the number of crossings, and limit impervious cover that directly discharges stormwater to streams.

Parcels North of I-95

Land use north of I-95 is predominantly undeveloped, with mixed hardwood forest, palustrine forested wetlands, and palustrine scrub-shrub wetlands. Some commercial buildings do exist north of the interstate and are located along the eastern portion of the watershed, bordering Waterford Parkway North, Cross Road, Foster Road, and I-95. According to the Waterford zoning map, this portion of the watershed consists of five zones including the C-R Zone (Regional Commercial District), I-G Zone (General Industrial District), I-C Zone (Industrial Commercial District), I-MF Zone (Industrial and Multifamily Residential District), and the RU-120 Zone (Rural Residential District).

Parcels South of I-95 and North of Route 1

Land use between I-95, Waterford Parkway South, and Route 1 includes undeveloped land with mixed hardwood forest, dry and wet meadows, and residential properties. The residential properties are primarily restricted to Route 1 and Cross Road. Large tracts of maintained meadow are located along the eastern portion of the watershed while large tracts of mixed hardwood forests dominate the western portion. Zoning within this section of the watershed includes IP-1 Zone (General Industrial Park Zone), NBPO Zone (Neighborhood Business Professional Office District), R-20 Zone (Medium Density Residential Zone), R-40 Zone (Low Density Residential Zone), and the I-MF Zone.

Parcels South of Route 1

Land use south of Route 1 is predominantly residential, retail, and undeveloped mixed hardwood forests. Several parcels of residential lands have the potential to be subdivided in the future. Zoning within this section of the watershed includes the NB Zone (Neighborhood District), C-G Zone (General Commercial District), R-MF Zone (Multifamily Residential District), R-20 Zone, and the R-40 Zone.

The recently completed interchange at the I-95 on and off-ramps and Cross Road intersection was intended to provide better vehicular traffic movement patterns. The northern part of the watershed supports several acres of vacant land that is zoned primarily for mixed commercial and industrial uses. The large vacant parcels bordering the southern portion of I-95 (zoned for multifamily and commercial) provide additional opportunities for future development. Future development, if not designed and constructed using best management practices, could have adverse impacts to the Stony Brook watershed watercourse and wetlands.

2.3 Surficial Geology

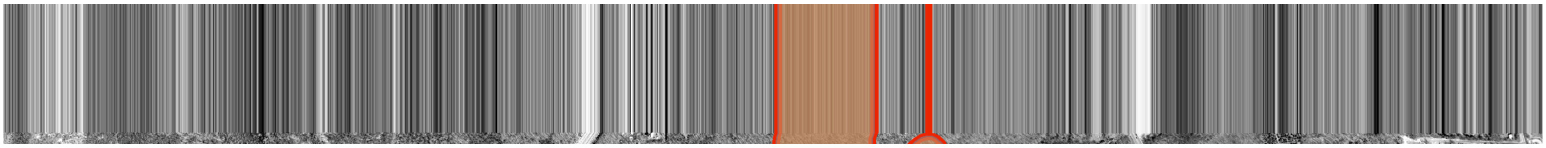
According to the State of Connecticut's surficial materials GIS mapping, the Stony Brook watershed consists of approximately 1.91 square miles (1,225 acres) of till and approximately 0.95 square miles (610 acres) of stratified drift. Till is defined as unsorted glacial sediment consisting of unstratified sand, silt, and rock. The origin of most of the till soils found within this watershed is schist, gneiss, and granite. Stratified drift is defined as sorted glacial sediment and consists of sorted sand, silt, and rock. The stratified drift deposits within this watershed are glaciofluvial in origin, formed from acidic crystalline rock.

Surficial geology is often used to help calculate base flows within streams, determining septic system suitability and soil erodibility. The surficial geology of the Stony Brook watershed is presented on Figure 2-4.

Soil erodibility was assessed within the Stony Brook watershed by reviewing the NRCS universal soil loss equation along with the K-factors of the existing soil types. Determining the erodibility of a soil is important when evaluating future development projects, especially when dealing with the potential for adverse impacts to nearby wetlands and watercourses from soil erosion. Eroding soils can lead to water quality degradation and sediment deposition within nearby wetlands and watercourses.

Soil erodibility (K) is a term that has been used to describe the detachment, entrainment, and transport forces of rainfall/runoff. The K factor by definition is the soil loss from a unit plot per erosion index unit. A unit plot is defined as a 72.6-foot length of uniform nine percent slope, maintained in continuous fallow, tilled up and down hill to periodically control vegetation (Lal, 1988). The K factor is determined by identifying the geological mode of deposition, soil texture, percent organic matter, dominant soil classification, and soil permeability. The K factor is conventionally an average annual value for estimating soil loss. Several methods are available to determine the K value for a plot, including field plot studies, laboratory erosion flume studies, or soil erodibility prediction.

Soils high in clay have low K values, about 0.05 to 0.15, because they are resistant to detachment. Coarse textured soils, such as sandy soils, also have a low K value, approximately 0.05 to 0.2, even though these soils are easily detached. Medium-textured soils such as silt loam soils have moderate K-values, about 0.25 to 0.4 because they are moderately susceptible to detachment and they produce moderate amounts of runoff. Soils having high amounts of silt content are the most erodible of the soils. They are easily detached and tend to produce the highest rates of runoff. K values for these soils



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

LOCATION:

MMI#:

MXD:

SOURCE:

DATE:

SCALE:

SHEET:

tend to be greater than 0.4. Organic matter reduces the erodibility of a soil because it reduces the susceptibility of a soil particle to become detached.

Figure 2-5 illustrates the representative K-value ranges for the soils mapped by the NRCS for the Stony Brook watershed. Based on the soil types and surficial geology of the Stony Brook watershed, the soil erodibility K values can be classified as moderate. Most of the soils within the watershed have a K value less than 0.3, meaning that they are moderately susceptible to erosion. Some of the wetland soils within this watershed do not have a determined K value.

Based on the K values, protection of Stony Brook and the other wetland resources within its watershed require the use of best management practices for any construction related activities. The use of the *2002 Connecticut Guidelines for Soil Erosion and Sediment Control* and the *2004 Stormwater Quality Manual* provides a base line for adequately addressing soil erosion and stormwater management to help protect water quality, wetland habitat, and watercourse health.

2.4 Natural Resources

The Stony Brook watershed is unique in that a majority of the watershed has remained undeveloped. As a result of large undeveloped areas, the watershed supports several important natural resources. The large upland mixed hardwood forests located within the northern portion of the watershed provide valuable habitat for wildlife, especially interior forest birds. The palustrine forested wetland communities also within this area provide vernal pool habitat for wood frogs and mole salamanders. The large wetland systems provide high quality habitats for reptiles and waterfowl. Stony Brook's headwaters in the northern part of the watershed provide cool, oxygenated water to instream biota.

Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

MMI#:	**LOCATION:**	
MXD:	**DATE:**	**SHEET:**
SOURCE:	**SCALE:**	

The central portion of the watershed supports large tracts of mixed hardwood forests and meadows. The large forested areas provide similar habitat to those wildlife species mentioned above and the meadows provide habitat for grassland birds, pickerel frogs, and a variety of insects.

Within the central portion of the watershed, Stony Brook has experienced historic disturbances, including building of major and minor roads, channelization, farm crossings, and creation of impoundments. The transportation network has altered natural watershed hydrology by compacting and covering soils with impervious materials. This change in land cover reduces infiltration and leads to increased surface water runoff during storms. I-95 and Route 1 cross the watershed in an east-west direction while other major roads such as Niantic River Road and Cross Road run through a portion of the lower and middle watershed in a north-south direction.

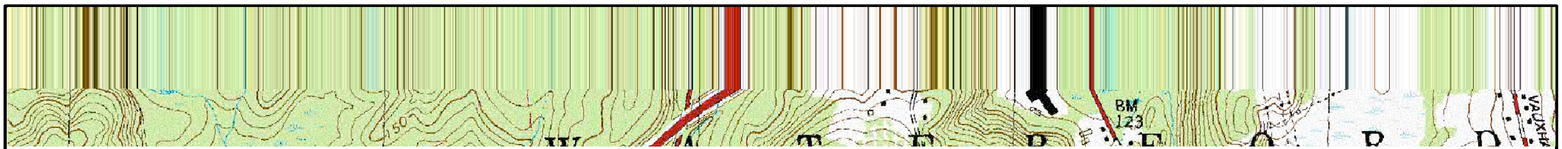
Disturbances have also occurred through land development. Residential development has occurred along Cross Road and Route 1. A former auto salvage business, currently in the process of being remediated, is located along the western portion of this watershed. Wetlands in this general vicinity include a mix of forested, scrub-shrub, open water, and wet meadow wetlands. Several intermittent watercourses and their associated forested riparian wetlands are major contributors of base flows to Stony Brook. The small open water wetlands and vernal pools support a variety of amphibians and reptiles.

The southern portion of the watershed has a mix of residential properties and vacant parcels. Some large important wetland systems also exist within this part of the watershed. These systems provide valuable wildlife habitat to amphibians, birds, and reptiles. Keeny Cove, an important coastal resource, is also located within this portion of the watershed. Wetlands here are predominantly forested, scrub-shrub and open water. Stony Brook is tidal within this reach. Several of the watercourses within this portion of the watershed discharge directly into Keeny Cove, with the exception of one intermittent watercourse, which is located behind the Oswegatchie School. This intermittent watercourse discharges directly into the Stony Brook main stem.

The June 2007 Connecticut Department of Environmental Protection Natural Diversity Database (NDDB) was consulted for the Stony Brook watershed. According to the database, the watershed does not have any known state or federally special concern, threatened, and/or endangered species. Several NDDB areas of concern abut the watershed; however, they appear to be associated with the Niantic River and Jordan Brook watersheds. The June 2007 NDDB locations map is presented as Figure 2-6.

2.5 Coastal Resources

According to the coastal resource mapping and MMI field observations, Stony Brook is tidal to within approximately 50 meters of the downstream side of the Route 1 bridge. Stony Brook discharges into Keeny Cove, which is part of the Niantic River. Both designated coastal flood hazard areas and shorelands surround Keeny Cove. Coastal flood hazard areas are defined as the 100-year coastal flood hazard area as identified by the Federal Emergency Management Agency (FEMA). Shorelands are defined by upland areas at elevations in excess of the 100-year still water flood level and located within a coastal boundary. Keeny Cove provides several important recreational resources for abutting property owners including boating, swimming, bird watching, and fishing.



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

LOCATION:

MMI#:
MXD:
SOURCE:

DATE:
SCALE:
SHEET:

3.0 WATERSHED HYDROLOGY AND HYDRAULICS

3.1 Subwatershed Delineation and Nomenclature

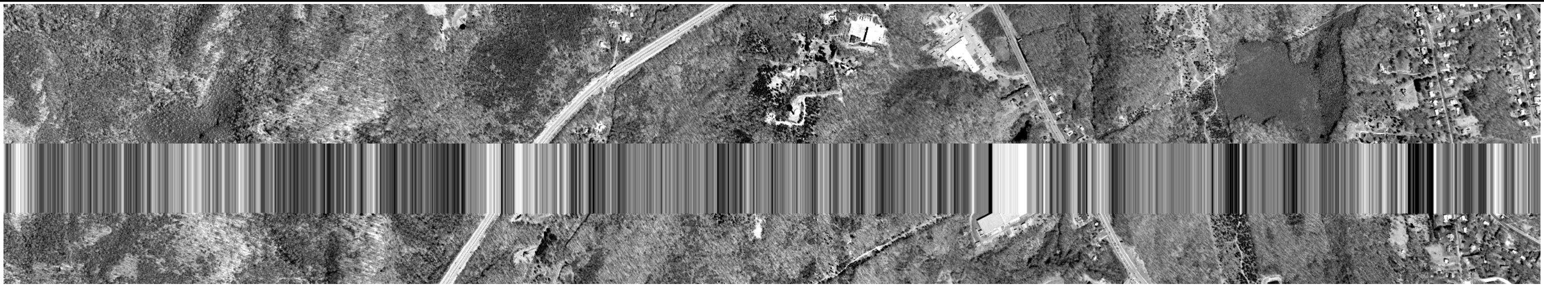
For the purposes of this analysis, the 2.86-square mile Stony Brook watershed was subdivided into nine subwatersheds, presented in Table 3-1 and depicted on Figure 3-1. Watersheds were numbered descending from north to south. This system is consistent with standard watershed hydrology modeling programs, such as TR-20. Several parameters guided the subwatershed delineation, including the presence of major contributing tributaries, existing land use, subwatershed size, major wetland systems, and topography.

TABLE 3-1
Subwatershed Nomenclature and Sizes

Watershed Number	*Size (square miles)*
SB-10	0.19
SB-20	0.25
SB-30	0.29
SB-40	0.29
SB-50	0.39
SB-60	0.35
SB-70	0.44
SB-80	0.19
SB-90	0.47

3.2 Flow Conditions

The mean average flow, mean August flow, and the 7Q10 flow within the Stony Brook watershed were estimated. Regression equations provided by the 1982 CTDEP Bulletin No. 34 entitled "A Method for Estimating the 7-Day, 10-Year Low Flow of Streams in Connecticut" was used for determining 7Q10 flows. The mean August flow and mean average flow were determined by using "Figure 18. Regional Duration Curves of Daily Mean Streamflow." "Figure 18" is located in the Water Resources Inventory of Connecticut Part 3 Lower Thames and Southeastern Coastal River Basins.



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

LOCATION:

MMI#:

MXD:

SOURCE:

DATE:

SCALE:

SHEET:

An important parameter for estimating stream flows is the percentage of stratified drift versus glacial till within a watershed. Based on the State GIS surficial material layers, the Stony Brook watershed consists of approximately 1.91 square miles of till (67 percent) and 0.95 square miles of stratified drift (33 percent). Using these values, regression equations, and Figure 18, the average mean flow was calculated to be 3.58 cubic feet per second (cfs); mean August flow was calculated to be 1.32 cfs, and 7Q10 was calculated to be 0.66 cfs.

Ideally, peak flows for a stream can be obtained from a USGS gauging station that has a significant period of record, if one is available. A minimum of 10 years of recorded data is desirable. However, there is no USGS gauge station along Stony Brook. In the absence of gauge station records, peak flows can be estimated by comparing the peak flows at a gauge station located at another stream with similar watershed characteristics and a significant period of record.

The drainage area of the Stony Brook watershed is approximately 2.86 square miles. The watershed is rural with mostly woodlands and farms and some commercial and residential land use in the lower third of the watershed. Pendleton Hill Brook near Clarks Falls has a drainage area of 4.02 square miles with similar watershed characteristics. Other streams in the vicinity of Stony Brook either do not have gauging stations or do not have a sufficient record of data. Pendleton Hill Brook is part of the Pawcatuck River Basin. Gauge station 01118300 has 43 years of records from 1959 through 2001.

The peak flows at Stony Brook were estimated based on the ratio of drainage areas of Pendleton Hill Brook and Stony Brook. These values are presented in Table 3-2. According to existing FEMA flood hazard mapping map panel 0901070005D dated 1990 and 0901070015F dated 1995, Stony Brook has a determined 100-year flood zone south of the Route 1 Bridge. The flood zones VE, AE and A are found south of Route 1 and are illustrated on Figure 3-2.

Engineering,
Landscape Architecture
and Environmental Science
MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

LOCATION:		
MMI#:	DATE:	SHEET:
MXD:		
SOURCE:	SCALE:	

TABLE 3-2
Peak Stream Flows in Pendleton Hill Brook and Stony Brook

Storm Frequency	***Pendleton Hill Brook Near Clarks Falls***[1]	***Stony Brook***[2]
	Peak flows (cfs)	*Peak flows (cfs)*
2-year	132	94
10-year	242	172
25-year	303	216
50-year	351	250
100-year	402	286
500-year	528	376

[1]Measured at USGS gauge 01118300
[2]Estimated Based upon Drainage Area Ratio

Zone VE, which occurs within Keeny Cove, represents the flood insurance rate zone that corresponds to areas within the 100-year coastal floodplain that have additional hazards associated with storm waves. Base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplain and that has been quantified in the Flood Insurance Study (FIS) by detailed methods of analysis. In most instances, base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplain with no determined elevations. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

3.3 Time of Concentrations

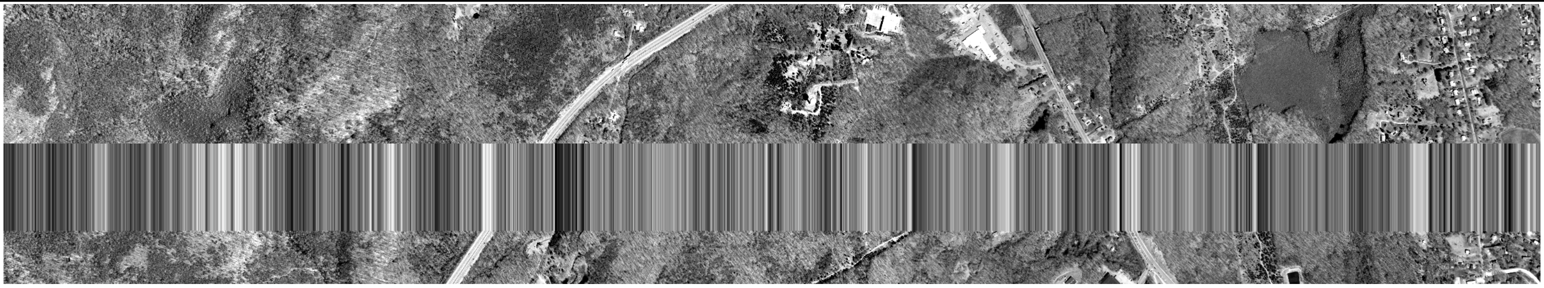
The time of concentration (Tc) is the amount of time, in hours, required for rainwater falling within a watershed to travel from the most hydraulically distant point in the watershed to the outlet. The runoff flowing out of a watershed during a storm is distributed over a period of time due to the variations in distance that each drop of water must travel. A long time of concentration will distribute the storm runoff over a longer time period, while short time of concentration will result in more concentrated flows and a higher peak flow rate at the outlet.

The surface roughness and slope of the terrain as well as length of travel influence the time of concentration value. Land use changes, modifications to storm drainage systems, and modifications to topography can alter the time of concentration associated with a watershed, thus affecting peak flow rates.

Times of concentrations were calculated for each subwatershed in the Stony Brook watershed. Times of concentrations for subwatersheds that are not associated with a watercourse were not calculated. Time of concentration was calculated by estimating the longest flow path to the sub-basin outlet. The flow path was then subdivided into reaches based upon the type of flow expected to be observed in the reach (i.e., sheet flow, concentrated flow, and channelized flow) as well as the flow velocities. The time of concentration for each subwatershed is presented in Table 3-3. The time of concentration flowpath for each subwatershed is presented in Figure 3-3. Worksheets used to calculate time of concentration are included in Appendix A.

TABLE 3-3
Time of Concentration

Subwatershed	*Description or Name*	*Time of Concentration (Tc in Hours)*	*Watershed Area (mi^2)*
SB-10	Tributary to Stony Brook	0.92	.17
SB-20	Tributary to Stony Brook, and Stony Brook	1.17	.25
SB-30	Tributary to Stony Brook	1.33	.29
SB-40	Tributary to Stony Brook, and Stony Brook	1.61	.39
SB-50	Tributary to Stony Brook	1.65	.35
SB-60	Tributary to Stony Brook, and Stony Brook	1.53	.19
SB-70	Tributary to Stony Brook, and Stony Brook	2.30	.44
SB-80	Tributary to Stony Brook, and Stony Brook	0.85	.47
SB-90	Tributary to Stony Brook, and Stony Brook	2.19	.27



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

MMI#: MXD: SOURCE:		LOCATION:	DATE: SCALE:	SHEET:

Unchecked or unregulated development can have profound negative impacts on the surrounding environment in the form of changes to stream flow, flooding, erosion and sedimentation, and deteriorated water quality in streams, ponds, and public water supplies. Many communities have attempted to address these issues through local zoning or subdivision regulations that prohibit increases in peak stormwater runoff rates. However, regulation is only one aspect of the no-increase runoff concept. Of equal importance is consideration of the individual subwatersheds in which stormwater detention is proposed. Depending on the specific hydrology, detention could actually be detrimental to the watershed and even exacerbate downstream flooding impacts.

For example, if detention of stormwater runoff were implemented in the lower end of a watershed, the stormwater hydrograph could potentially overlap peak flow coming from other contributing upstream watersheds. The delay in peak release and associated modified time of concentration could exacerbate peak flows downstream, instead of dampening them. Therefore, any future regulations must be carefully crafted to account for the complex hydrologic and hydraulic processes occurring in the watershed. In watersheds with alluvial streams, a zero increase in peak flow does not preclude channel erosion. Sensitive streams are also stressed by increased stormwater volume and flow duration, even if peak flows are equalized. Accordingly, each of these components must be considered in the development and application of stormwater management regulations.

4.0 STREAM ASSESSMENT

4.1 Introduction

On June 7, 2007, Stony Brook and its tributaries were investigated by visual inspection, rapid channel measurements, and measurement of basic water quality parameters. Geographic locations of each sampling location can be seen in Figure 4-1. A summary of trends in the watershed follows. Section 4.2 contains a description of the measurements used during this assessment, and Section 4.3 contains the observation details at each site.

Stony Brook and its tributaries begin in red maple/alder/skunk cabbage swamps in a wide wetland complex in the upper watershed. This area is typically flat with wide, heavily vegetated floodplains and a network of many small channels full of organic material and fine sediments. An occasional cascade over boulders is present in the upper watershed. Instream habitat is minimal in the upper watershed, but where present appears to be of good quality. The primary disturbance in the upper watershed is road crossings consisting of culverts or dirt roads that actually travel through the stream channel.

The slope of the watershed increases further down the watershed, and as the channel travels towards the I-95 crossing, it becomes well defined and takes on a step-pool pattern. The main stem flows through large boulders and rock vanes and is thus quite stable. The smaller tributary originating to the east in the vicinity of Cross Road is also stable due to large diameter particles on the bed and banks. The water in this tributary has a distinct red color and appears to influence water quality from the confluence with the main stem and downstream. The small channels upstream of I-95 typically consist of high quality physical aquatic habitat due to good channel stability, intact riparian areas, and floodplains free of human encroachments.

Downstream of the I-95 crossing, the slope of the Stony Brook channel decreases and the channel widens. A riffle-pool pattern is present. Human alterations to the channel are more abundant in the mid to lower watershed. For example, immediately downstream of the I-95 culvert, the stream appears to have been channelized alongside a roadway and farm field. This channelization has reduced habitat quality by causing more embeddedness, decreased amount of material retained for colonization, and a general decrease in the heterogeneity of the channel bed. Signs of excess sediment deposition begin to appear at this location.

As Stony Brook and its tributaries approach Route 1, the channel flattens and takes on a dune-ripple pattern. The channel bottom is primarily sand, with some small gravels. Some point bars are evident, indicating sediment deposition and movement through the system. The aquatic habitat upstream of Route 1 is of high quality as the channels travel through large wetland complexes that are abundant in organic material and have good floodplain access unimpeded by human infrastructure. The small tributaries entering Stony Brook tend to have silty bottoms and deliver loads of fines to the channel. The small, partially breached dam immediately upstream of the Route 1 bridge appears to be holding back excessive amounts of fine sediments.

Downstream of Route 1, both water and habitat quality decline relative to upstream locations. The wetland immediately downstream appears deteriorated, containing garbage and an oily sheen on the water surface. The water has a reddish hue indicative of iron oxide leachate that can indicate water pollution or may be due to microbial action within the soil. Once back into a well-defined channel, Stony Brook is relatively deep and wide and consists of fine substrates. The stream flows though neighborhoods where it is channelized amongst homes. The channel is largely disconnected from its floodplain at this location. Tidal influence is evident in the majority of the channel in this stream segment.

In general, the water quality parameters measured in the field fell in standard ranges, with a few exceptions as seen in Table 4-1. Habitat values are presented in summary form in Table 4-2. Trends of each parameter are discussed in the ensuing narrative.

Temperature stayed relatively constant, with high values in a headwater vernal pool (T2-1) and at the downstream end of Stony Brook where the channel and floodplain open up allowing sunlight to warm the water. Cooler water temperatures were seen in the upper reaches that had closed forest canopies shading the channel.

A few sampling locations consisted of multiple channels flowing across broad wetlands, and the water quality at these locations included locally higher values for turbidity and lower values of dissolved oxygen (DO). DO is a function of temperature, with colder water able to have higher oxygen concentration. As is often the case, DO seemed to correspond to the amount of turbulent flow, with more turbulence leading to higher DO concentrations due to increased entrainment of oxygen from air. DO is also a function of the amount of sunlight reaching the channel, increasing during photosynthesis when plants are producing oxygen when in the sun and decreasing during respiration when organisms are consuming oxygen when not in the sun (M-10). DO also can decrease during periods of increased breakdown of organic matter (i.e., biodegradation).

As with DO, turbidity also corresponded to water velocity. For example, on reaches with low mean velocity having a sand and silt bed higher turbidity values were observed in locations with relatively high local velocity (e.g., outside of a meander or a ripple in the bed) and particles were suspended in the water column. In low velocity locations where deposition was taking place (e.g., inside of a meander or flat bed), turbidity tended to be low as particles settled out of the water column and onto the bed.

Specific conductivity was high in the T2/T3-1 tributary, which corresponded to an observed reddish water color. The high conductivity seems to influence all downstream sections of Stony Brook. The potential for a water quality problem in this eastern subwatershed exists. The specific conductivity also shows an increase at M-10, a stagnant wetland type reach that receives multiple inputs from nearby roads. The sampling points farthest downstream are affected by the tides and mixing of salt and fresh waters as seen in the salinity and specific conductance values.

TABLE 4-1
Water Quality Variables Recorded During the Stony Brook Stream Inventory

Site	*Temperature (deg C)*	*Dissolved Oxygen (%)*	*Dissolved Oxygen (mg/L)*	*Specific Conductance (microS)*	*Turbidity 1*	*Turbidity 2*	*Turbidity 3*	*Turbidity Average*	*Salinity (ppt)*
M-1	13.1	69	6.9	51.6	2.5	2.7	2	2.4	N/M
M-2	13.9	74	7.5	45.9	0.75	0.9	0.7	0.8	N/M
M-3	14.8	96	9.7	39.9	0.68	0.71	0.7	0.7	N/M
T2-1	16.3	22	2.0	68.8	2.5	2.8	3.2	2.8	N/M
/T3-1	15.4	79	7.9	139.1	1.3	1.28	1.32	1.3	N/M
M-4	15.0	93	9.4	110.1	1	0.9	0.9	0.9	N/M
M-5	15.0	70	7.0	114.4	1.3	1	1.1	1.1	N/M
M-6	15.1	95	9.6	116.6	1.06	1.13	1.14	1.1	N/M
M-7	15.6	100	9.9	116.6	1	1	1	1.0	N/M
T4-1	15.8	77	7.6	123.4	2.9	2.9	2.3	2.7	N/M
W-1	15.0	6	0.5	122.6	50	50	55	51.7	N/M
T6-1	14.7	102	10.2	119.7	0.8	0.6	0.75	0.7	N/M
T6-2	15.0	98	9.8	119.5	1.1	0.85	0.85	0.9	N/M
/T8-1	15.3	95	9.4	111.7	4.1	4.2	4	4.1	N/M
T7/T8-1	15.2	75	7.3	110.7	3.34	3.54	3.06	3.3	N/M
M-8	15.6	95	9.5	115.1	1.72	1.65	1.63	1.7	N/M
M-9	15.9	96	9.6	114.4	1.29	1.27	1.32	1.3	N/M
M-10	14.7	18	1.8	270	15	13	13	13.7	0.1
M-11	16.5	96	9.0	5000	2	1.9	1.9	1.9	2.8
M-12	17.1	98	9.3	3566	2.2	2.3	2.8	2.4	1.9

= Not measured

TABLE 4-2
Habitat Variables Recorded During the Stony Brook Stream Inventory

Site	*Stream Type*	*RHA 1 Epifaunal Substrate/ Cover*	*RHA 2 Embeddedness / Pool Substrate*	*RHA 3 V/ D Regime / Pool Variability*	*RHA 4 Sediment Deposition*	*RHA 5 Channel Flow Status*	*RHA 6 Channel Alteration*	*RHA 7 Freq. Riffles / Channel Sinuosity*	*RHA 8 Bank Stability Left Bank*	*RHA 8 Bank Stability Right Bank*
M-2	High	20	14	18	18	18	16	13	10	10
M-3	High	20	19	18	20	19	20	19	10	10
/T3-1	High	19	19	16	17	19	15	17	10	10
M-4	High	20	18	18	20	20	19	18	10	10
M-6	High	10	9	11	13	18	13	15	10	10
M-7	Low	16	14	14	14	19	20	16	9	9
T6-1	Low	15	11	10	15	18	20	18	9	9
M-8	Low	15	13	13	13	20	20	14	8	8

Site	*RHA 9 Veg. Protection Right Bank*	*RHA 9 Veg. Protection Left Bank*	*RHA 10 Riparian Zone Right Bank*	*RHA 10 Riparian Zone Left Bank*	*Total RHA Score out of 200*	*RHA Score (%)*
M-2	10	10	10	10	177	89
M-3	10	10	10	10	195	98
/T3-1	10	10	10	10	182	91
M-4	9	9	10	10	191	96
M-6	5	10	3	5	132	66
M-7	10	10	10	10	171	86
T6-1	10	10	10	10	165	83
M-8	8	8	10	10	160	80

A rain event occurred on June 4, producing 1.4 inches in the area based on a gauge in nearby Groton. This amount was close to the monthly total as June was a dry month. Area flow gauges on the East Branch of the Eightmile River in the northern part of Lyme and on the Yantic River in Norwich show declining flows on June 7th, when the assessment on Stony Brook was performed. Flows were neither at peak storm nor base flow but at some intermediate. The Eightmile River gauge data suggests that stream flow in Stony Brook could have been slightly elevated due to the June 4th precipitation event but likely no more than 20% over base flow conditions. The shallow and clear flows observed in Stony Brook at the time of inspection were indicative of nonevent flow.

Increased flow can influence measured water quality and habitat parameters. Water temperatures would likely be cooler than base flow conditions, which would likely lead to higher than usual dissolved oxygen concentrations. Increased flow may also lead to lower specific conductance measurements due to dilution. By contrast, turbidity is often higher during storm runoff. Flow-related habitat parameters such as channel flow status may appear better than normal with the increased flows.

4.2 Methods

Stony Brook and its tributaries were investigated by visual inspection, rapid channel measurements, and measurement of basic water quality parameters as listed in Table 4-3 and described below.

Temperature (T) – Temperature is an important aspect in determining water quality, particularly since it affects so many other parameters. Increased temperatures accelerate biodegradation of organic materials both within the water column and in bottom deposits. Accelerated biodegradation leads to increased demands on dissolved oxygen within the system. Its effects on aquatic life are extremely important.

TABLE 4-3
Variables Recorded During the Stony Brook Stream Inventory

Visual Observations	*Rapid Channel Measurements*	*Water Quality Measurement*
Dominant stream channel type	EPA-RBP rapid habitat assessment (Barbour et al., 1999)	T (^oC)
Areas of excessive bank erosion	Bankfull channel width (m)	K_s (μmhos/cm)
Areas of excessive bed erosion	Bankfull channel depth (m)	DO (%, mg/l)
Areas of excessive sediment deposition	Dominant particle size	Turbidity (NTU)
Areas that exhibit signs of flooding		
Areas likely vulnerable to flooding		
Signs of water quality degradation in channel		
Selected storm drainage outfalls for debris, sediment, turbidity, oil, color, etc…		

Natural vegetation is important for keeping stream water temperatures low by maintaining a supply of both cool ground water and surface overland flow. Natural vegetation allows for infiltration of precipitation and an abundant supply of cool ground water to streams that makes up a large proportion of flow during low and moderate flow periods. Overland runoff flowing through natural vegetation does not heat up due to the shaded environment and cool soil temperatures.

Increased surface water temperatures are frequently caused by watershed urbanization where natural vegetation is removed. Once vegetation is removed and soils are either compacted or covered with impervious materials for development, infiltration is reduced and the amount of runoff increases. The temperature of the runoff typically increases as it flows over hot paved surfaces and reaches stream channel more rapidly. The clearing of vegetation along banks allows more sunlight to reach the water.

Most aquatic organisms are cold-blooded and therefore regulate their body temperature through the water temperature (EPA Yellow Book 1986). Sudden temperature increases can have a great impact on aquatic organisms. In order to meet the needs of cold-blooded organisms, the Connecticut Department of Environmental Protection (DEP) and the U.S. Army Corps of Engineers (ACOE) recommend that average yearly water temperature range between 3^oC and 16^oC (37.4^oF to 60.8^oF). Average yearly water temperature ranging between 15°C and 25°C (59°F to 77°F) is recommended to meet criteria for warm-blooded organisms.

Specific Conductivity (K_s) – Specific conductivity is the measure of the number of ions present in solution. In freshwater systems, this is taken to be an approximation of the dissolved mineral content of the water and is often used in water analysis to estimate dissolved solids concentrations. There is no set standard for specific conductivity in water.

Dissolved Oxygen (DO) – Dissolved oxygen is a common indicator of water quality and is a necessary component of healthy aquatic environments. The Connecticut DEP has established a DO concentration criterion of 5.0 milligrams per liter (mg/L) for Class B freshwater systems. This criterion was established because a significant proportion of aquatic macroinvertebrate species and fish is not tolerant of acute exposures to low DO. Water having a chronic DO content of less than 5.0 mg/L has severe production impairment on the embryonic and larval stages of coldwater and warm water species (EPA Yellow Book 1986-1998).

Deoxygenation of rivers is typically caused by the aerobic decomposition of organic matter such as leaf litter. The discharge of sanitary effluent (whether treated or untreated) can also deplete DO concentrations. DO concentrations are also dependent on temperature, with DO concentrations decreasing as water temperatures increase.

Turbidity – Suspended solids and turbidity affect fish and other aquatic life (both in the water column and following sediment deposition on the bottom of the water body). Turbidity is the cloudiness of water measured by the optical scatter produced when passing a beam of light through a sample. Settleable materials that blanket the bottom of water bodies damage the invertebrate populations, affect gravel spawning areas and, if organic, remove DO from overlying waters (EPA Yellow Book 1986). Excessive suspended solids also interfere with species that are drift feeders that rely on visual identification of food.

Suspended solids and turbidity in freshwater systems can be generated by bed load (i.e., natural bed erosion), but more often are the result of poor construction management practices. The improper use of construction site sedimentation controls often leads to high loadings of total suspended solids, especially during rain events.

The DEP has established a turbidity limit of less than 5 NTU over the ambient (i.e., long-term mean nonevent flow) level. There have been no set criteria established by the DEP for suspended solids. However, it is suggested by the DEP that suspended solid levels should not exceed 10 mg/L over ambient level conditions.

Rapid Habitat Assessment (RHA) – The reach-averaged stream habitat was also evaluated using the Rapid Bioassessment Protocols published by the U.S. Environmental Protection Agency (Barbour *et al*., 1999). The RHA score considers epifaunal substrate and available instream cover, degree of embeddedness, the mixture of velocity and depth regimes, amount of sediment deposition, status of channel flow, degree of channel alteration, frequency of riffles, bank stability, vegetative protection, and the width of the riparian vegetative zone. Table 4-4 provides a listing and description each of these RHA parameters.

Each habitat parameter included in the RHA was assigned a value from 0 to 20. In conjunction with one another, these values were added to formulate an overall habitat evaluation ranging from 0 to 200. Higher assessment values indicate better aquatic habitat conditions.

Embeddedness (%) – Embeddedness is the average percentage that the vertical dimensions of the dominant (larger) bed particles are covered by finer particles. A completely embedded river would lack interstitial spaces important to macroinvertebrates.

TABLE 4-4
Rapid Habitat Assessment Parameters

Parameter	***Description (Quoted from Barbour et al., 1999)***
EPIFAUNAL SUBSTRATE/AVAILABLE COVER (H, L)	Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provide macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity.
EMBEDDEDNESS (H)	Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased.
POOL SUBSTRATE CHARACTERIZATION (L)	Evaluates the type and condition of bottom substrates found in pools. Firmer sediment types (e.g., gravel, sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants.
VELOCITY/DEPTH COMBINATIONS (H)	Patterns of velocity and depth are included for high-gradient streams under this parameter as an important feature of habitat diversity. The best streams in most high-gradient regions will have all four patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow.
POOL VARIABILITY (L)	Rates the overall mixture of pool types found in streams, according to size and depth. The four basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species.
SEDIMENT DEPOSITION (H, L)	Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition.
CHANNEL FLOW STATUS (H, L)	The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading streambeds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought.
CHANNEL ALTERATION (H, L)	Is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams.
FREQUENCY OF RIFFLES (OR BENDS) (H)	Is a way to measure the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community.
CHANNEL SINUOSITY (L)	Evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms.
BANK STABILITY (H, L)	Measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable.
BANK VEGETATIVE PROTECTION (H, L)	Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur.
RIPARIAN VEGETATIVE ZONE WIDTH (H, L)	Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream.
H = Parameter assessed for high-gradient streams, L = Parameter assessed for low-gradient streams	

Bankfull Flow, Width and Depth – For undisturbed alluvial rivers, the flow where water begins to spill over the channel and access the floodplain. In the majority of river systems that are altered and have undergone some level of channel down-cutting, the elevation of the bankfull flow is located at lower elevations than the top of bank and more accurately defined by the field indicators such as the top of point bars on the inside of meanders, the limit of perennial vegetation on the banks (i.e., ferns, shrubs, trees), and a well-formed low bench on the bank where some sediment deposition is evident (Rosgen and Silvey, 1996).

A common design flow that typically has a mean recurrence interval of 1.5 years, the bankfull flow is central to the formation of a given channel plan form and cross-section for meandering rivers (Wolman and Miller, 1960). Bankfull width is the width of the wetted channel during bankfull flow and bankfull depth is the mean depth across the channel during bankfull flow.

4.3 Results

Stony Brook Main Stem – Approximate Source Location – The main stem of Stony Brook begins at the base of a steep boulder wall, sloping down from a flat field. The stream does not appear to be moving through the wall or along its base, but surfaces for the first time in this location. Maps show the stream beginning farther up in the watershed, but on the day of field investigations, it appeared to begin at this location. The water was stagnant, with no visible flow velocity in the stream. There is a closed canopy above the stream, and the riparian zone is wide and forested. The channel bottom is covered with silt and organic material that is approximately 0.3 meters deep, with a water depth of approximately 0.1 meter. Herbaceous vegetation is present in the stream, with a mix of trees, shrubs and herbs on the channel banks and in the floodplain. The banks are shallow and connected with the floodplain. The multiple small channels flowing through the floodplain are poorly defined, but appear to have moderate sinuosity.

M-1 Stony Brook Main Stem ~100 Meters Downstream From Approximate Source Location – The majority of the stream remains multiple small channels filled with silt and organic material amongst wide floodplains, with some short stretches of a more confined channel with coarse substrate due to the presence of large natural deposits of boulders or constructed old stone walls. In these locations, there is some evidence of riffles and pools over a cobble bottom partially embedded with sand and gravel.

Site M-1	T = 13.1°C	K_s = 51.6 µS
	DO = 69 % = 6.9 mg/l	Turbidity = 2.4 NTU

Stony Brook Main Stem ~100 Meters Downstream from Approximate Source Location to ~100 Meters Upstream from the Rock wall and Dirt Road Crossing – This section of Stony Brook runs through a densely vegetated swamp. Multiple small channels flow through large bordering wetlands. The slope of the land in this location is low, and thus stagnant water with little velocity is present. The channel bottom is filled with thick organic debris and silt, with the same material surrounding the channels. Shrubby vegetation is very thick, with larger trees and thick herbaceous vegetation. Although there is no distinct channel structure, this section does not seem particularly unstable likely due to the wide floodplain and low slope. Water depths remain shallow with underlying silty debris up to 0.5 meters deep.

M-2 Stony Brook Main Stem ~20 Meters Upstream from the Rock Wall and Dirt Road Crossing – This section of stream is located just upstream of the location where the dirt road known as Clam Lane crosses the channel bed and a stone wall that extends most of the way across the channel. Some backwater pooling was noted just upstream of these crossings. Data collected at this location occurred upstream of the backwatered area. This location contains a steep cobble and boulder bedded section of small steps, pools and rock cascades. A wide range of depth-velocity combinations were present, with only fast and deep conditions absent. The rocks in the river were covered in a thick moss and embedded approximately 25%.

This reach appeared to be very stable with natural armoring of boulders and cobbles exposed at the channel margin. A closed wooded canopy exists in this area, with vegetation extending to the channel margin. The underbrush was thin, with large trees and herbaceous vegetation still present. The floodplain in this area is connected to the stream, wide, and completely vegetated as far as can be seen from the channel. This section is not particularly representative of the upstream and downstream reaches, only extending approximately 100 meters upstream before changing to the gradual sloping, multiple channels with silty bottoms.

Site M-2	Bankfull depth = 25 cm	T = 13.9^{o}C	K_s = 45.9 μS
RHA = 89 %	Bankfull width = 5.0 m	DO = 74 % = 7.5 mg/l	Turbidity = 0.8 NTU

<u>*Stony Brook Main Stem Downstream of Dirt Road Crossing (SB-1A)*</u> – Downstream of the dirt road crossing, multiple channels flow through a wide floodplain with abundant flood storage. The floodplain consists of a red maple and alder swamp, with skunk cabbage abundant in the herb layer. At this location, sheet flow is more prominent than flow in well-defined channels. The canopy is 90% closed, so shallow water is not subject to excessive solar heating.

The channel itself is broad and low gradient with a stable channel and banks. The dominant material is organic silt, approximately 0.3 meters deep in the floodplain channels. The main channel is slightly deeper and contains a sand bed with an approximately one meter wide active floor. There was a light oily sheen on the water surface in the adjacent floodplain, but it did not appear to be due to human-induced pollution. Multiple wildlife species were observed at this site including adult dragonflies, various adult midges, spring peeper, green frog, wood frog, gray catbird, ovenbird, belted kingfisher, Baltimore oriole, black and white warbler, red winged blackbird, and rose-breasted grosbeak.

Macroinvertebrate collections were made in this location and upstream above the dirt road crossing in select locations where the bed was sand or coarser material. A d-framed kick net was used to survey macroinvertebrate larvae. Four stoneflies (two adult and two larvae), three caddisflies (one adult and two different larvae), two amphipods, two midges, and one diptera pupae were collected.

M-3 Stony Brook Main Stem ~80 Meters Upstream from Confluence of Tributary T2/T3 ~270 Meters Upstream from I-95 Culvert – This is a stable channel with a relatively small floodplain, and no flood vulnerability due to the absence of infrastructure in the area. The channel has a step-pool pattern. The riparian zone is wide and forested, with sparse underbrush likely due to shading from the canopy. The vegetation extends to the water's edge. In this location, Stony Brook has natural grade control and bank armoring and is thus very stable. A brief survey for macroinvertebrates revealed caddisfly cases made of coarse sand and amphipods. Schools of small fish were observed in many of the pools as was an unidentified frog.

Site M-3	Bankfull depth = 50 cm	T = 14.8^{o}C	K_s = 39.9 μS
RHA = 98 %	Bankfull width = 7.0 m	DO = 96 % = 9.7 mg/l	Turbidity = 0.7 NTU

Tributary T2 – Upstream of Dirt Road at the End of Foster Road – This tributary resembles a vernal pool at this location, with no visible defined channel. This location is likely near the source of the tributary. This section is forested. The water quality was measured on the upstream side of the culvert under the road. Downstream of the culvert a small channel with some flow was evident.

Site T2-1	T = 16.3^{o}C	K_s = 68.8 μS
	DO = 22 % = 2.0 mg/l	Turbidity = 2.8 NTU

Tributary T2/T3 – Eastern Tributary ~100 Meters Upstream from the Confluence with Main Stem ~250 Meters Upstream of the I-95Culvert – The red color of the water is a prominent characteristic of this tributary, which is not apparent in the main stem upstream of the confluence. At this point it is not known if the source of the reddish color is due to a natural geologic signal from the upper subwatershed, runoff from the east of Cross Road via the wetland detention area around Cross Road Mall, leachate from the west of Cross Road at the site of an abandoned landfill, or some combination of these. Note that this tributary also receives discharge from a stormwater detention pond constructed at Sonalysts, which is another potential source of the reddish water color. The discharge and stream are tested twice each year and reported to the Town.

The water color was evident from the confluence downstream. Approximately 15 meters upstream from the confluence, a walking path and a stone wall cross the tributary. The sample was taken another 35 meters upstream of these features. The channel has a step-pool pattern with a cobble bottom. There is a significant amount of moss growing on the substrate, and riparian vegetation is present adjacent to the channel. The cobbles are approximately 10% embedded with a gravel and sand mix, but there are no bars or signs of instabilities. Another peculiar aspect of this site is its unusually low DO level (i.e., 2 mg/l), which is likely partly due to respiration by the abundant aquatic plants.

Site T2/T3-1	Bankfull depth = 55 cm	T = 15.4°C	K_s = 139.1 µS
RHA = 91 %	Bankfull width = 4.5 m	DO = 79 % = 7.9 mg/l	Turbidity = 1.3 NTU

M-4 Stony Brook Main Stem - Typical Section ~130 Meters Upstream of I-95 Culvert – The channel at this location has a step-pool pattern, with boulder steps and pools with a substrate consisting of sand and gravel. Once away from the highway, there is a wide naturally vegetated riparian area, with a wide floodplain to the east. The channel is stable, and no flood vulnerabilities are present. The water has a reddish color due to the upstream tributary (T2/T3).

Site M-4	Bankfull depth = 60 cm	T = 15.0°C	K_s = 110.1 µS
RHA = 96 %	Bankfull width = 14.5 m	DO = 93 % = 9.4 mg/l	Turbidity = 0.9 NTU

M-5 Stony Brook Main Stem ~20 Meters Upstream of I-95 Culvert – This sample point is coincident with the long-term water quality monitoring location SB-1. A box culvert runs under I-95 just downstream from this point. A small stream of water runs down through the woods parallel to the highway and joins the stream to the east. This water as well as water coming from a 12-inch pipe in the wingwall of the I-95 culvert both contain high concentrations of iron oxides as is evident from the opaque red color. The culvert created a small backwater effect leading to increased local sediment deposition. The water continues to have a red hue at this location. The streambed has been disturbed in this area primarily due to unrestricted ATV travel through and across the brook.

Site M-5	Bankfull depth = 76 cm	T = 15.0^{o}C	K_s = 114.4 µS
	Bankfull width = 10.0 m	DO = 70 % = 7.0 mg/l	Turbidity = 1.1 NTU

M-6 Stony Brook Main Stem ~140 Meters Downstream of I-95 Culvert Next to Farm Field Looking downstream from the I-95 culvert, the left (east) bank of the river (facing downstream) is bordered by a narrow floodplain forest and topography rises sharply to newly constructed fill slopes of Waterford Parkway South. Further downstream, the left bank is bordered by woodland and the right (west) bank by hay fields associated with the old Barrett Farm property. The channel has likely been straightened at this location.

The right (west) bank may have been armored during channelization when stones were taken from the farm field. Cobbles line the right side of the channel next to the field. The left (east) bank of the river is steep, held together with a thick root layer from the trees. The riparian zone beyond the right bank consists of an open field that is accessible during flooding. The left floodplain is not as wide as the land quickly slopes up to Waterford Parkway South. The small area between the channel and road is forested. This section of stream has limited wood and overall channel heterogeneity, lacking features such as beneficial undercut banks and instream boulders. The cobble bottom was 60% to 70% embedded with sand and gravel. Hydraulic diversity is lower in this location as fast-deep and slow-deep habitats are absent. The stream channel receives stormwater runoff from I-95 and the Waterford Parkway South.

Site M-6	Bankfull depth = 70 cm	T = 15.1^{o}C	K_s = 116.6 µS
RHA = 66 %	Bankfull width = 4.0 m	DO = 95 % = 9.6 mg/l	Turbidity = 1.1 NTU

Stony Brook Main Stem Downstream Along the Farm Field to Edge of Woods – This channel was also likely straightened in the past, bordering a farm field, which is mowed within a few meters of the top of bank. This bank has only herbaceous vegetation as trees and shrubs have been removed. The lack of vegetation allows more sun to reach the channel so filamentous algae and large aquatic plants are growing in the channel. A box culvert providing access to a field via a farm road that is partially clogged is located in this reach.

<u>*M-7 Stony Brook Main Stem Upstream of Confluence With Tributary T4 From East*</u> – The channel in this area has a dune-ripple pattern with a primarily sand bed. This change in geomorphology is common where glacial history and the presence of the ocean has resulted in landforms with shallower slopes along the coast. This morphology is common where channel slope declines relative to riffle-pool channels and slower water velocity allows for deposition of sand. Even with the relatively mobile sand bed, the channel is stable in this area, likely a function of the large, forested floodplain with a high degree of heterogeneity to reduce the potential for erosion. Also, no structures were visible in the floodplain at this location and therefore low vulnerability for flooding.

Site M-7	T = 15.6°C	K_s = 116.6 µS
RHA = 86 %	DO = 100 % = 9.9 mg/l	Turbidity = 1.0 NTU

<u>*Tributary T4 - Eastern Tributary From Mid-Watershed Farming Areas ~ 60 Meters Upstream From the Confluence With Main Stem*</u> – This tributary joins Stony Brook from the east. The characteristics of this channel match the main stem in this area. Very little flow was observed to be coming out of this tributary, and the channel is small in size. Flow at this site may be affected by an upstream farm pond during lower flow conditions. The pond is retained by a stone/earth embankment with a small outlet pipe.

Site T4-1	T = 15.8°C	K_s = 123.4 µS
	DO = 77 % = 7.6 mg/l	Turbidity = 2.7 NTU

<u>*W-1 Tributary T7 Headwater Wetland Downstream of Auto Salvage Yard*</u> – This wetland is part of the headwater of tributary T7 to the west of Stony Brook. The wetland is filled with skunk cabbage. Local topography suggests that water in the wetland originates from the auto salvage yard that is located immediately upstream, giving rise to concern for

potentially polluted leachate. The auto salvage yard is currently undergoing renovation in anticipation of future residential development of the site. The junk, debris, and any stained soils are being removed from the site with oversight of a licensed environmental professional (LEP) as part of the locally approved residential subdivision plan. At present, there is no information regarding possible ground water impacts from this long established use.

The wetland is also bordered by Route 1 to the south, and therefore stormwater runoff is another concern. The standing water in the wetland was a murky orange/red, suggesting the presence of iron oxides and potentially water pollution. The water had a musty odor. No well-defined channel was present.

Site W-1	T = 15.0^{o}C	K_s = 122.6 µS
	DO = 6.0 % = 0.5 mg/l	Turbidity = 51.7 NTU

Tributary T6 ~270 Meters Upstream of Driveway – This small channel had a stable, riffle pool pattern. Cobbles and sand were most abundant on the channel bed. The floodplain is forested and does not appear to be susceptible to scouring, which could potentially increase turbidity values.

Site T6-1	Bankfull depth = 34 cm	T = 14.7^{o}C	K_s = 119.7 µS
RHA = 83 %	Bankfull width = 4.9 m	DO = 102 % = 10.2 mg/l	Turbidity = 0.7 NTU

Tributary T6 ~10 Meters Upstream of Driveway Culvert – This small channel was observed upstream of a culvert passing under a residential drive. The stream had a riffle-pool pattern, with a gravel bottom 50% embedded with sand. There were some sediment deposits likely due to backwatering at the culvert during high flow events. The stream was quite small, stable, and not vulnerable to flooding.

Site T6-2	T = 15.0^{o}C	K_s = 119.5 µS
	DO = 98 % = 9.8 mg/l	Turbidity = 0.9 NTU

Tributary T7/T8 ~5 Meters Upstream of Driveway Culvert – This tributary joins the tributary T6 prior to emptying into Stony Brook. The channel was investigated just upstream of the culvert flowing under the residential drive. This stream is small with a riffle-pool pattern and a sand bed. Some deposition near the structure has led to the formation of upstream bars. There is some dumping of yard waste taking place next to the stream.

Site T7/T8-1	T = 15.3°C	K_s = 111.7 µS
	DO = 95 % = 9.4 mg/l	Turbidity = 4.1 NTU

Tributary T6/T7/T8 ~50 Meters From Confluence With Main Stem – This tributary joins Stony Brook from the west, in a swampy area of the stream that is characterized by large silt deposits. Possible sources of the silt may be fines mobilized during natural channel degradation, accelerated deposition of fines due to increased down-cutting due to higher watershed peak flows, or nonpoint source pollution from developed areas moving more fines to the stream channel. This area is underlain with glaciofluvial deposits with very sandy soils in the area adjacent to Route 1, where an esker formation may be present. The wide floodplain and multiple flow paths create a sheet flow condition with very little water moving through the channels at the confluence. The riparian zone is densely vegetated in this area. The organic deposits were quite deep and complicated moving around in this location and taking measurements.

Site T6/T7/T8-1	T = 15.2°C	K_s = 110.7 µS
	DO = 75 % = 7.3 mg/l	Turbidity = 3.3 NTU

M-8 Stony Brook Main Stem, ~30 m Downstream of Confluence With Tributary T6/T7/T8, Which is ~160 m Upstream of US Route 1 – The channel has a dune-ripple pattern and has some braiding due to the change in slope with the confluence of T6/T7/T8. The channel banks are stable with an abundance of debris and roots, and a densely vegetated floodplain is present. The channel bottom is primarily sand. The increase in fine sediment deposition and the channel braiding suggests that this area is possibly affected by backwatering from the deteriorated dam located at the US Route 1 bridge just downstream. The partial dam under the US Route 1 bridge is holding back large amounts of silt. In its deteriorated condition, the dam is a prime candidate for removal to improve local hydraulics, sediment transport, and aquatic organism passage. The fine sediment would have to be removed from behind the structure, which would potentially avoid an unintended sediment-release event should the remaining parts of the dam wash out. Floodplain access is good, and there is a low vulnerability for flooding.

Site M-8	Bankfull depth = 76 cm	T = 15.6°C	K_s = 115.1 μS
RHA = 80 %	Bankfull width = 6.7 m	DO = 95 % = 9.5 mg/l	Turbidity = 1.7 NTU

Tributary T9 - Eastern Tributary Just Upstream of Route 1 – This tributary was small and shallow, with clear flowing water. The channel was well defined, appeared stable, and had a sandy bottom. There was thick layer of silt and organic material around the channel that limited the extent of the investigation.

M-9 Stony Brook Main Stem ~30 Meters Upstream of US Route 1Bridge and Breached Dam – Wading upstream of the dam was impossible due to thick deposits of organic muck. The dam has caused the stream to increase its bankfull width and deposit fine sediments upstream. The channel has a low gradient and appears locally stable. Stormwater inputs are evident around the bridge. M9 is the site of long-term monitoring location SB-2.

Site M-9	T = 15.9°C	K_s = 114.4 μS
	DO = 96 % = 9.6 mg/l	Turbidity = 1.3 NTU

M-10 Stony Brook Main Stem, ~50 m Downstream of US Route 1 Bridge – An old road/ path has been filled across the floodplain perpendicular to US Route 1. Wetlands are located on both sides of the embankment, but no defined channel or signs of flow were observed. It is likely that the split flow creates a sheet flow scenario as observed in other parts of the watershed where the water appears stagnant. Much of the standing water in this area has a thick oily sheen on the surface, indicative of urban runoff. The water has a reddish color to it, indicating that there are iron oxides.

Salinity was measured at this location at a very low concentration (0.1 parts per thousand, ppt), and it appears as though this location is at or just above the limit of the influence of salt water. High conductivity was measured, likely due to the increased ion content associated with road salt and other pollutants from roadways, but could also be attributed to higher background salinity. The floodplain in this location is forested, albeit in a degraded state, with trash and the presence of some invasive species. A municipal sewer pump station is located just downstream of this site, where the channel is more well defined.

Site M-10	T = 14.7^{o}C	K_s = 270 μS
	DO = 18 % = 1.8 mg/l	Turbidity = 13.7 NTU

<u>*Tributary T10 - Western Tributary in Brook Street Neighborhood*</u> – This small tributary flows through several back yards with manicured lawns. A small buffer of woody vegetation lines the banks at some locations. The tributary barely had any flow and is likely intermittent during the dry summer months. This stream receives stormwater directly from local roadways and lawn areas.

<u>*M-11 Stony Brook Main Stem ~5 Meters Upstream of Oswegatchie Road Bridge*</u> – This tidal channel (salinity = 2.8 ppt) is largely confined by houses, with limited floodplain access. Lawns are typically mowed to the top of bank and small structures such as patios and sheds are very close to the channel or even projecting out into the active flow area. At the time of observation, the high tide had just passed and water was flowing out of the system. Water actually appeared to be flowing in both directions through the large twin box culvert in a large slow back eddy. The bridge does not appear to be a flow constriction. Flood vulnerability is high in this area due to the confined nature of the channel and the infrastructure in the floodplain. A large storm at high tide could lead to property damage. No evidence of sediment contributions from the residential lots sloping towards the channel was observed, yet the manicured nature of the lawns suggests that fertilizers and pesticides are likely present that could be carried from the lawns to the stream in stormwater runoff.

Site M-11	Bankfull depth = 3 cm	T = 16.5°C	K_s = 5,000 μS
	Bankfull width = 1.0 m	DO = 96 % = 9.0 mg/l	Turbidity = 1.9 NTU

M-12 Stony Brook Main Stem ~10 Meters Downstream of Oswegatchie Road Bridge – On the downstream side of the Oswegatchie Road bridge, the stream widens into a small pond (salinity = 1.9 ppt at the pond margins out of the main flow). This pond is the tidal headwater of Keeny Cove, a depositional tidal environment. Local residents indicate concerns about sediment deposition, which has prompted the Town to conduct three bathymetric studies over the past two decades to evaluate the rate of sedimentation. Several members of the public also expressed concern about low flows in the pond, especially during low tide.

Both sides of the pond contain residential infrastructure, with yards and gardens extending to the banks of the stream. The floodplain at this location is mostly developed with houses, roadways, and other infrastructure. There did not appear to be a severe flood hazard here. As the bridge likely passes large flows, the pond will transfer them to Niantic Bay, and most homes are located well above the edge of the pond. Nevertheless, some vulnerability to flooding does exist if a large storm were to take place at high tide.

Site M-12	T = 17.1°C	K_s = 3,566 μS
	DO = 98 % = 9.3 mg/l	Turbidity = 2.4 NTU

4.4 Review of Water Quality Monitoring Program – Results and Recommendations

Stony Brook is designated as a Class A waterbody (CTDEP, 2002) from its headwaters down to Keeny Cove where it enters the Niantic River. These surface waters are designated for habitat for fish and other aquatic life and wildlife, potential drinking water supplies, recreation, navigation, and water supply for industry and agriculture.

Based on the water quality data collected by the Town of Waterford from 1999 to 2006 (summary data included in Appendix B) and the rapid field water quality assessment performed by Milone & MacBroom, Inc. in June 2007, Stony Brook appears to be mostly meeting this high water quality designation. However, data indicate some water quality issues may exist that warrant further study.

The historical water quality data typically show normal natural water quality trends for surface waters, with the following observations:

→ The water in Stony Brook is slightly acidic, with a pH near 6.5.

→ Water temperature is generally cool (< 15 degrees Celsius), with a slight increase moving down the watershed as the channel widens and the canopy opens to allow more sun to reach the water surface.

→ Specific conductivity is low (< 150 μmhos), indicative of cleaner water, with a small increase moving downstream, likely due to more dissolved particles present either due to geology or increased runoff from road crossings.

→ Chloride, a common component of stormwater runoff near roadways where salt is applied in the winter months, is low (typically < 20 mg/l), with concentrations increasing moving downstream likely due to more runoff from roads and developed areas in the lower watershed.

→ Dissolved oxygen is high (9.5 mg/l) and consistently above the 5.0 mg/l standard for Class A waters.

→ Turbidity is at normal levels for clear water (~1 NTU), with typical variability observed across data collected in different flows and in different locations.

→ *E. coli* is low and meeting the Class A standards, with some other typical coliform bacteria present in higher amounts that are usually associated with watershed geology or normal stormwater runoff.

→ Phosphorus levels are low (< 0.03 mg/l) and, as usual, the limiting nutrient for plant growth in freshwater. The measured concentrations are near the low limit where nuisance plant growth is possible, yet in flowing waters algal blooms typically occur at higher levels of total phosphorus (USEPA, 2000). The shading by the dense riparian canopy typical along Stony Brook combined with the measured phosphorus concentrations leads to the observed plant growth at normal levels that in turn leads to more available substrate for colonization by benthic macroinvertebrates. A normal crop of aquatic plants also reduces the likelihood of large dissolved oxygen sags during the day due to respiration.

→ Nitrogen, in the various forms measured, is present in typical concentrations, with a minor increase in nitrate moving downstream. In general, nutrient levels appear typical for a partially developed watershed such as around Stony Brook.

Metals data collected between 1999 and 2003 suggest the potential for both acute and chronic toxicity to aquatic life due to high lead and copper concentrations, yet are ultimately inconclusive due to nonstandardized analytical techniques with high detection limits.

Lead was detected once at sample point SB-3 in June 2003 at a value of 0.02 mg/l, which is above the chronic toxicity limit (0.0012 mg/l) (CTDEP, 2002) and just below the acute toxicity limit (0.03 mg/l). Copper was detected frequently above toxicity limits in water samples from around the watershed in the vicinity of roadways, highways, and developed parcels during both wet weather and dry weather. Most of the samples from sites SB-1 and SB-3 exceeded the acute copper toxicity limit (0.0143 mg/l). Approximately half of the samples from site SB-2 exceed the chronic toxicity limit (0.0048 mg/l), and the other half exceeded the acute toxicity limit. Note that for copper, "biological integrity is impaired when the ambient concentration exceeds this acute/chronic value on more than 5%/50% of days in any year (CTDEP, 2002)." Thus, the limited sampling does not confirm impairment, yet suggests that a potential problem exists and more testing is needed.

It is important to note that the laboratory analysis detection limit (0.01 mg/l) exceeds both the chronic and acute toxicity limit for lead and copper. This means that nondetect samples, of which many exist in this data set, may still have lead and copper concentrations that can be toxic to aquatic life. This raises concerns about the quality and utility of the trace metal data. The low macroinvertebrate abundance and richness observed in previous studies in Stony Brook (RES study dated December 14, 2000 and rapid field assessment conducted in 2007 by Milone & MacBroom, Inc.) suggest that toxicity problems may exist in the watershed.

Field observations indicate some possible departure from the Class A water quality standards, with a qualitative rapid bioassessment revealing limited abundance and diversity of macroinvertebrates. This is in contrast to the criteria (CTDEP, 2002), which states: "A wide variety of macroinvertebrate taxa should normally be present and all functional feeding groups should normally be well represented. Presence and productivity of aquatic species is not limited except by natural conditions, permitted flow regulation or irreversible cultural impacts. Water quality shall be sufficient to sustain a diverse macroinvertebrate community of indigenous species. Taxa within the Orders Plecoptera (stoneflies), Ephemeroptera (mayflies), Coleoptera (beetles), and Trichoptera (caddisflies) should be well represented." Please note that only an informal, qualitative survey was performed so more definitive conclusions are not possible at this time.

Accurate analysis of trace metals is challenging from both a sample collection and analytical point of view due to the potential of substantially obscuring results from minor contamination of samples. The many nondetects from the laboratory analysis and the use of nonstandardized analytical techniques is a cause for concern and limits the amount of accurate interpretation possible from these data. Furthermore, copper concentrations are suspect as high concentrations were consistently measured at all of the 28 sample sites around Waterford, some of which are located in undeveloped areas that appear to have no likely sources of metals.

A more detailed analysis of additional samples is necessary, along with a higher level of well documented quality control to confirm and expand the results of the existing trace metal analyses. Trace metal analyses should be conducted with more standard testing and quality control methods. Academic institutions, government water quality departments, and others that regularly test for trace metals such as copper, lead, and zinc with detection limits that are low enough for exploring toxicity to aquatic organisms should be contacted to perform such a study.

The strong red color in the eastern subwatershed in the upper watershed (tributaries T2 and T3) appears to be in excess of the possible signal from natural watershed geology. With streams in this region originating in stormwater detention ponds near a large shopping plaza and flowing near the site of a former landfill, there is concern that rust or some other substance is leaching into the ground and/or surface water. Various streams of dense iron oxide precipitate were observed in the watershed that could indicate the presence of human-induced degradation.

The water quality review and recent investigation lead to several recommendations relative to the water quality testing program to hone in on potential problems. The following highlights future tasks that are recommended based on the existing data.

1. Perform a full stream walk of tributaries T2 and T3 in an attempt to visually identify the source or sources of discolored water. If a distinct change is located, perform water quality sampling above and below this location to analyze a full set of parameters. If no distinct location of water color change is found, analyze several

samples along the main watercourses to investigate the source water. Some possible areas of demarcation include the shopping plaza detention ponds, upstream of the former landfill site, and downstream of the former landfill site.

2. Conduct additional sampling of metals and other parameters at select locations to confirm findings and extend the previous metals study. Approach a laboratory, preferably at an academic institution or other facility with specific trace metal experience, about conducting a study of trace metals in the watershed. At a minimum, water should be collected and analyzed for lead and copper at sample sites SB-1, -2, and -3 with enough frequency to confirm if metal toxicity is a water quality issue in these locations. Sites such as M-1 or M-2 that are presumably located away from possible sources of metals should also be sampled as reference locations. Strict quality control on sampling and laboratory analysis must be performed for the results to be useful. If high metal concentrations are identified, the study should be extended to locate the point or diffuse sources of metals. The sampling should include an upstream-downstream comparison of copper concentrations in subwatershed SB-70 where an underground copper wire antennae at the old WNLC property exists.

3. A macroinvertebrate biomonitoring study should be conducted to support the continued water quality investigation. These organisms typically live in the stream for at least three years as larvae and thus serve as a long-term monitoring tool. Samples should initially be collected from each major watercourse, and then the sampling design can be fine tuned based on the data if another collection round is feasible. Combined with additional visual observations and water quality analysis, the biomonitoring program will support results and improve the chances of focusing in on potential sources of impairment. A rigorous macroinvertebrate study will help identify if the previously observed low abundance and richness at select sites is common.

5.0 WETLAND SYSTEM EVALUATION

5.1 Introduction

Milone & MacBroom, Inc. conducted a watershed wetland inventory of the Stony Brook watershed, encompassing small and large wetland areas as well as complementary stream inventories within a variety of Stony Brook subwatersheds. As part of this effort, GIS base mapping was compiled to depict watershed boundary overlays, land uses and Town-owned lands, natural diversity database areas, and wetland areas (based on soil types).

Site-specific wetland assessment was conducted throughout the Stony Brook watershed. Wetland quality ranged from marginal to excellent, with varying degrees of prior disturbance. This assessment also included the identification of critical wetland systems, discussed in Section 5.8. It should be noted that this assessment was a broad analysis and is not a substitute for site-specific analysis for proposed development projects. The results of this analysis are presented in the ensuing narrative.

5.2 Existing Resources Mapping

The Town of Waterford wetland resource mapping, entitled *Town of Waterford Inland Wetlands and Watercourses Map, August 2005,* is based on soil types that have been designated by the National Cooperative Soils Survey as consisting of poorly drained, very poorly drained, alluvial, and/or floodplain soils. In addition, the Town of Waterford works extensively with geospatial data provided by the NRCS web soil survey website to determine current USDA–NRCS soil survey mapping and U.S. Fish and Wildlife National Wetland Inventory mapping for Waterford.

Wetland cover types present in the Stony Brook watershed can be described and categorized using the U.S. Fish and Wildlife Service's wetland classification system described in *Classification of Wetlands and Deepwater Habitats of the United States*

(Cowardin, et al., 1979). The more than 306 acres of wetlands in the watershed represent several ecological categories that include palustrine open water, forested, scrub-shrub, and emergent marsh/wet meadow. Stony Brook watersheds palustrine wetland communities are presented on Figure 5-1. The relative proportions of each are presented in Table 5-1.

TABLE 5-1
Wetland Types Within the Stony Brook Watershed

Wetland Type	***Acreage Within the Stony Brook Watershed***	***Percentage Within the Stony Brook Watershed***
Palustrine Open Water	4.7	<1%
Palustrine Emergent Wetland	17.4	<1%
Palustrine Scrub-shrub Wetland	7.6	<1%
Palustrine Forested Wetland	180.0	10%
Palustrine Forested/Scrub-shrub Wetland	88.0	5%
Palustrine Scrub-shrub/Emergent Marsh Wetlands	8.0	<1%

The acreages provided above were determined using a compilation of the NRCS soils survey mapping, the Town's digital wetland boundaries, and field assessments conducted by Milone & MacBroom, Inc. The palustrine ecological system is the most dominant and widespread wetland system in the Stony Brook watershed. Wetlands belonging to the palustrine ecological system include nontidal wetlands dominated by trees, shrubs, herbaceous growth, and emergent mosses or lichens. Ponds and watercourses are also included within this system. Palustrine wetland cover types identified within the watershed include palustrine open water, palustrine emergent wetlands, palustrine scrub-shrub wetlands, and palustrine forested wetlands.

Approximately five acres (<1%) of the wetlands in the Stony Brook watershed are classified as palustrine open water. Palustrine open water communities can be natural or artificial and consist of permanently flooded open water (0.5 to 20 acres in size) that is usually free of vegetation during the nongrowing season.

Floating vascular plants and free-floating algae usually comprise the majority of the vegetation mass during the summer months. Rooted vegetation may be present but is normally restricted to the shallows. Bottom sediments are primarily composed of fines (silt and clay), sand, cobbles, gravel, and organic debris. Several of these wetland systems are located within the Stony Brook watershed; most are manmade and were most likely constructed for agricultural purposes.

Palustrine emergent wetland communities comprise approximately 17 acres (<1%) of the total wetland area within the watershed. Palustrine emergent wetland communities are wet meadows consisting of moist to saturated soils that experience brief to moderate periods of inundation during the growing season. Plant species composition can be diverse but is dependent upon length of inundation. Common plant communities consist of herbaceous species such as sedges, rushes, and grasses. Woody vegetation, if present, is less than 30% of the overall vegetation present in the wetland.

Palustrine scrub-shrub dominated wetlands comprise approximately eight acres (<1%) of the total wetland area within the Stony Brook watershed. Scrub-shrub wetlands are primarily found along the edge of emergent marshes. They are commonly a transition zone between an emergent marsh and forested wetland. Scrub-shrub wetlands consist of woody vegetation (<20 feet tall), which accounts for at least 30% of the total vegetation present in the wetland. Plant specie composition is usually dependent upon length of inundation. Microtopography (i.e., hummocks) is a common occurrence within scrub-shrub wetland communities.

Approximately 180 acres (10%) of the wetlands in the Stony Brook watershed are classified as palustrine forested. Palustrine forested wetlands lack continuously standing water but can experience seasonal flooding. Forested wetlands often have diverse plant communities that depend on canopy cover, hydrology, and landscape position. Forested floodplain wetlands that experience frequent flooding often have low abundance and diversity in perennial herbaceous species but consistently have a high abundance and low diversity in annual species. Drier forested wetlands usually have a high abundance and diversity in perennial and annual herbaceous species.

Field investigations found other wetland systems that had an equal mix of wetland cover types, and those areas were identified as being either palustrine forested/scrub-shrub wetlands and/or palustrine scrub-shrub/emergent marsh wetlands. The palustrine forested/scrub-shrub wetlands comprise approximately 88 acres (5%) while the palustrine scrub-shrub/emergent marsh wetlands occupy eight acres (<1%) of the total wetlands within the Stony Brook watershed.

5.3 Overview of Wetland Assessment Methods

Wetland assessments are an important tool for determining a wetland system's functions and values. This type of assessment can be used by planners, managers, regulators, and the general public. Wetland assessments evaluate the functions of the system, often assigning a value to each individual wetland function. Assessment methods provide a basis for comparing wetland resources, determining the success of policies intended to protect or manage wetland resources, and identifying long-term trends in the condition of wetland resources.

Several wetland evaluation methods and technologies have been developed in the past 20 years by federal, state, and local agencies. Existing wetland evaluation and assessment methods are described below, along with a discussion of how and why each method was applied to this Watershed Management Plan.

5.3.1 The Highway Methodology Workbook – A Descriptive Approach

Several wetland assessment methods were developed by the federal government in the early 1980s. In 1987, the U. S. Army Corps of Engineers developed a wetland assessment method referenced as "The Highway Methodology Workbook," a descriptive approach to assessing wetland functions and values based on physical, chemical, and biological characteristics. This system assigns values to several important wetland functions, including the following:

- Ground Water Recharge
- Ground Water Discharge
- Flood Flow Alteration
- Sediment Stabilization
- Sediment/Toxicant Retention
- Nutrient Removal/Transformation
- Production Export
- Wildlife Diversity/Habitat
- Fish and Aquatic Diversity/Habitat
- Recreation
- Educational/Scientific Value
- Uniqueness
- Threatened or Endangered Species Habitat

Each of these functions is defined in the ensuing text as defined by the U.S. Army Corps of Engineers Highway Methodology Handbook (1993).

Ground Water Recharge – Ground water recharge is defined as the potential for a wetland to serve as a ground water recharge area. Recharge wetlands occur when water levels within the wetland are higher than the water table of its surroundings, resulting in ground water flow out of the wetland (Mitsch and Gosselink, 2000). More importantly, recharge should relate to the potential for a wetland to contribute water to an aquifer.

Ground Water Discharge – Ground water discharge is defined as the potential for a wetland to serve as a ground water discharge area. Discharge wetlands occur when the surface water (or ground water level) of a wetland is lower hydrologically than the water table of the surrounding land (Mitsch and Gosselink, 2000). Moreover, discharge wetlands should relate to the potential for the wetland to serve as an area where ground water can be discharged to the surface.

Flood Flow Alteration – This function considers the effectiveness of the wetland in reducing flood damage by attenuation of floodwaters for prolonged periods following precipitation events.

Sediment Stabilization – This function relates to how well a wetland stabilizes stream banks and/or shorelines against erosion. Wetlands performing such functions are commonly found along the floodplain of a watercourse and waterbody.

Sediment/Toxicant Retention – This function reduces or prevents degradation of water quality. It relates to the effectiveness of a wetland as a trap for sediments, toxicants, and/or pathogens.

Nutrient Removal/Transformation – This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as watercourses and waterbodies.

Production Export – This relates to the effectiveness of a wetland to produce food or usable products for human and/or other living organisms.

Wildlife Diversity/Habitat – This function evaluates the effectiveness of the wetland to provide habitat for various types of wildlife typically associated with wetlands and the wetlands riparian edge. This function also considers the wetlands ability to support resident and/or migratory species.

Fish and Aquatic Diversity/Habitat – This function evaluates the effectiveness of a seasonal or permanent watercourse and/or waterbody associated with a wetland in question for fish and aquatic invertebrate habitat.

Recreation – This function considers the effectiveness of a wetland to provide recreational opportunities such as canoeing, boating, fishing, hunting, and other active and passive recreational activities.

Educational/Scientific Value – This value considers the effectiveness of a wetland to provide opportunity for outdoor education and/or as a scientific study or research site.

Uniqueness – This value relates to the effectiveness of the wetland or its associated waterbodies to produce certain special values such as unusual aesthetic quality, unique plants, animals, or geologic features, etc.

Threatened or Endangered Species Habitat – This value relates to the effectiveness of the wetland and/or waterbody to support threatened or endangered species.

Overall, this system evaluates functions and values in terms of efficiency, opportunity, social significance, and habitat suitability. It does not estimate the degree or magnitude to which the function is performed.

5.3.2 Hydrogeomorphic Approach (HGM)

In 1995, the USACE published a technical report (WR-DE-9, Smith et al), describing an approach for assessing wetland functions based upon hydrogeomorphic factors (Brinson 1993), such as:

- The wetland's geomorphic setting (i.e., its landform, topographic setting, and geologic evolution)
- The wetland's immediate water source
- The hydrodynamics (energy level) and direction of water and ground water flow through the wetland system

Wetlands are then grouped into classes of which seven are recognized at the highest level of classification: depression, lacustrine fringe, tidal fringe, slope, riverine, mineral flat, and organic flat.

This analysis provides a foundation for assessing the physical, chemical, and biological functions of wetlands. The program is still being researched and revised to help simplify it as well as to broaden its geographic applicability. The HGM approach compares the characteristics of a specific wetland with the characteristics of a group of wetlands in the region. This information is then used to assess the performance of each individual wetland based on selected functions.

5.3.3 National Wetland Inventory (NWI)

The U.S. Fish and Wildlife Service has been conducting the National Wetland Inventory for the past 27 years. Wetlands are classified according to the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin, et al., 1979). The primary classification is based on the wetland's ecological system (i.e., marine, estuarine, lacustrine, riverine, and palustrine). Wetlands are further classified into subsystems that may include water depth or hydrology and by class system (i.e., vegetation diversity and substrate type).

5.3.4 Bulletin No. 9 Method for the Evaluation of Inland Wetlands in Connecticut

In October of 1986, the USDA Soil Conservation Service, in partnership with the Connecticut Department of Environmental Protection, developed a method of evaluating wetlands. This system is known as "Bulletin No. 9 Method for the Evaluation of Inland Wetlands in Connecticut." This evaluation method was intended for use by public officials and others. Some of the wetland functions that are analyzed by this method include wildlife and waterlife habitat, ground water use potential, ecological integrity, flood control, and water-based recreation. This method assigns functional values similar to the federal wetland assessment methods.

5.3.5 Classification of Wetlands and Deepwater Habitats of the United States

The U.S. Fish and Wildlife Service publication entitled "Classification of Wetlands and Deepwater Habitats of the United States" was used to classify wetland cover types and describe hydrologic regimes of the Stony Brook watershed. Wetland cover types were described in Section 5.2 of this plan. The hydrologic regime of a wetland is one of the key components for development of a wetlands vegetative community. Duration and timing of surface inundation and understanding ground water fluctuations strongly influence wetlands. The hydrologic regimes of the Stony Brook watershed were evaluated by assessing vegetative communities, observing annual watermarks, and by evaluating the soils. The hydrologic regimes observed within the Stony Brook watershed include the following:

Permanently Flooded – Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes. Examples include vegetated littoral shelves of man-made impoundments.

Intermittently Exposed – Surface water is present throughout the year except in years of extreme drought.

Semipermanently Flooded – Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface. Examples include the abutting floodplain wetlands of Stony Brook.

Seasonally Flooded – Surface water is present for extended periods, especially early in the growing season, but absent by the end of the season in most years. When surface water is absent, the water table is near the land surface. Examples include vernal pools.

Seasonally Saturated – The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present. Examples include many of the sloped extremely stony wetland systems found within this watershed.

Temporarily Flooded – Surface water is present for brief periods during the growing season, but the water table usually lies well below the surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.

Intermittently Flooded – The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity.

5.3.6 Metropolitan Conservation Alliance (MCA) Technical Paper Series No.5 Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States

In 2002, the MCA published a best development practices bulletin for conserving pool breeding amphibians in northeastern United States. Authors Michael Klemens and Aram Calhoun presented scientific reasons for protecting vernal pools and their inhabitants. Part of the bulletin also presented ways of categorizing vernal pools into a three-tier system: Tier I, Tier II, and Tier III pools.

Tier I pools are considered exemplary pools that exhibit high biodiversity, >25 amphibian egg masses, an undisturbed vernal pool envelope, and a large, undeveloped critical terrestrial habitat. Tier II pools are considered good pools that have biodiversity and that may or may not have >25 egg masses, have a relatively (at least 75%) intact vernal pool envelope or at least a (50%) intact critical terrestrial habitat. Tier III pools are considered somewhat to moderately good, support amphibian breeding, but lack the intact vernal pool envelope and critical terrestrial habitat. These vernal pool classification categories were applied to those pools found during our investigations.

5.3.7 Study Methods

The subject Watershed Management Plan evaluated wetland systems using a combination of the six methods described above. Combining these methods enabled a broader view of wetland functions and values and gave the research team greater flexibility in describing the characteristics of the wetlands in the Stony Brook watershed.

5.4 Overview of Wetland Evaluation and Assessment

Milone & MacBroom, Inc. wetland scientists performed wetland reconnaissance surveys at select wetland systems within the Stony Brook watershed. With the assistance of Town staff, wetland systems were selected based upon their size, watershed, soil type, surrounding land use, development potential, national wetland inventory mapping, prior vernal pool survey mapping, and potential for high biodiversity or the presence of state and federal listed species.

Wetland reconnaissance surveys were conducted during the spring and summer of 2007. A description of each wetland system including wetland classification, hydrologic variables, dominant and significant biota, and wetland functions and values is presented in the narrative that follows. Important information was gathered during the field visits, including development landscape, hydrologic characteristics, soil and vegetation types, and disturbance variables for each wetland system analyzed. Additional information, including land use bordering the wetland, hydrologic source and regime, and dominant wetland type, was gathered. Major wetland system cover types were photo-documented and are presented in Appendix C.

5.5 Upper Watershed – Wetlands North of I-95

5.5.1 Watershed SB-90

The SB-90 watershed is primarily undeveloped and consists of mixed upland hardwood forests, rock outcrops/glens, forested wetlands, and scrub-shrub wetlands. Watershed SB-90 is depicted on Figure 5-2. The surficial materials within this watershed are predominately till; however, a swath of stratified drift is located at its eastern boundary. Wetlands located along the eastern part of the watershed are underlain by stratified drift while all other wetlands are underlain by till.

The dominant wetland soils types within the watershed are poorly drained Raypol series, poorly and very poorly drained Ridgebury, Leicester, and Whitman complex, very poorly drained Catden and Freetown complex, very poorly drained Scarboro muck series, and poorly drained Aquents.

The wetlands within this watershed are the headwaters to Stony Brook. Instream habitat of both the intermittent watercourses and Stony Brook main stem is minimal in the upper watershed but where present appears to be of good quality. This watershed also supports a critical wetland system, which is represented by CWS-1, described in Section 5.8 of this plan. In addition, this watershed's large tract of mixed hardwood forests and wetlands also provides the Town with an important unfragmented natural area.

		LOCATION:	
MMI#: MXD: SOURCE:		DATE: SCALE:	SHEET:

SB-90-1 Wetlands North of Power Line Corridor – 1 (Parcels 0201800 & 0115200)

Stony Brook originates at the northern portion of the watershed as a palustrine forested ground water seep wetland. The ground water breakout quickly becomes channelized, forming a braided intermittent watercourse that has diffuse flows through extremely stony soils. The substrate within this portion of the wetland ranges from poorly drained to very poorly drained soils. The intermittent watercourse has silty/sandy-bottom substrate. The topography within this wetland ranges from relatively flat (<4%) to steeply graded (15%). One of the most notable features within this wetland is the intermittent watercourse cascading over a rock outcrop located north of the power line corridor. The intermittent watercourse discharges under the power line corridor via a corrugated metal pipe.

The primary hydrologic source of this forested wetland is ground water discharge and surface water runoff abutting upland forests. Several seasonal ground water seeps were noted breaking out along the edges of this wetland. The hydrology within this portion of the wetland is classified as seasonally saturated and temporarily flooded.

This forested wetland is bordered to the east by an old field and to the north, south, and west by a mixed hardwood forest. The overstory consists of red maple, yellow birch, black birch, and tulip poplar. Nonnative invasive species such as Japanese barberry, oriental bittersweet, and multiflora rose were present within the understory. These species were noted within the upper limits of the wetland near the old field and edge habitats. As the wetlands surrounding habitats become more densely forested and thus more shaded, the understory transitions to primarily native shrubs and herbaceous plants. The native understory consisted of spicebush, bloodroot, skunk cabbage, Canada mayflower, trillium, jack-in-the-pulpit, and bryophytes (e.g., mosses). The abutting uplands are transitioning from early successional forests into mid successional forests. Dead Eastern red cedars where noted within the forest understory.

As the wetland flows through the power line corridor, it transitions from a forested wetland to a scrub-shrub wetland habitat. Trees are routinely cleared along the utility corridor, providing high sunlight conditions within the wetlands. As a result, a small scrub-shrub wetland has formed and is vegetated with mountain laurel, spicebush, Northern arrowwood, skunk cabbage, soft rush, and sensitive fern.

Wildlife observed within this wetland system included several edge habitat birds such as the Eastern towhee, Northern cardinal, tufted titmouse, house wren, and American robin. This wetland does not support amphibian breeding. The important functions and values this wetland provides are ground water discharge and wildlife habitat. Recommendations for this wetland include:

- controlling the spread of nonnative invasive species
- maintaining base flow and water quality

SB-90-2 Forested Wetland Corridor South of Power Line Corridor – 3 (Parcel 0115200)

This wetland system consists of palustrine forested depressional, flat, and slope wetlands and includes an intermittent watercourse. The wetland has extremely stony poorly and very poorly drained soils. It is fed by several hydrologic sources, including the surface water discharges from the forested wetlands/intermittent watercourse described above, seasonal ground water seeps, and surface runoff from abutting upland forests. The first section of this wetland system is classified as a forested depressional flat wetland that is approximately 300 feet in width, exhibits some microtopography, and has a braided intermittent watercourse meandering through it. The hydrology within this wetland is classified as seasonally saturated, temporarily flooded, and semipermanently flooded.

The overstory is dominated by red maple, yellow birch, green ash, and black tupelo. The trees are large diameter specimens here as they are protected by higher land to the north and west. The low to moderate density shrub layer is dominated by spicebush, sweet pepper bush, and high bush blueberry. Mountain laurel is thick in adjoining uplands. Herbaceous vegetation consisted of skunk cabbage, false hellebore, royal fern, cinnamon fern, and mosses. The braided intermittent watercourse becomes a single defined channel at the southern end of the wetland where it then discharges down steep topography toward another flat forested wetland system (SB-90-4).

Wildlife utilization within this flat wetland system is high. Several large snags are present within the wetland and low flow channels, and depressional pools found along the eastern portion of the wetland provide valuable habitat for both wood frogs and spotted salamanders. Several large spotted salamander egg masses were noted within this part of the wetland. A snake was observed that may have been an eastern ribbon snake, a Connecticut species of special concern. Bird species noted were yellow-throated vireo, yellow-rumped warbler, American robin, yellow-shafted flicker, white-breasted nuthatch and blue-gray gnatcatcher.

An interesting rock grotto formation was observed southwest of the depressional flat wetland system described above. The wetland that originates at this location is classified as a forested slope wetland. This wetland is bordered by rock outcrops and mixed, mesic, hardwood forests. Large boulders, stones, and shallow poorly drained wetland soils dominate this wetland. The dense overstory was dominated by red maple, tulip poplar, green ash, black tupelo, and shagbark hickory. The wetland edge and bordering uplands provide rich woodland habitat for herbaceous plant species such as blue cohosh, wild leek, and wood anemone. The understory of the wetland receives limited sunlight and is sparsely vegetated with Christmas fern and a few grasses.

Seasonal ground water discharges from the rock grotto area flow east into another steeply sloped forested wetland. Here the overstory is less dense, allowing herbaceous plants such as skunk cabbage to dominate. Observed wildlife within this portion of the wetland included eastern phoebe, titmouse, and eastern chipmunk. Amphibian breeding habitat is nonexistent within this wetland.

Overall, this wetland system described above has several important functions and values that include ground water discharge, flood flow alteration, and wildlife habitat (amphibian breeding). This wetland is a valuable resource within this watershed because it is a major hydrologic source for Stony Brook. Recommendations for this wetland include:

- Preserve forested buffer around the wetland to protect amphibians
- Protect water quality within the wetland
- Maintain base flow

SB-90-3 and SB-90-3a Wetlands North of Power Line Corridor – 2 (Parcels 0201700 & 0202000)

A second headwater wetland of Stony Brook is located north of the power line corridor as well. This wetland is classified as a palustrine forested depressional wetland. Soils within this wetland consist of poorly and very poorly drained soils. The hydrologic regime of this wetland consists of seasonally saturated and semipermanently flooded. The large pool has several vegetated islands within it.

This depressional wetland has an overstory dominated by red maple, yellow birch, white oak, and black tupelo. The dense shrub layer consists of mountain laurel, sweet pepperbush, highbush blueberry, winterberry, spicebush, and northern arrowwood, while the sparse herbaceous stratum is dominated by royal fern, sensitive fern, and grasses. The wetland is surrounded by a large contiguous mixed xeric hardwood forest.

During field investigations, both wood frog larvae and spotted salamander egg masses were found within the center portion of this wetland system. Only five spotted salamander egg masses were found within this pool, which is a low number given its overall size. The pool has an approximate diameter of 40 feet and would be classified as

Tier I type vernal pool using the Calhoun and Klemens vernal pool criteria. The water depth within the depressional pool ranges from six inches at the shallowest edges to approximately 30 inches at its center. Vegetated islands of varying sizes are found within this depression. The overhanging stems from the shrubs provide attachment sites for amphibian egg masses.

High seasonal surface water levels are discharged from this vernal pool via an intermittent watercourse located at its southern edge. The intermittent watercourse has a narrow channel and is armored by a mix of exposed bedrock and boulders. Water cascades down a 15% slope across the power line corridor and into another forested depressional pool. This lower depressional pool is much smaller in size, approximately 20 feet in diameter, with shallow water levels ranging between one to six inches in depth. The understory is much more open and has a low shrub density consisting of a few spicebush and swamp azalea shrubs. A single adult wood frog was found in the pool; however, no egg masses or other breeding signs were found within the pool. Based on the shallow water depths and the pool's relatively small size, it is unlikely to successfully support amphibian breeding.

Bird life was plentiful within this wetland and included suburban species such as gray catbird, Northern cardinal, tufted titmouse, brown-headed cowbird, and American goldfinch, plus forest species including ovenbird and great-crested flycatcher with several neo-tropical migrant species: hermit thrush, yellow-rumped warbler and black-throated green warbler. Deer browse was heavy, and gray treefrogs were calling.

This wetland system does not appear to provide the degree of hydrologic input to Stony Brook as does the wetlands system located to its west. Nevertheless, it does provide some important functions and values within this watershed including wildlife habitat and ground water discharges. Recommendations for this wetland include:

- Preserve forested buffer around wetland SB-90-3 to protect amphibians
- Maintain hydrology to the vernal pool located in SB-90-3
- Protect water quality within the wetlands

SB-90-4 Scrub-Shrub/Forested Wetland Corridor Northwest of Former Radio Tower Parcels (Parcels 0115200 & 0115100)

This wetland is located in a relatively topographically flat area and is largely dominated by scrub-shrub and forested wetlands. Two intermittent watercourses, one from the northwest and the other from the northeast, join within this wetland and form the main stem of Stony Brook. The wetland consists of both extremely stony poorly and very poorly drained soils. Contributing hydrology to this wetland system includes surface waters from the two intermittent watercourses, seasonal ground water seeps, and surface runoff from abutting mixed upland hardwood forests. The hydrologic regime of this wetland consists of seasonally saturated, semipermanent inundated, seasonally flooded, and permanent inundated conditions.

This wetland exhibits some microtopography and has vegetated hummocks located throughout. The forested portions of the wetlands, which are primarily located along the periphery, have an overstory dominated by red maple and black tupelo. The scrub-shrub wetlands are densely vegetated with speckled alder, highbush blueberry, spicebush, and northern arrowwood. The herbaceous stratum consists of skunk cabbage, false hellebore, and various sedges. Uplands bordering this wetland system consist of mixed xeric hardwood forests.

Wildlife utilizing this wetland includes birds, mammals, reptiles, and amphibians. During field investigations, observed common yellowthroat, yellow warbler, and hermit thrush were observed within the wetland. The small depressions and floodwater areas provide suitable breeding habitat for amphibians such as spotted salamanders. Stony Brook itself supports macroinvertebrates and fish.

Overall, this wetland provides several important wetland functions and values including flood flow alteration, thermal protection, wildlife habitat, production export, fishery habitat, and shoreline (bank) stabilization. To a lesser degree, this wetland system provides nutrient retention and sediment retention. This system is a valuable resource within the watershed. Recommendations for this wetland include:

- Preserve forested buffer around wetland to protect fish and amphibians
- Protect water quality within wetlands
- Maintain base flow to Stony Brook
- Eliminate ATV use within wetlands

SB-90-5 Scrub-Shrub/Forested Wetland Corridor West of Cross Road (Parcel 0290200, 0224600)

Wetlands within this corridor include forested and scrub-shrub flat/depressional wetlands. This wetland system serves as another headwater to Stony Brook and originates near Parcel 0290400 (UPS Facility). The wetland soils consist of both poorly and very poorly drained soils. The supporting hydrology includes ground water seeps and surface runoff from abutting upland mixed hardwood forests. An intermittent watercourse (T1) is also supported by this wetland system and discharges surface waters into the main stem of Stony Brook. The hydrologic regime of this wetland consists of seasonally saturated, seasonally flooded, and semipermanently inundated conditions.

The forested wetland areas have a dense overstory consisting of red maple, black tupelo, and yellow birch. The moderate density understory consisted of winterberry, highbush blueberry, spicebush, and skunk cabbage. Within the scrub-shrub wetlands, the dense stratums consist of spicebush, common winterberry, northern arrowwood, sweet pepperbush, highbush blueberry, sphagnum moss, royal fern, skunk cabbage, false hellebore, cinnamon fern, and sensitive fern. Adjacent uplands are mixed and include large areas of young and mature mixed hardwood forests, small old fields, and industrial development.

Wildlife habitat quality within this wetland is considered high because of the expansive scrub-shrub wetland habitats and diversity of wetland vegetation. Snags provide refuge for birds, and the depressional pools support a significant amphibian breeding population. The quiescent moving surface waters of the intermittent watercourse support hundreds of spotted salamander egg mass clumps. Several of the observed forested depressional pools are classified as Tier I type vernal pools.

The northeastern portion of the forested wetland, at the drainage divide, has been historically disturbed as evidenced by large fill piles, some of which appear to have been placed on top of former wetlands. Despite the prior disturbance, the wetland has continued to provide valuable wildlife habitat and other important wetland functions and values. Overall, this large forested and scrub-shrub wetland system provides several important functions and values including wildlife habitat, flood flow alteration, production export, ground water discharges, and nutrient renovation. This wetland system is a valuable resource within this watershed. Recommendations for this wetland system include:

- Preserve forested buffer around the wetland to protect amphibians
- Consider restoration of filled wetlands in upper watershed
- Protect water quality within the wetlands
- Maintain base flow to Stony Brook

SB-90-6 Mid-Reach of Upper Stony Brook (Parcel 0115100)

At this location, Stony Brook flows through a ledgy, bedrock outcrop area. The grade of the stream increases. A step-pool morphology is present, and the water is cooler and better oxygenated. Small fish and benthic invertebrates are present. The stream is well shaded, and the forest is dominated by Eastern hemlock and mixed oaks with mountain laurel common in the understory. A stony ford marks an old road crossing.

North (upstream) of the ford the topography flattens into a semipermanently flooded depression. A shrub swamp predominates, with the forested component restricted to small diameter red maple and ash trees. The shrub layer is dense and consists of high-bush blueberry, sweet pepper bush, alder, common winterberry, and clammy azalea. Pronounced microtopography results in a dense and variable herbaceous layer of skunk cabbage, tussock sedge, and marsh marigold with mixed ferns and sedges. Backwater sloughs and tree-throw pools are common, providing likely places for amphibian breeding and good reptile habitat as well. Adult wood frogs were observed.

The surrounding uplands are relatively undisturbed apart from the trail network and occasional clearings. Woodland birds such as great-crested flycatcher, wood thrush, and scarlet tanager were heard here. The flooded swamp includes many dead/dying trees, and woodpeckers were common here. Wetland functions and values include ground water recharge/discharge, flood flow alteration, pollutant renovation, production export, and fish/wildlife habitat. Recommendations for this wetland system include:

- Preserve forested buffer along Stony Brook for thermal protection and allochthonous material inputs
- Protect water quality within Stony Brook
- Maintain base flow to Stony Brook

SB-90-7 Stony Brook Above Eastern Tributary (Parcels 0839100, et al)

Approximately 1,500 feet upstream of the I-95 culverts, Stony Brook flattens, broadens, and meanders through the forested landscape. The terrain is less rocky here, and the step-pool pattern of the lower brook is less pronounced. The brook is still two feet deep and six to 10 feet across with a coarse-grained bed. Fish were observed in the brook, and aquatic insects were present. The riparian corridor is forested with well developed microtopography. This diversity in the landscape is reflected in the vegetation as well.

Dominant trees include red maple, black tupelo, and yellow birch, with an upland fringe of mature oaks and American beech. Shrubs found here and throughout the brook corridor are sweet pepper bush, spice bush, common winterberry, alder, and mountain laurel. The wetter margins along the brook supported skunk cabbage and false hellebore. Less saturated areas had mixed ferns, sedges, and mosses with wood anemone and violets present.

As the disturbance associated with the highway corridor lessens, more forest species are observed including ovenbird, wood thrush, and yellow-throated vireo. Deer tracks and heavy browse were noted. No vernal pools were observed here.

Wetland functions and values within this watershed include ground water interaction, flood flow alteration, pollutant renovation, production export, and fish/wildlife habitat. Recommendations for this wetland system include:

- Preserve forested buffer along Stony Brook for thermal protection and allochthonous material inputs
- Protect water quality within Stony Brook
- Maintain base flow to Stony Brook

SB-90-8 Western Tributary to Cliff / Outcrop (Parcel 0115100, 0839100)

A small, intermittent watercourse from the northwest joins Stony Brook at the northern limit of the "meanders" described above. The stream is approximately three feet wide and approximately one foot deep. It shows evidence of erosion from higher in the watershed where several rough road crossings exist. ATV traffic and land clearing are apparent. The watercourse was traced to an interesting bedrock outcrop or cliff, with the stream forming a small waterfall and cascade. Ground water seeps emanate from the base of the outcrop, forming a small wet meadow amidst the forested surroundings. Many wildflowers were observed here. The small pools had evidence of breeding spotted salamanders. This wetland has been disturbed by ATV traffic and bare, muddy soil is the result.

Wetland functions and values in this area are somewhat limited due to the impacts associated with the noted disturbance and the general low flow regime. Still, much of the surrounding landscape is relatively undisturbed, and the site is in close proximity to larger wetland systems, creating a valuable wildlife habitat. The wetland is absorbing much of the impacts from upgrade disturbances, with pollutant renovation serving an important function. Recommendations for this wetland include:

- Preserve/enhance forested buffer around wetland to protect amphibians
- Protect water quality within wetlands
- Maintain base flow to seasonal seeps and wetlands
- Eliminate ATV use within wetlands

5.5.2 Watershed SB-80

The SB-80 watershed is primarily undeveloped and consists of mixed upland hardwood forests and isolated forested wetlands. The surficial materials within this watershed consist entirely of glacial till deposits. Several isolated wetland pockets are found within this watershed, and they are classified as forested wetlands. Portions of this watershed have been disturbed in the past as evidenced by irregular grading and the young growth mixed hardwood forests found throughout. The dominant wetland soil types within the watershed are the poorly and very poorly drained Ridgebury, Leicester, Whitman soil complex, and poorly drained Aquents. Most of the hydrologic contribution from this watershed to Stony Brook is via ground water and overland runoff. Watershed SB-80 is depicted on Figure 5-3.

		LOCATION:
MMI#: MXD: SOURCE:		DATE: SCALE:	SHEET:

SB-80-1 Forested Wetlands and Intermittent Watercourse West of Main Stem (Parcel 0839100, 0839200).

At the location where Stony Brook is piped beneath I-95, there is a small intermittent watercourse with a narrow band of associated forested wetland. The roadway is close by, and the area is noisy due to the highway. Some fill, dumping, and invasive species were observed on the access road side, but the northern wetland edge is well buffered with a mature woodland of tulip poplar, birches, mixed oaks, and hickories with an understory of mountain laurel. Red maple, ash, and yellow birch line the intermittent watercourse, which is moderately steep and rocky. Mountain laurel, witch hazel, high bush blueberry, spicebush, poison ivy, and grape occupy the wetland understory. Wildlife in the wetland area is sparse due to the proximity of the highway and better habitat nearby.

The wetland here stabilizes the intermittent watercourse. There are flatter areas within the wetland where it broadens out and sediment becomes entrapped. Local wildlife habitat exists but no vernal pools were observed and no fishery habitat exists. Recommendations for this wetland include:

- Protect water quality within wetlands
- Occasionally, inspect road margins and remove debris from wetlands
- Maintain base flow to intermittent watercourse

SB-80-1a and SB-80-1b Forested Wetlands (Parcel 0839200)

Two isolated forested wetland pockets were observed within parcel 0839200. Neither wetland system appeared to support amphibian breeding. The overstory within these wetlands consisted of red maple, black birch, and yellow birch; and the understory consisted of spicebush, mountain laurel, sweet pepperbush, and winterberry. The forested upland areas bordering these wetlands appear to have been logged several years ago. The primary function and value of these forested wetlands is limited wildlife habitat. Recommendations for these wetlands include:

- Protect water quality within wetlands

5.5.3 Watershed SB-70

The SB-70 watershed is primarily undeveloped; however, former land uses west of the commercial development on Cross Road (between Foster Road and I-95) have had negative impacts upon the wetland margins. Watershed SB-70 is depicted on Figure 5-4. The SB-70 watershed is predominately mixed upland hardwood forests, forested wetlands, scrub-shrub wetlands, and commercial developments. The surficial materials within this watershed consist of a mix of stratified drift and till deposits. Wetlands are primarily underlain by stratified drift with the exception of the wetlands located to the west, which are underlain by till.

The dominant wetland soil types within the watershed are the poorly drained Raypol series, very poorly drained Timakwa and Natchaug complex, the very poorly drained Scarboro muck series, and poorly drained Aquents. Ground water and surface waters within these wetland systems flow into an unnamed perennial watercourse (T2/T3). The perennial watercourse serves as a tributary to Stony Brook. This watershed also supports a critical resource area discussed later under Section 5.8.

SB-70-1 Forested Wetland Corridor (Parcels 0224600 Plus 0147700, 0147800, 0148000, 0148200, 0148100, 0148300, and 0148500)

This wetland system is one of the largest within the Stony Brook watershed. It is comprised of one large parcel (0224600) plus several smaller and developed parcels. The predominant cover type is a palustrine forest, red maple swamp; however, extensive areas are dominated by a shrub swamp community. A channelized, intermittent watercourse (T2) drains this system. It flows beneath Foster Road, east of the old radio tower clearing.

		LOCATION:
MMI#: MXD: SOURCE:		DATE: SCALE:	SHEET:

This wetland occupies a topographic depression and is hydrologically supported by shallow ground water, seeps, and surface runoff from adjoining uplands including runoff from developed parcels and perhaps Cross Road drainage as well. The soils are poorly drained at the margins and very poorly drained in the interior swamp. Conditions are seasonally saturated and seasonally flooded (at least) in many places.

Vegetation density is high. The swamp canopy is overwhelmingly red maple trees of small diameter, subject to frequent blowdown. This results in a varied, hummocky topography that encourages the development of a dense shrub and herbaceous layer including high bush blueberry, winterberry, sweet pepper bush, arrow-wood, spicebush, clammy azalea, Japanese barberry, multiflora rose (these two invasive species are mostly confined to disturbed edges along the eastern border), greenbriar, false hellebore, skunk cabbage, soft rush, marsh marigold, meadowsweet, sensitive fern, Canada mayflower, and tussock sedge.

Wildlife habitat values are very good. Several vernal pools were observed supporting high numbers of wood frogs and spotted salamanders (Tier 1 pools). Dead and dying trees provide birds and small animals with abundant perches, feeding areas, and nest/roost cavities. Mostly suburban species were observed including American robin, blue jay, American goldfinch, blue-gray gnatcatcher, black and white warbler, Northern cardinal, tufted titmouse, Carolina wren, prairie warbler (cleared field edges), and ruby-throated hummingbird. Habitat for turtles and snakes is very good as well.

Despite the disturbed edges, significant wetland functions and values include flood flow alteration, water quality renovation, production export, and wildlife habitat. Recommendations for this wetland system include:

- Preserve forested buffer around the wetland to protect amphibians
- Manage invasive species along wetland margins
- Protect water quality within wetlands
- Maintain base flow to intermittent watercourses and wetlands

SB-70-2 (a-d) Palustrine Forested, Emergent Marsh, and Scrub-Shrub Wetland Corridor (Parcel 0224700)

These wetland systems are located at the former WNLC radio tower parcel accessed from Foster Road. The wetlands consist of a nutrient-poor emergent marsh and wet meadow bordered by a scrub-shrub system. Forested wetlands are also located on the parcel. This wetland system has been significantly disturbed in the past as evidenced by the fill piles and existing ATV trails. In fact, this parcel had been used for sand and gravel mining. When the radio tower was present, the surrounding wetlands were continually maintained via burning, clearing, cutting, and herbicide application. The soils consist of both poorly and very poorly drained soils. Hydrology feeding this wetland system includes hillside seeps and surface water runoff from abutting upland mixed hardwood forests. The hydrologic regime of the wetlands includes seasonally saturated, semipermanently saturated, and temporarily flooded.

Varying vegetation communities exist within this wetland system. Forested wetland areas are dominated by red maple, sweet pepperbush, and skunk cabbage. The scrub-shrub wetlands are dominated by black willow, speckled alder, maleberry, highbush blueberry, swamp azalea, sheep laurel, meadowsweet, and common reed. The nutrient-poor emergent marsh and wet meadow wetlands are dominated by swamp laurel, sheep laurel, maleberry, steeplebush, cattail, marsh marigold, Nuttall's reed grass, rough boneset, bog clubmoss water sedge, wool sedge, and American burreed.

Previous flora surveys conducted by other environmental consulting firms identified a *Carex aquatilis* within the emergent marsh. This is a species of special concern. Other surveys have identified rose pogonia, grass pink, *Iris prismatica*, *Eleocharis tuburculosa*, *Rynchospora capitata*, and *Drosera rotundifolia* within these wetlands.

The diversity of wetland cover types within this wetland system increases its wildlife habitat value. Depressional pools found within the scrub-shrub portion of wetlands provide breeding habitat for spotted salamanders and wood frogs. The wet meadow and emergent marsh wetlands provide habitat for a variety of amphibians, insects, and birds. Observed species included red-winged blackbird, song sparrow, American goldfinch, Eastern towhee, Northern cardinal, white-eyed vireo, and several foraging swallows. A female mallard was found incubating a nest full of eggs nearby. Spring peepers and a northern water snake were also found within this wetland.

There is a high degree of alteration and disturbance within this wetland system, which must once have been predominantly a palustrine forested system. Large fill piles and a road bed are present in the wetland. Invasive species are common along the eastern margins, near the commercial development. The concrete platform for the radio tower is a prominent feature. Dumping and ATV traffic is an ongoing problem due to unrestricted access and is heavily impacting the existing wetland vegetation. However, the natural hydrologic regime and altered conditions have combined to enable the development of a very unusual wetland cover type. It will be very interesting to follow its progress. The area is ripe for wetland restoration, but caution should be exercised when evaluating proposals. Potential restoration efforts for this wetland include removal of anthropogenic debris and *Phragmites* management control and reestablishment of native wet meadow and emergent marsh wetland communities.

Overall, this large wetland system provides several important functions and values including nutrient removal (nutrient rich wetland areas), toxicant retention, and wildlife habitat (amphibian breeding).

Based on the diversity of wetland communities, plant diversity, wildlife habitat and its connection to large unfragmented natural areas, this wetland has been identified as a critical wetland system (CWS-1) within the Stony Brook watershed. This designation is described in greater detail in Section 5.8. Recommendations for this wetland system include:

- Preserve/enhance forested buffer around vernal pool to protect amphibians
- Protect water quality within wetlands
- Maintain base flow to wetlands and intermittent watercourses
- Restore wetlands colonized by invasive species
- Eliminate ATV use within wetlands and repair damage

SB-70-3 Palustrine Scrub-Shrub and Forested Wetland (Parcel 0146500)

This wetland system occupies the low-lying land west of the commercial development on Cross Road, north of I-95. It is contiguous with wetlands to the north described above and the eastern tributary to Stony Brook described below. The bordering uplands are steeply sloped and terraced with old-field regeneration species such as red cedar and field grasses dominating the dry landscape. The toe of the slope flattens and is crisscrossed by old roadways. Several large fill piles occur in wetlands, and there is at least one excavated farm pond. The disturbed wetland edges have been heavily colonized by invasive species; however, beyond this disturbed edge, excellent wetland habitat is preserved.

This wetland is a palustrine forested and scrub-shrub system dominated by a red maple canopy. Common shrubs are high bush blueberry, sweet pepper bush, and silky dogwood. The wetland edges are thick with oriental bittersweet, multiflora rose, Japanese barberry, and greenbriar, resulting in a virtually impenetrable tangle. Microtopography is pronounced, and the hummocks support skunk cabbage and a variety of sedges and mosses. The wetland is semipermanently to seasonally flooded, which further limits accessibility. The wetland is in a topographic depression with dispersed through-flow toward a tributary to Stony Brook. Soils are poorly to very poorly drained.

Wildlife habitat is very good in this area due to the vegetative diversity and varied topography. Green frogs, spotted salamanders, wood frogs, and red-spotted newts were observed. Habitat for snakes and turtles appears excellent as well. Apart from the common suburban birds expected along an old field edge, pileated woodpecker, white-eyed vireo, and common grackle were observed within the swamp community.

Wetland functions and values include ground water recharge/discharge, flood flow alteration, pollutant renovation (sediment / toxicant retention and nutrient removal), production export, and fish/wildlife habitat. Recommendations for this wetland system include:

- Preserve/enhance forested buffer around vernal pool to protect amphibians
- Protect water quality within wetlands
- Maintain base flow to wetlands and intermittent watercourses
- Restore wetlands colonized by invasive species and control invasive plant species along upland margins
- Increase native tree species within uplands bordering wetlands.
- Monitor water quality near former landfill
- Remove fill from wetlands and restore natural conditions

SB-70-4 Palustrine Forested, Scrub-Shrub and Emergent Marsh Wetland Corridor (Parcels 0838300, and 0146500, 0146600)

This wetland system consists of several vegetative cover types including forested, scrub-shrub, and small sections of open-canopy emergent marsh wetlands. These wetlands have been significantly impacted by bordering commercial development, a utility line corridor, and proximity to I-95 and Cross Road. The wetland soils consist of poorly drained soils. Palustrine forested wetlands are primarily located along the east side of Cross Road. These wetlands receive stormwater runoff from Cross Road. Dominant hydrophytic vegetation includes red maple, yellow birch, spicebush, highbush blueberry, and skunk cabbage.

The forested wetlands transition into a swampy scrub-shrub and emergent marsh wetland. Organic muck soils (very poorly drained) are dominant with hummocky topography present. Small shallow open water depressions with vegetated islands dominate this system. The primary hydrology to this wetland is ground water discharge. Vegetation included speckled alder, silky dogwood, buttonbush, highbush blueberry, broad leaved and narrow leaved cattail, purple loosestrife, common reed, sphagnum moss, skunk cabbage, marsh fern, and royal fern. Surface water is conveyed towards the northwest within a man-made channel. This channel is conveyed west under Cross Road and into a large scrub-shrub/forested wetland. This wetland has diverse vegetation structure; however, its ability to serve as good wildlife habitat is limited by its isolation, existing barriers (primarily roads), and a heavily developed contributing watershed.

In addition to the wetlands described above, a *Phragmites*-dominated emergent marsh is located within an existing utility line corridor. The plant diversity is low and available wildlife habitat is limited although green frogs were heard calling from within the stands of *Phragmites*. Overall, this wetland system is providing several important functions and values including nutrient removal and renovation, sediment and toxicant retention, floodwater storage, and limited wildlife habitat. Recommendations for this wetland system include:

- Occasionally monitor water quality at Cross Road to evaluate pollutant renovation
- Maintain base flow to wetlands
- Restore wetlands colonized by invasive species

SB-70-5 Eastern Tributary (Parcel 0838600)

Stony Brook is joined by a large tributary (T3) from the east, approximately 500 feet above the I-95 culverts. This watershed consists of an expanse of palustrine, mixed-class wetlands with large tracts of undisturbed habitat. However, the wetlands in the southern section (near I-95) adjoin a commercial development (Parcel 0838600) that has had an impact upon the wetlands. Much of the edge habitat in this area has been negatively impacted by clearing, cut/fill operations, and construction of parking lots and driveways. There are also ponds that were excavated, in wetlands. As a result, the wetland edges are heavily infested with invasive species, particularly Japanese barberry and multiflora rose.

The wetland system near the tributary's confluence with Stony Brook is more representative of the nonimpacted expansive wetland than the disturbed edges. The red color of the water is very noticeable in the tributary watershed, in contrast to Stony Brook which is uncolored. Additional water quality monitoring is recommended (see additional discussion in Section 4.4). A rough dirt path and a stone wall cross perpendicular to the tributary.

The lower section of the channel has a step-pool pattern with a cobble bottom as it drops to the lower elevation of Stony Brook. The channel is approximately two feet deep and 10 feet across. A short distance upstream, the wetland is semipermanently flooded, broadening out into a forested swamp with dense shrub and herbaceous layers. The bordering uplands are relatively undeveloped apart from the dirt roads and occasional small forest clearings. ATV use was apparent, and the area has also been recently logged. The wetland extension (southeastward) back toward the commercial development along the highway access road included several vernal pools but the edge habitat was badly degraded.

The forested swamp consists of red maple, black tupelo, ash, and ironwood with mixed oaks, maples, and birches at the upland edge. Dominant shrubs are sweet pepper bush, high-bush blueberry, common winterberry, and mountain laurel with some invasives and greenbriar. The stream supported aquatic vegetation, and small fish were observed. Spotted salamander egg masses, adult wood frogs, and green frogs were present in the backwater pools. Deer browse was heavy.

This is an important wetland system, not just for its excellent wildlife habitat, including vernal pool obligate species, but for production export, flood flow alteration, ground water interaction, and removal/renovation of pollutants.

Recommendations for this wetland system include:

- Remove trash and debris from wetlands near Parcel 0838600
- Enhance forested buffer around vernal pools to protect amphibians
- Protect water quality within wetlands from commercial site runoff
- Maintain base flow to wetlands and intermittent watercourses
- Manage invasive species along wetland edges

SB-70-6 Stony Brook Upstream of I-95 Culverts (Parcels 0838600, 0839100)

Stony Brook at this location (from the I-95 culverts upstream/northward to the confluence with a tributary (T2/T3) from the east) has a step-pool pattern, with boulder steps and pools. The width is approximately 30 feet; the depth is variable, averaging about two feet deep. Away from the highway culverts is a wide, naturally vegetated riparian area, with a floodplain to the east. Vegetation and stones stabilize the channel. No serious erosion or scouring impacts were observed. Water quality is good but has a reddish tint, presumably iron oxide or tannins originating from the eastern tributary (T2/T3), which is swampier and marshier than the main stem. The water is cool and well oxygenated. Benthic invertebrates are well represented, and fish were observed.

The banks are primarily a mature upland forest of mixed maples, hickories, and oaks, plus American beech and tulip poplar. The shrub layer is moderately dense with sweet pepper bush, mountain laurel, high-bush blueberry, spice bush, and witch hazel present. Herbaceous growth is less dense under the canopy, but false hellebore and skunk cabbage occupied wetter areas, and Canada mayflower and a variety of ferns and sedges are present in drier areas. Wildlife habitat is very good, beginning with the brook itself, a cold water fishery. The brook side had small mammal tracks and scat. Both forest birds and suburban species were well represented including Eastern phoebe, a typical streamside nester.

At this location, the brook provides many important wetland functions and values beyond the expected fish and wildlife habitat, ground water discharge/recharge, shoreline stabilization, and production export. This location has reasonable public access possibilities so that visual and aesthetic values become important. Access also allows for active and passive recreation and educational values. Recommendations for this wetland system include:

- Preserve forested buffer along Stony Brook for thermal protection and allochthonous material inputs
- Protect water quality within Stony Brook
- Maintain base flow to Stony Brook
- Occasionally, inspect this area for dumping and remove accumulated trash and debris

5.6 Mid-Watershed – Wetlands South of I-95

5.6.1 Watershed SB-60

Watershed SB-60 is located south of I-95 and is comprised primarily of undeveloped parcels and residential properties. Watershed SB-60 is depicted on Figure 5-5. The undeveloped parcels consist of mature growth mixed hardwood forests. A former auto salvage business was also located within this watershed. Based on field investigations, debris from this operation has been removed.

The wetlands in SB-60 consist of forested wetlands, open water, unnamed perennial tributary (T6), and several intermittent watercourses. Stratified drift deposits consist of a sand and gravel as well as alluvial deposits beneath the Stony Brook corridor. Land areas to the west are underlain by till. The wetland soil types within this watershed include the very poorly drained Timakwa and Natchaug complex, the Ridgebury, Leicester, and Whitman soils complex, and the poorly drained Walpole series.

SB-60-1 Gurley Road Headwaters (Parcels 0280900, 0075700)

This wetland is at the western boundary of the watershed near I-95. The surroundings are forested and relatively undeveloped except for a former farm and existing residential development accessed from Gurley Road. Old farm ponds, stone walls, access roads, and some fill were noted in this area. This headwater wetland is a palustrine forested wetland and includes an intermittent watercourse (T6). The tree stratum is dominated by red maple, yellow birch, tupelo, ash, American beech, mixed oaks, and tulip poplar. The upland forest is mature, and many of the trees are large. Predominant shrubs are spice bush, sweet pepper bush, mountain laurel, and witch hazel. The herbaceous growth is diverse due to the rocky, hummocky terrain and consists of skunk cabbage, false hellebore, jewelweed, trillium, Jack-in-the-pulpit, and mixed ferns and sedges. Where disturbance was noted especially near clearings and fill areas, multiflora rose and particularly Japanese barberry were common invasive species.

LOCATION:

MMI#:
MXD:
SOURCE:

DATE:
SCALE:

SHEET:

Wildlife was diverse, reflecting the nearby field habitat, wetlands, and mature upland forest. Blue jays, American goldfinch, Eastern towhee, Baltimore oriole, gray catbird, tufted titmouse, yellow warbler, and red-bellied woodpecker are typical in these areas and were recorded. Forest species such as wood peewee, scarlet tanager, red-eyed vireo, rose-breasted grosbeak, great-crested flycatcher, and white-breasted nuthatch were observed. Near the former farm property, an excavated pond supported spotted salamander and wood frog, the common vernal pool obligate species in this region. Green frogs were common in and around the watercourse and small pools.

The soils are rocky and the stream channel is sinuous with good vegetative diversity and stable banks. Backwater pools and isolated hummocks from fallen trees add topographic relief. Ground water seeps are present. The result is a good mix of hydrophytes, facultative, and upland plants in close proximity. Nearby ledges and outcrops provide additional shelter for wildlife.

As the stream flows southeastward, flow becomes more persistent and is likely perennial. The auto salvage site has cleared the landscape of vegetation to (at least) the wetland edge. This has the potential to cause long-term negative impacts to the wetland as seems to have occurred on the opposite side of the property near the Post Road (SB-60-2, below). However, apart from the shift from native species to invasive species near the clearing and fill areas, there was little direct impact noted within the wetland or the watercourse itself.

The watercourse flows into a larger, flat forested wetland system that is part of the Stony Brook main stem riparian wetland system. Here a series of small intermittent watercourses convey flow to the primary watercourse as described above. Wetland vegetation is similar to what was previously described. It appears that a former sand and gravel quarry bordered this wetland's southern boundary.

Overall, this wetland system provides several important functions and values including wildlife habitat, nutrient removal, sediment retention, and limited flood flow alteration. Recommendations for this wetland system include:

- Preserve forested buffer around vernal pool
- Preserve forested buffer along unnamed tributary to Stony Brook for thermal protection and allochthonous material inputs
- Protect water quality within wetland and perennial watercourse
- Manage invasive species colonization of wetland edges near clearings
- Maintain base flow to perennial watercourse

SB-60-2 Boston Post Road (West) (Parcels 0078200, 0076900, 0081513, et al)

This small wetland trough is isolated by the Boston Post Road, residential development, and by a large cleared site (former auto salvage yard) at its upper limit. The wetland is predominantly forested, but flow constrictions near the Boston Post Road result in semipermanently flooded conditions and open marsh areas. The common tree is red maple with a moderately dense understory of shrubs including the invasive species Japanese barberry and multiflora rose throughout. A luxuriant stand of skunk cabbage occupies the very poorly drained central marsh area. Fill was observed along the wetland margins especially at the Boston Post Road and upgrade at the former auto salvage site. The wetland may be affected by leachate as heavy orange (oxidized iron) discoloration was noted throughout the wetland.

Although heavily impacted by the surrounding development and possibly by pollutants, this wetland system is buffered by a young stand of woodland on the north side. This woodland borders another wetland and watercourse (T6) that is a tributary to Stony Brook. The associated connectivity increases what would be at best modest wildlife habitat in the Boston Post Road wetland. Otherwise, the wetland has very limited functions and values, except to the extent that it is now functioning as a sediment trap and renovates pollutants. Further investigation into the water quality issue at this location is warranted. Recommendations for this wetland system include:

- Increase vegetated upland buffer along wetlands at the former auto salvage yard
- Monitor water quality within wetland specifically iron and manganese

5.6.2 Watershed SB-50

Watershed SB-50 is located south of I-95 and consists of primarily undeveloped parcels and residential properties. Watershed SB-50 is depicted on Figure 5-6. The undeveloped parcels consist of young and mature growth mixed hardwood forests as well as maintained hay fields. The wetlands consist of forested floodplain, wet meadow, emergent marsh, open water and scrub-shrub wetlands. Stratified drift deposits consisting of sand and gravel are found beneath the Stony Brook corridor while land areas to its east and west are underlain by till. The wetland soil types within this watershed include the very poorly drained Timakwa and Natchaug complex, the Ridgebury, Leicester, and Whitman soils complex, and the poorly drained Walpole series.

This section of the Stony Brook main stem has limited wood and overall channel heterogeneity and lacks features such as beneficial undercut banks and instream boulders. The cobble bottom was 60% to 70% embedded with sand and gravel. Hydraulic diversity is lower within this reach as fast-deep and slow-deep habitats are absent.

		LOCATION:	
MMI#: MXD: SOURCE:		DATE: SCALE:	SHEET:

SB-50-1 Stony Brook Corridor South of I-95 (Parcels 0075700, 0840100, 0074700, 0074200, & 0074400)

This wetland system consists of several wetland cover types including palustrine forested, scrub-shrub, emergent marsh, and wet meadow. A tributary to Stony Brook originates near Waterford Parkway South Road. A stormwater outfall from this road discharges water into a flat forested wetland system. The wetland also receives ground water discharges from the forested hillside located to its west. The wetlands substrate consists of extremely stony poorly drained soils and has a muddy surface with stained leaves. The dense overstory consisted of red maple and American elm. The sparse shrub layer consists of spicebush and highbush blueberry. The herbaceous stratum consists of poison ivy, sensitive fern, skunk cabbage, grasses, and sedges.

Ground water and surface water from this forested wetland drains to the south and into a man-made drainage ditch/intermittent watercourse. Soils within the drainage ditch/intermittent watercourse are classified as very poorly drained Aquents, and its bordering uplands are classified as pasture lands. This drainage ditch/intermittent watercourse has approximately 90% herbaceous cover and supports a diverse assemblage of emergent marsh and wet meadow hydrophytes. The dominant species observed within this emergent marsh/wet meadow wetland includes sensitive fern, marsh fern, royal fern, cinnamon fern, narrow-leaved cattail, woolgrass, soft stem bulrush, soft rush, spike rush, green bulrush, jewelweed, fringed sedge, lurid sedge, blue flag iris, violets, skunk cabbage, water plantain, and small clumps of swamp rose and multiflora rose. An adult green frog and a pickerel frog were observed within this wetland. This ditch does not support amphibian breeding. It drains into the forested floodplain wetlands of Stony Brook.

The main channel of Stony Brook is located east of the tributary described above. The channel has likely been straightened at this location. The right (facing downstream) bank of the river may have been armored during channelization when stones were taken from the farm field. Cobbles line the right (field) side of the channel. The left bank of the river is steep, held together with a thick root layer from the trees. Portions of this channel are mowed to within a few meters of the top of bank. The lack of vegetation allows more sun to reach the channel, fostering the growth of filamentous algae and large aquatic plants in the channel. This section of stream has limited woody debris and overall channel heterogeneity, lacking features such as beneficial undercut banks and instream boulders. The cobble bottom was 60% to 70% embedded with sand and gravel.

Stony Brook flows into a forested floodplain wetland. Ground water seeps are present on both the east and west sides of this wetland system. The wetland canopy has approximately 85% cover and consists of red maple, yellow birch, black birch, American elm, and black tupelo. The dense understory consists of eastern hornbeam, spicebush, highbush blueberry, Japanese barberry, multiflora rose, skunk cabbage, false hellebore, sensitive fern, and jewelweed. Stony Brook has a braided channel through portions of this wetland corridor. Land use bordering this wetland corridor includes mixed hardwood forest, pastureland, and a single-family residence. An adult coyote was observed walking within this wetland.

The forested floodplain wetlands of Stony Brook flow into a scrub-shrub wetland system located north of Route 1. This wetland consists of very poorly drained soils and has a high shrub stem density. The shrub stratum consists of speckled alder, silky dogwood, highbush blueberry, common winterberry, swamp azalea, northern arrowwood, and spicebush. The herbaceous stratum consists of skunk cabbage, marsh marigold, sensitive fern, royal fern, purple loosestrife, water willow, grasses, and sedges.

Another unnamed tributary (T4) to Stony Brook is located to the east and originates from the wetland system located near the I-95 off ramp. This wetland is described below under SB-50-2 and SB-50-3.

As the watercourse flows west away from the forested and open water wetlands, it becomes channelized. It flows through open pastures, a wet meadow, and is heavily vegetated. The boarding wet meadow wetland has a diversity of herbaceous plants including soft rush, skunk cabbage, blue flag iris, spike rush, and fringed sedge. This wetland is mowed annually as evidenced by the tractor tire ruts and lack of shrubby vegetation. Within the channel, a diversity of emergent marsh and wet meadow hydrophytes were observed including sensitive fern, marsh fern, royal fern, cinnamon fern, narrow-leaved cattail, woolgrass, soft stem bulrush, soft rush, spike rush, green bulrush, jewelweed, fringed sedge, lurid sedge, blue flag iris, violets, and skunk cabbage.

A small forested wetland depression is located south of the wet meadow wetland described above. This wetland appears to be a man-made depression and is supported by ground water discharges and overland runoff from bordering forested uplands. The depression wetland supports amphibian breeding as evidenced by the presence of both wood frog and spotted salamander larvae. The wetland depression has a tree canopy of approximately 50%. The lack of a dense tree canopy allows filamentous algae to grow within the wetland depression. The wetland has a sparse understory that consists of spicebush, royal fern, sensitive fern, and skunk cabbage.

Recommendations for this wetland system include:

- Preserve forested buffer along unnamed tributary to Stony Brook and Stony Brook main stem for thermal protection and allochthonous material inputs
- Enhance streamside plantings along Stony Brook main stem
- Protect water quality within wetland and perennial watercourses
- Maintain base flow and restrict any peak flow increases to Stony Brook
- Manage invasive species within wetlands and along the Stony Brooks riparian zone

<u>Farm Property South of I-95 - Cross Road Side</u>

<u>SB-50-2 Woodland at Intersection of I-95 and Cross Road (Parcel 0840100)</u>

Highway runoff is routed to the interchange wetland, which has an outlet to the southeast into a wet depression at the junction with Cross Road. This wetland is flat and forested. It appears to flood at least occasionally and probably seasonally. Dominant trees are red maple, yellow birch, and ash. The shrub layer is moderately thick with sweet pepper bush, high bush blueberry, mountain laurel, greenbriar, Japanese barberry, and multiflora rose being common species. The herbaceous cover is also thick except for the open water pools. The terrain is hummocky, and there are many small, isolated pools in which wood frog tadpoles and green frogs were observed. Mainly suburban bird species were present such as Northern cardinal, red-bellied woodpecker, Carolina wren, tufted titmouse, and common grackle being representative. The small patches of forest remaining in the surroundings support wood thrush and red-eyed vireo. White-tailed deer and turkey tracks were observed.

This wetland is a headwater location for a tributary (T4) to Stony Brook. It accepts highway runoff and temporarily retains it, allowing for added pollutant removal and renovation. It also provides very good local wildlife habitat due to the diversity of wetland classes here and nearby.

Recommendations for this wetland system include:

- Monitor and manage invasive species within wetlands
- Be aware of potential impacts from additional flow detention in the interchange zone from increases in impervious surfaces

SB-50-3 Man-Made Pond and Outlet Stream (Parcel 0840100)

This 1.5-acre impoundment was partly excavated and partly dammed to support the once active farm operation. The outlet is via a cross culvert under a farm access road. The pond is moderately deep, perhaps six to eight feet, and grades back into the forested wetland described above. The margins are thickly vegetated with trees and shrubs upgrade and open fields and thin wood lots near the outlet. A thick herbaceous margin of sedges, rushes, and ferns provides excellent habitat for amphibians and reptiles. Warm-water fish species were observed. Rooted aquatic plants are present as well. Green herons were observed hunting along the banks, and swallows searched for insects over the open water.

Ponds such as this one in a mixed land use area add a great deal to habitat diversity. However, the warm, shallow nutrient-rich water leads to luxuriant plant and algae growth. This accumulation of organic matter plus the warm temperatures often results in shifts in downstream waterbodies, which may negatively impact cold-water fishery habitat.

The outlet stream from this pond is likely intermittent as the thick forested zone above the pond and evaporation from the pond itself may result in a no-flow condition during the summer months. The stream is at the farm field edge protected by a stone wall in places and shaded for the most part by residual forest. The banks are steeply incised, and some seeps were noted which, together with the tree cover, may help cool water temperatures somewhat. Invasive species were common here as expected so near the cleared fields.

Recommendations for this wetland system include:

- Preserve forested upland buffer along pond and wetlands
- Determine thermal impact, if any, of the pond upon Stony Brook
- Protect water quality within pond, intermittent watercourse, and wetland

- Maintain base flow to intermittent watercourse and pond
- Inspect cross culvert occasionally for deterioration or blockage to protect the impoundment from overtopping and erosion

SB-50-4 Intermittent Watercourse (T5) From Small Farm on Cross Road (Parcels 0074200, 0073100, 0145400, et al)

This wetland is nearby and very similar to the wetland trough described under SB-40-3 below. It is differentiated mainly by the condition of the upland buffer at the headwater area of the intermittent watercourse. This wetland is bordered by a small, active farm operation with livestock and an excavated pond, with an abundance of bare soil. Runoff from such areas, unless scrupulous housekeeping practices are maintained, tends to be high in nutrients and sediment. Fortunately, there is an intact stone wall with a dense hedgerow acting as a barrier and buffer.

Wetland functions and values include good local wildlife habitat support and opportunities for sediment retention, nutrient removal, and pollutant renovation from the nearby farm and residential development.

Recommendations for this wetland system include:

- Preserve forested upland buffer around vernal pool and along unnamed tributary to Stony Brook for thermal protection and allochthonous material inputs
- Preserve stone walls around wetlands as a physical barrier to encroachment
- Protect water quality within wetland and watercourse by encouraging BMPs on the farm
- Maintain base flow to Stony Brook
- Manage invasive species within wetlands

SB-50-5 Isolated Wetlands on Parkway Road South (Parcels 0840000, 0146400, 0839800, & 0839900)

There are two wetland pockets located east of Cross Road and border Parkway Road South. The first wetland pocket is classified as a palustrine forested depressional wetland system. This wetland is bordered by residential property to the west and a commercial property to the east. The hydrologic regime of this wetland includes seasonally saturated, semipermanently saturated, and temporarily flooded. The wetlands vegetation is dominated by red maple, spicebush, highbush blueberry, and sweet pepperbush. This wetland does provide significant functions and values including wildlife habitat and nutrient and toxicant retention.

The second wetland pocket is associated with the power line corridor. This wetland has been significantly disturbed in the past. The wetlands communities consist of scrub-shrub and emergent marsh communities. Dominate vegetation includes silky dogwood, speckled alder, and *Phragmites*. This wetland has limited functions and values because of the disturbances. Recommendations for this wetland system include:

- Protect water quality within wetland
- Manage invasive species within wetlands

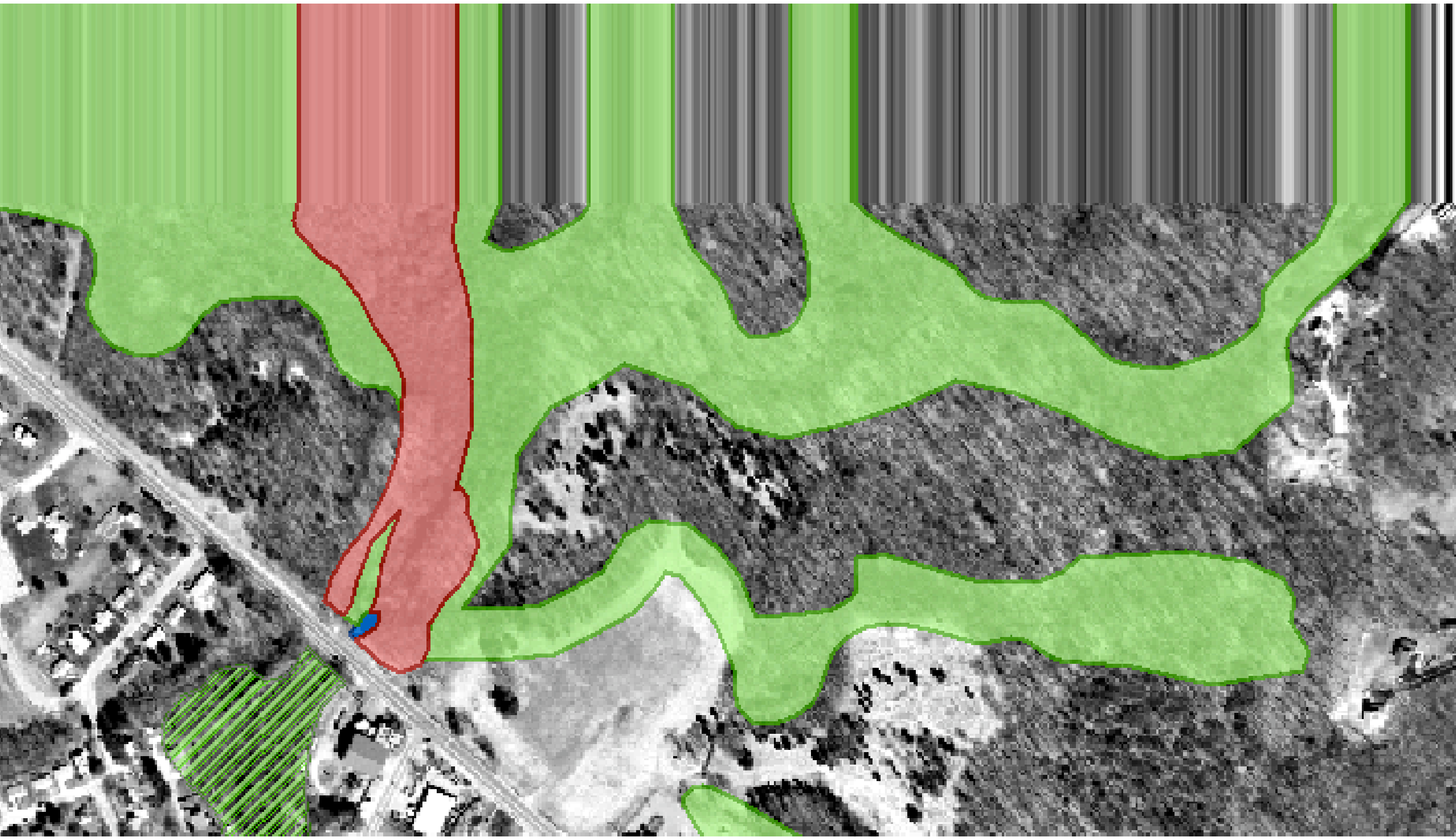
5.7 Lower Watershed – Wetlands Near and South of Route 1

5.7.1 Watershed SB-40

The SB-40 watershed is located along the Route 1 corridor. Watershed SB-40 is depicted on Figure 5-7.

Land use within this subwatershed is a mix of residential, neighborhood retail, recreational fields, old fields, and mixed hardwood forests. Wetlands include forested and scrub-shrub wetlands, open water, intermittent watercourses, and the Stony Brook main stem. A deteriorating concrete and stone dam was observed upstream of the Route 1 culvert crossing. Large deposits of stratified drift are located along Stony Brook main stem corridor including wetland and upland areas. Glacial till deposits are located along the west and east portions of this watershed. Wetland soil types include the very poorly drained Timakwa and Natchaug complex, the Ridgebury, Leicester, and Whitman soils complex, and the poorly drained Walpole series.

Based on the diversity of wetland communities, plant diversity, wildlife habitat and its connection to large unfragmented natural areas, wetlands within this watershed have been selected as a critical wetland system (CWS-3).



West of Stony Brook

SB-40-1 Oswegatchie School (Parcel 0075200)

This wetland system is beyond the school building, parking lots, and ball fields at Oswegatchie School. It is a palustrine wetland of mixed classes including a permanent open water pool several feet in depth. The margins and tussocks support a diverse shrub layer of high-bush blueberry, sweet pepper bush, and clammy azalea. Greenbriar is quite thick, and the edge habitat includes multiflora rose as well. The forested areas are predominately red maple saplings. Many trees have been toppled by wind throw, creating a system of hummocks. The herbaceous layer includes many sedges and ferns including large stands of royal fern. Skunk cabbage is thick in the very poorly drained areas, soft rush in poorly drained areas, and water lilies occupy the standing water pool.

Typical suburban wildlife species were observed. The mix of forested swamp, open water pool, flooded shrub zone and open grassy fields provide an abundant edge habitat. The pool was heavily populated by wood frog larvae despite the likelihood that warm-water fish species are also present. The pool drains via an intermittent watercourse (T10) through a culvert pipe at Stony Brook Drive. Homes with lawns press close upon the small watercourse.

There is a small trail network from the school with a series of bird houses and bat boxes. The remains of a wood boardwalk were also noted. Wetland values like education and passive recreation are available here due to the proximity of the school with parking and public access opportunities. Other functions are pollutant/nutrient renovation and wildlife habitat.

Recommendations for this wetland system include:

- Preserve forested upland buffer around permanent pool.
- Protect water quality within wetland and intermittent watercourse. Carefully review management of the school's playing fields, roof drains and parking lots to prevent wetland impacts.
- Increase educational outdoor classroom opportunities within wetland.
- Encourage restoration of vegetative buffers near home sites along outfall stream.
- Exercise caution regarding changes to roadway drainage in the area to avoid affecting water surface elevations in the pool.
- Manage invasive species within wetlands.

SB-40-2 Stony Brook Drive Subdivision (Parcels 0075200, 0096812, 0096807, et al)

This wetland system is in close proximity to the Oswegatchie School wetland and is similar in character. It is less forested and more shrub dominated. Instead of one large central pool, there is a series of smaller pools and backwater troughs. These provide the same opportunity for amphibian breeding but without the presence of fish as potential predators. The natural drainage discharge pattern may have naturally joined with the outfall from Oswegatchie School, but a small secondary ditch seems to have been excavated that flows directly toward the cove via a culvert at Oswegatchie Road. Other evidence of encroachment includes earthen fill and brush piles, wood road runoff, and edges heavily infested with invasive species.

These two wetland systems, when viewed as a single unit interspersed with mature, forested uplands and well buffered to the west and south, provide many important local functions and values. The area is designated as CWS-3.

Recommendations for this wetland system include:

- Protect water quality within wetland and intermittent watercourse
- Restrict further encroachment, tree cutting and filling near wetland edges

- Investigate hydrology to determine the effect of secondary drainage ditch
- Manage invasive species within wetlands and along watercourse

East of Stony Brook

SB-40-3 Intermittent Watercourse (T9) From Residences on Cross Road (Parcels 0073100, 0074200, et al)

This wetland is a narrow, seasonally saturated, rocky trough that begins near residential development on Cross Road. It is widely buffered from impacts by unmaintained grassland with scattered trees and shrubs plus an intact stone wall along the wetland border. The watercourse flows through a palustrine, forested wetland system dominated by red maple, yellow birch, and ash with mature oaks and tulip poplars along the upland margin. Common shrubs are spice bush, common winterberry, and mountain laurel. There is a modest percentage of the invasive species Japanese barberry and multiflora rose, especially near the open fields and old rock walls where prior disturbances have taken place. The herbaceous layer is well developed and includes skunk cabbage, false hellebore, and mixed ferns and sedges. Overall, vegetation density is high in each stratum.

As the stream is intermittent, there is no fishery habitat, but where the topography flattens out, several vernal pools were observed. The large adjoining tract of forest provides suitable habitat for rose-breasted grosbeak, wood thrush, scarlet tanager, wood peewee, ovenbird, and American robin, all of which were recorded. The nearby field edge habitat supports suburban species such as Northern cardinal, Caroling wren, common yellowthroat, and tufted titmouse.

Wetland functions and values include good local wildlife habitat support and opportunities for sediment retention, nutrient removal and pollutant renovation from nearby fields and residential development.

Recommendations for this wetland system include:

- Preserve forested upland buffer along unnamed tributary to Stony Brook for thermal protection and allochthonous material inputs
- Preserve stone walls near wetlands as physical barriers to encroachment
- Protect water quality within wetland and watercourse
- Maintain base flow to intermittent watercourse
- Manage invasive species within wetlands.

SB-40-4 Forested Wetland Opposite Arrowhead Court (Parcels 0073100, 0073700, 0072200, et al)

This is a system of loosely connected, seasonally saturated wetlands north of the Post Road and opposite the new Arrowhead Court cul-de-sac. The wetland is primarily forested but clearing has taken place at the eastern and western margins where development encroaches upon the wetland. The central section is in better condition. It is forested with an intermittent watercourse that may once have drained southward. Now, it appears that drainage is to the west, parallel to the Post Road and joining the intermittent watercourse flowing from the residential sites along Cross Road to Stony Brook.

The dominant species are red maple and yellow birch with large mixed oaks and tulip poplar in the adjoining upland forest. The stream margins support witch hazel, common winterberry, spice bush, and the two common invasive shrubs, Japanese barberry and multiflora rose. These seem to gain a toehold when clearing occurs along the wetland periphery. The herbaceous layer is moderately dense and moderately diverse. The wetland is physically protected by a stone wall that separates it from the upland parcel along the Post Road frontage. Suburban species were observed including chipmunk, raccoon, Northern cardinal, tufted titmouse, and green frog. A wood thrush was heard calling from the upland forest attesting somewhat to the size and integrity of the upland buffer to the north of this wetland. Local wildlife habitat and some opportunity for pollutant renovation to take place are the main wetland functions and values.

Recommendations for this wetland system include:

- Preserve existing stone walls as limits-of-disturbance along Post Road
- Protect water quality within wetland by preserving or restoring forested buffers
- Manage invasive species within wetlands

5.7.2 Watershed SB-30

The SB-30 watershed is located along the southwestern portion of the Stony Brook watershed and drains into Keeny Cove. Watershed SB-30 is depicted on Figure 5-8. Land use within this watershed includes residential, old field, and mixed hardwood forests.

Wetlands consist of forested, scrub-shrub, open water wetlands, and an intermittent watercourse. Most of the watershed is underlain by glacial till deposits with the exception of the southeast corner were stratified drift is present. Wetland soil types include very poorly drained Timakwa and Natchaug complex and the poorly drained Walpole series.

SB-30-1 Mixed Class Wetlands Off Shawandassee Road (Parcel 0548200)

Several fallow farm fields border Shawandassee Road. A series of low dams impounds runoff and creates several small pools just north of the fields. Discharge flows to Keeny Cove via a culvert beneath Oswegatchie Road. Other abandoned farm ponds were also observed in woodlands northwest of the fields nearer Shawandassee Road. Although the wetland system is rather large and semipermanently flooded, the discharge watercourse appears to be intermittent.

MILONE & MACBROOM

LOCATION:

MMI#:
MXD:
SOURCE:

DATE:
SCALE:

SHEET:

This is a palustrine system, primarily forested, but with open water pools (described above) and areas of flooded, scrub-shrub wetlands. Ground water seeps and surface runoff supply the wetland's hydrology. The forested sections are dominated by red maple. The understory shrub layer is diverse and often very dense with high bush blueberry, common winterberry, sweet pepper bush, northern arrowwood, and mountain laurel. Button bush was present in the shallow ponds. Greenbriar was dense in many areas. The herbaceous layer includes skunk cabbage, Jack-in-the-pulpit, Canada mayflower, trillium, jewelweed, and a variety of ferns, sedges and mosses. The density of the herbaceous layer is variable depending upon light penetration. Microtopography was pronounced providing stratification for both plants and animals. Tree-throws were common in the flooded scrub-shrub areas. Near the abandoned fields, multiflora rose and Japanese barberry were problematic. Away from disturbed areas, invasive species were uncommon.

The surrounding uplands are forested with a good representation of large diameter oaks, maples, hickories, and tulip trees. The mixed habitat supports a representation of forest interior species such as wood peewee, scarlet tanager, wood thrush, and great-crested flycatcher. Red-shouldered hawk, formerly a state-listed species, was observed here. It requires larger forested wetland systems such as this one as nesting habitat. Common suburban species are present as well. The man-made ponds and backwater pools provide good habitat for warm-water fish, aquatic invertebrates, amphibians, and reptiles. Vernal pool obligate species are likely to be present.

Soils here are both poorly drained and very poorly drained based upon duration of saturation. Areas of wetland fill, including dam construction and pond excavation, were observed. The lower reaches of the watercourse have been channelized but appear stable. Current and former cleared areas have invasive species management problems.

This wetland's diversity of classes increases its ecological value. Further, the linkage of this wetland with the nearby CWS-3 wetland system elevates its importance to the surrounding area. The primary functions and values within this watershed are flood flow alteration, sediment retention, pollutant renovation, production export, and wildlife habitat. As discharge is directly to Keeny Cove, water quality protection measures should be maintained and improved. For example, although the man-made ponds provide varied habitat, the warm shallow water results in luxurious algae growth with discharge to the cove.

Observations of this watershed's outflow should be recorded seasonally and after heavy rains or snowmelt. These observations should be accompanied by sampling for nutrients (nitrogen and phosphate), suspended solids, and temperature. This data should be correlated to see if, in fact, the man-made ponds are a significant threat to water quality in Keeny Cove. For example, although water may be warm and nutrient laden in summer, output may be so low as to be of no consequence. In spring, suspended solids may be high due to the eroded outlet controls and bare soils in the surrounding area.

5.7.3 Watershed SB-20

Subwatershed SB-20 is located along the southeast portion of Stony Brook watershed and is depicted on Figure 5-9. Land use within the watershed includes residential, patches of upland forests, and forested wetlands. A large parcel of Town-owned open space is located within the central portion of this watershed.

Wetland cover types are predominantly palustrine forested wetlands, open water, and an intermittent watercourse. The surficial geology of this watershed is predominantly stratified drift; however, a swath of glacial till is located along its northeast corner. The wetland soils within this watershed include very poorly drained Timakwa and Natchaug complex and the Ridgebury, Leicester, and Whitman soils complex.

MILONE & MACBROOM

LOCATION:

MMI#:
MXD:
SOURCE:

DATE:
SCALE:

SHEET:

SB-20-1 Wetlands at Locust Court (Parcels 0072700, et al)

This is a small, somewhat isolated wetland area between residential development along Locust Court and the new subdivision on Arrowhead Court. Parcel 0072700 is designated as Open Space and the associated wetlands on this parcel are restricted from future development and/or encroachment. The contributory watershed is small, and the wetland is supported by the discharge of shallow infiltrated ground water and surface runoff. It is only seasonally saturated. The area is rocky and forested with the beginnings of an intermittent watercourse that discharges under Locust Court joining a similar waterway from the end of Fulmore Drive. Flow is then directly to Keeny Cove.

This is a palustrine forested wetland with an overstory of red maple, yellow birch, and white ash surrounded by a mature upland forest of mixed oaks. The shrub and herbaceous layers are somewhat sparse and include spice bush, witch hazel, skunk cabbage, Jack-in-the-pulpit, false hellebore, and jewelweed. Invasive species, particularly Japanese barberry and multiflora rose, are common along the disturbed wetland edges adjacent to the cul-de-sac.

The wetlands support local wildlife, which consists primarily of suburban species such as Northern cardinal, tufted titmouse, chickadee, American robin, Virginia opossum, chipmunk, skunk, and deer. The wetland has a moderately well-developed upland buffer on its northern edge toward Arrowhead Court while buffering is limited along Locust Court where roadside fill, trash, debris, and invasive species are readily observed.

In headwater areas such as this one, it is important to prevent pollutants and nutrients from reaching the watercourse, which will readily transport material to more sensitive receptors, in this case Keeny Cove.

This wetland area provides local wildlife habitat and drainage conveyance. It is important to prevent added disturbance along Locust Court and to preserve a mature woodland buffer along its northern edge.

SB-20-2 Wetlands at Fulmore Drive (Parcels 0477500, 0313801, 0230900, et al)

This is a moderately sized, mixed class wetland that includes an intermittent watercourse. The wetlands located on Parcel 0313801 are part of the Open Space associated with the Ina Boulevard subdivision. Hydrology is supplied by overland runoff and shallow infiltrated ground water. The area is seasonally flooded with seasonally saturated margins. Outflow joins the discharge from the Locust Court wetland system described above. Drainage is directly to Keeny Cove. Although residential subdivisions closely border the wetland on the north (Paula Lane) and the south (Fulmore Drive), there is a substantial forest of mature trees around the wetland, which increases its habitat value and buffers water quality impacts. There is evidence of disturbance within the wetland including trails, dirt roads, an excavated pond, some fill piles, stone walls, trash, and invasive species.

The wetland is predominately a palustrine forested system but includes some open water as well as a very poorly drained marsh area and a poorly drained shrub area. Red maple, yellow birch, ash, and black birch are common trees in and around the wetland. Japanese barberry, multiflora rose, spice bush, sweet pepper bush, and common winterberry are representative of the understory shrubs. Herbaceous species include skunk cabbage, jewelweed, trillium, Jack-in-the-pulpit, false hellebore, arrowhead with mixed ferns, sedges, and grasses.

Wildlife in this system is typical of wetlands in suburban settings with common yellowthroat, Northern cardinal, tufted titmouse, downy woodpecker, American goldfinch, and gray catbird, but the surrounding upland forest was large enough to support ovenbird, great-crested flycatcher, red-eyed vireo, wood peewee, and red-shouldered hawk (formerly state-listed). Small mammal tracks were noted along the watercourse. This undeveloped wetland corridor provides an important habitat link all the way to Keeny Cove. Several of the pools and an impoundment may provide breeding habitat for vernal pool obligate species, although it was late in the season for satisfactory field observations.

This wetland area provides good wildlife habitat with a link to other nearby wetland systems and good upland habitat as well. Other important functions are drainage conveyance and pollutant/nutrient renovation. It is important to prevent additional disturbance along the existing residential developments and to preserve much of the bordering mature woodland. Headwater wetlands such as this one are crucial links in water quality preservation. It is important to buffer small watercourses to prevent pollutants from being transported to more sensitive receiving waters such as Keeny Cove.

5.7.4 Watershed SB-10

Sub watershed SB-10 is the smallest watershed within this study area and is depicted on Figure 5-10. The watershed is located along the southern tip of Stony Brook watershed. Land use includes a mix of upland forested lands, residential, and forested wetlands. Wetland cover types within this watershed include palustrine scrub-shrub, forested wetlands, and an intermittent watercourse. This watershed drains directly into Keeny Cove. Glacial till dominates most of this watershed; however, patches of stratified drift are located along its periphery. The wetland soils within this watershed include poorly and very poorly drained the Ridgebury, Leicester, and Whitman soils complex.

MILONE & MACBROOM

LOCATION:

MMI#:

MXD:

SOURCE:

DATE:

SCALE:

SHEET:

SB-10-1 Wetlands Along Niantic River Road (Parcels 0474400, 0473900, 0562401, 0473400, 0473200, 0473100, 0472800, 0481914)

The wetland is bordered to the west by Niantic River Road and to the north, east, and south by residential properties. This wetland is classified as a palustrine forested and scrub-shrub wetland system. The wetland has both poorly and very poorly drained soils. The hydrologic regime of this wetland includes seasonally saturated, semipermanently saturated, and temporarily flooded. Microtopography is present within the wetland with vegetated hummocks consisting of highbush blueberry, sweet pepperbush, and winterberry. Saplings of red maple, yellow birch, elm, and black tupelo are also found scattered throughout the wetland. In addition to live trees, there are several large snag trees that provide habitat for cavity nesters also present within the wetland. This wetland may also support amphibian breeding for species such as wood frogs and spotted salamanders.

Overall, this wetland provides several important functions and values including wildlife habitat, nutrient removal, and toxicant retention. Recommendations for this wetland system include:

- Preserve forested upland buffer around amphibian breeding habitat
- Protect water quality within wetland
- Maintain contributing watershed to wetland
- Manage invasive species within wetlands

5.8 Critical Resource Area Identification and Mapping

Mapping and analysis of critical environmental resources provides a baseline of information from which good planning can follow. This is true for individual sites and projects as well as for broad-scale planning at the municipal, regional, or statewide level. It is difficult for planning boards, regulatory commissions, and local officials to fully evaluate the merit and/or potential impact of an action when it is out of context of the broader environment in which it is to take place.

A basic question that comes to bear is "*What constitutes a critical or unique environmental resource?*" The answer to that question can be rather complex. Inland wetlands, vernal pools, unfragmented forested habitat, riparian corridors, native fisheries, prime agricultural land, unique land forms, free flowing rivers, and critical habitat areas that support threatened or endangered species are all contenders. Other possibilities could include privately held "490" open space lands, open space near schools for educational training, aquifer protection areas, mineral resources, cultural or historic resources, or scenic ridgeline protection areas.

The inventory, mapping, and habitat analysis conducted for the Stony Brook watershed is expected to have multiple applications as follows:

- to help guide and prioritize open space land acquisition
- to serve as an active reference tool for the Waterford Conservation Commission in reviewing applications
- to provide the basis for comparison in the review of the applicability and adequacy of current zoning designations
- to distinguish a hierarchy of protection for natural resources based on their function and value in their respective ecological communities

Given the anticipated application of this Watershed Management Plan by the Conservation Commission, a hierarchy of wetland types and resources has been developed to distinguish critical resources that by their nature and function may warrant controls and protection that are above and beyond what is appropriate for other resources. These are described in the narrative that follows.

5.8.1 Critical Wetland and Watercourse Systems

Through decades of well-documented research, it has become clear that wetlands and watercourses provide a host of important physical and chemical functions as well as a suite of beneficial societal values. These functions and values operate at all scales, from the microscopic up to the local and regional landscape. While most wetlands perform some, or even many, of these functions and values, some wetlands, because of their geology, location, vegetation, aesthetics, prior impacts, or their history, are inherently more valuable than others. The identification of critical wetland and watercourse systems was completed to provide assistance in development of management practices and guidelines that would be applied to land-use decisions and conservation practices to protect these important resources within this watershed.

Within this management plan, these special wetlands and watercourses have been referenced as "critical wetland systems." Two objectives were established for identifying critical wetland systems within the Stony Brook watershed. These objectives included (1) establishing a network of wetland systems that fully represented a diversity of wetland types and that performed key ecological and hydrological functions on a local and regional scale; and (2) ensuring local and regional wetland biodiversity through designation and management of critical wetland systems.

Several data sets were used to help establish Stony Brook's critical wetlands. These data sources included field data collection and data forms, personal communications with Town staff, NRCS soil surveys, 2004 aerial photographs, national wetland inventory maps, 2007 Natural Diversity Database maps, vernal pool surveys, Town-provided topographic maps, aquifer protection maps, and additional historical environmental and wetland assessment reports provided by Waterford.

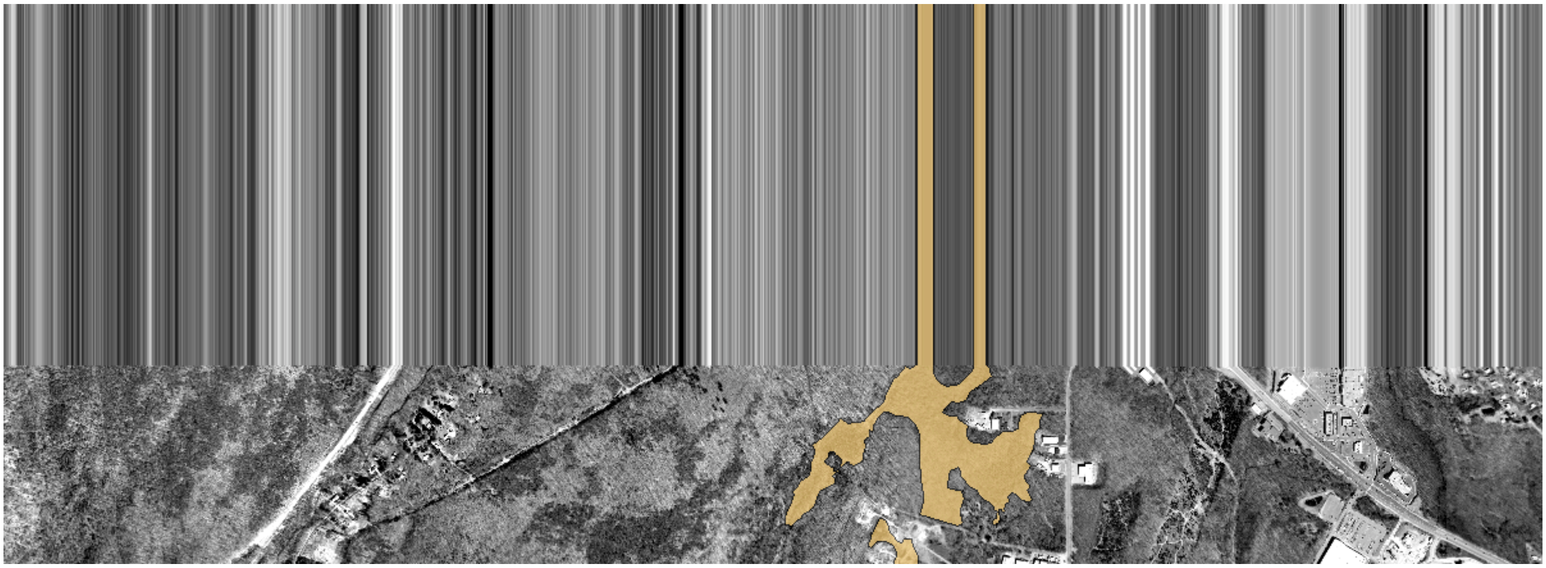
This management plan identifies three critical wetland systems (CWS) within the Stony Brook watershed. These wetland systems include forested, scrub-shrub, and emergent wetlands which provide important functions including preservation of biodiversity, flood flow alteration, and water quality protection and renovation. The critical resource areas within the Stony Brook watershed are presented in Table 5-1. In addition, Figure 5-11 illustrates the critical resource areas.

TABLE 5-1
Critical Wetland Systems

Critical Wetland System	*Watershed ID*	*Size (acres)*	*Dominant Wetland Cover Types*	*Important Functions*
CWS-1	SB-70 SB-90	40.2	PFO and PSS	Biodiversity Nutrient retention Flood flow alteration Production export Fishery habitat
CWS-2	SB-70	64.3	PFO, PSS, PEM	Biodiversity Flood flow alteration Nutrient retention
CWS-3	SB-30	5.0	PFO, PSS, POW	Biodiversity Pollutant Renovation

PFO = Palustrine Forested Wetlands
PSS = Palustrine Scrub-shrub Wetlands
PEM = Palustrine Emergent Marsh
POW = Palustrine Open Water

CWS-1 – This wetland system is one of the largest contiguous wetlands within the Stony Brook watershed. It is a palustrine wetland of mixed vegetative classes including several open water depressional pools as well as an intermittent watercourse. The wetland margins exhibit well-developed microtopography that supports a diverse herbaceous and shrub layer. Red maple trees dominate the canopy in forested areas. Many trees have been toppled by wind-throw creating a system of hummocks and small pools. Scrub-shrub communities are abundant and provide diverse habitat for wildlife. Large contiguous blocks of upland forest border this wetland providing unfragmented natural corridors for wildlife. Breeding amphibians and reptiles are abundant throughout this wetland system including vernal pool obligate species such as spotted salamander and wood frog. Another important attribute of this wetland is that it serves as one of the major headwater areas to the main stem of Stony Brook.



Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

MMI#:		LOCATION:	
MXD:		DATE:	SHEET:
SOURCE:		SCALE:	

<u>CWS-2</u> – This wetland system is the largest contiguous wetland system within this watershed. Similar to CWS-1, CWS-2 is a palustrine wetland of mixed vegetative classes. This wetland also includes the former radio tower site which as described previously has a diverse wet meadow assemblage. This large wetland also contributes significant base flow to the Stony Brook main stem. There is some development along the eastern and southern borders, but disturbance is limited to the wetland edges, not the interior portions of the wetlands.

The forested wetland areas are dominated by red maple. The scrub-shrub wetland systems are dominated by spicebush, winterberry, speckled alder and highbush blueberry. Many trees have been toppled by wind-throw creating a system of pools and hummocks. Scrub-shrub communities are abundant and provide diverse habitats for wildlife. Large contiguous upland forests also border this wetland to the north and west providing unfragmented natural corridors for wildlife. Breeding amphibians and reptiles are abundant throughout this wetland system including the vernal pool obligate species spotted salamander and wood frog.

<u>CWS-3</u> – This wetland system occupies a topographic depression south of Oswegatchie School and the cul-de-sac at Stony Brook Drive. It is a palustrine wetland of mixed classes including several open water pools. The margins and tussocks support a diverse herbaceous and shrub layer. Red maple dominates the canopy. Many trees have been toppled by wind-throw creating a system of hummocks. Rooted aquatic plants, including water lilies, add to the aesthetic appeal. Fingers of upland forest separate the wetland systems creating a more diverse habitat mosaic beneficial to wildlife. The two nearby rivers, Stony Brook and the Niantic River, create a natural peninsula here with development along the Post Road forming the northern boundary.

The proximity of the school and public parking adds wetland values such as passive recreation and education to other wetland functions including flood flow alteration, pollutant renovation, production export, and wildlife habitat.

5.8.2 Unfragmented Areas of High or Unique Resource Value

Large unfragmented areas of natural or even altered habitat are often a critical component in conserving biodiversity on a local and regional scale. Biodiversity encompasses the richness of life at all levels, from the genetic level of species, metapopulations, natural communities, and ecoregion levels. In most cases, biodiversity is at its highest in unfragmented natural areas.

It is important to identify these resource areas in order to maintain and protect biodiversity, natural connectivity, and dispersal opportunities for sensitive native species. Unfragmented areas, including riparian corridors along streams and rivers, often serve as important migratory corridors. They facilitate the dispersal of plants and animals among habitats, thereby maintaining gene pools and preventing local extinctions.

The most effective corridors are not narrow linear strips of land between habitat islands. Instead they tend to be broad swaths of unfragmented land connecting various habitats. Wider corridors permit the development of interior habitat conditions, which allows for movement within the corridor and provides better habitat for so-called "area-sensitive" species. In addition, wider corridors provide better cover from predators, reduce incursions of domestic animals, and limit impacts from human disturbance.

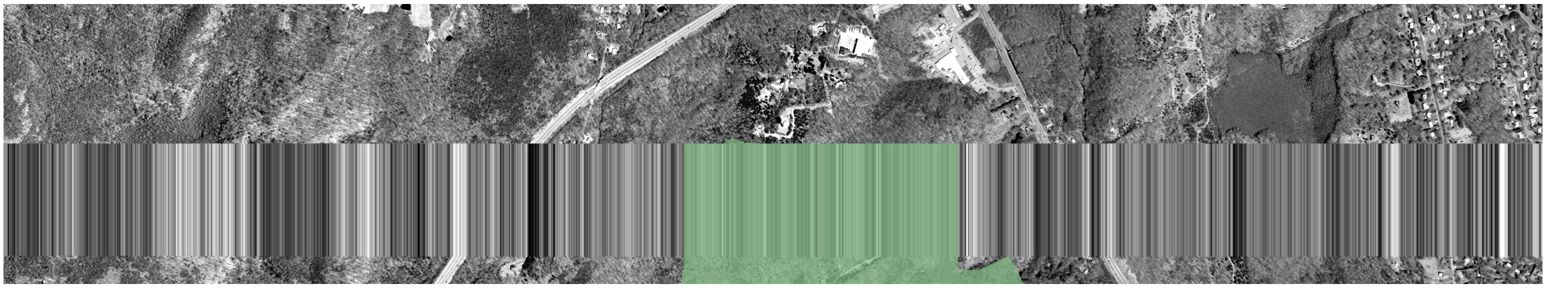
There are many benefits to maintaining these unfragmented areas. Healthy, ecologically diverse systems that are unfragmented perform important natural, abiotic processes such as decomposition of organic matter, soil and sediment creation, filtration of ground and surface water, air cleansing, pollutant renovation, and nutrient retention. In addition, these unfragmented lands provide educational and recreational opportunities to the public such as bird watching, hiking, skiing, hunting, and fishing.

As part of this study, a preliminary assessment was made of the unfragmented areas within the Stony Brook watershed. One of the goals in conducting this assessment was to aid the Town's land use planning agencies in their efforts to conserve and protect natural areas. Several resources were used to identify unfragmented natural areas including 2004 aerial photography, the DEP Natural Diversity Database, field investigations, and discussions with the Town staff. Unfragmented natural areas are shown on Figure 5-12.

Virtually the entire Stony Brook watershed north of I-95 can be viewed as an unfragmented area of high resource value. Only narrow strips of development exist, and these are, for the most part, closely confined to Cross Road and the access road north of the highway. Otherwise, the area is comprised of mixed-age hardwood forest stands with only small woods roads incursions and widely spaced clearings where logging has taken place. There were once even broader links to undeveloped forest lands to the north, including the adjoining watershed lands of the Niantic River and its major tributary, Oil Mill Brook. Construction of I-395 and Route 85 has negatively affected this link but not eliminated it. Clearly, these large tracts of unfragmented natural areas north of I-95 are protecting Stony Brook's wetland biodiversity, its water quality, hydrology, and fishery resources.

Similarly, the lands south of I-95 and north of the Post Road are largely undeveloped. As viewed here, the "natural" state of the fallow farm fields, farm ponds, and wooded hedgerows adds diversity to the landscape and provides opportunities for wildlife not found in the forested sections of the watershed. Additionally, they offer easier access and vantage points for public enjoyment. Forested lands border the farm fields across Stony Brook, westward toward Gurley Road. There are broad expanses of open space to the east, just beyond the narrow residential band on Cross Road.

On a smaller scale, valuable undeveloped lands occur south of the Post Road. These include the high resource value wetlands near Oswegatchie School and beyond Fulmore Drive. The undeveloped woodlands that border these two wetland systems greatly increase the overall resource value although on a more local scale than areas to the north.



Engineering, Landscape Architecture and Environmental Science MILONE & MACBROOM®		LOCATION:
99 Realty Drive Cheshire, Connecticut 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com	MMI#: MXD: SOURCE:	DATE: SCALE:	SHEET:

5.8.3 Probable and Observed Vernal Pool Identification

As part of the wetland assessment and spring field investigations, MMI wetland scientists identified probable and observed vernal pool areas within the Stony Brook Watershed. Observed vernal pool areas were those wetland areas that had evidence of amphibian breeding, which included adults chorusing, spermatophores, egg masses, and/or larvae. Probable vernal pool areas were those wetland areas that appeared to have conditions suitable for amphibian breeding; however, MMI had visited these areas after breeding activities occurred or did not have conclusive evidence of amphibian breeding. The observed and probable amphibian breeding areas identified by MMI are represented on Figure 5-13. It should be noted that the MMI surveys are general in nature, and more detailed amphibian breeding surveys would be required if a regulatory action was proposed near such areas.

5.9 Recommendations

5.9.1 Framework for Recommendations

The protection and preservation of the wetland systems in the Stony Brook watershed are entrusted to the Conservation Commission of the Town of Waterford. The Commission's regulations comprise a framework for balancing the Town's need for economic development to maintain, preserve, and enhance the functions and values of diverse wetland systems. Tools to protect wetlands and watercourses from unnecessary and unwarranted negative impacts include a variety of engineering methods. These include erosion control techniques as described in the *Connecticut Guidelines for Soil Erosion and Sediment Control* (2002) and water quality renovation methods described in the *CT DEP 2004 Stormwater Quality Manual.*

Another well-documented and well-researched method to provide protection for wetlands and watercourses is the use of buffers, particularly vegetated buffers. These strips of land, whether natural, restored, or enhanced, provide a host of benefits that both protect wetlands and augment their functioning. Among these are:

→ preserving water quality by intercepting and renovating pollutants
→ improving wildlife habitat by creating corridors and upland safety zones
→ stabilizing soil and stream banks thereby reducing erosion and sedimentation into wetlands
→ providing a steady source of fine and coarse organic material that serves as fuel for the wetland ecosystem
→ Moderating conditions of temperature, moisture, and light penetration that might cause an imbalance in the wetland or watercourse. For example, thermal impacts to cold-water fishery resources, or colonization by non-native invasive species
→ Protecting downstream areas from serious storms and meltwater by storing and slowly releasing floodwaters

The width of an effective wetland buffer zone depends upon many biotic and abiotic factors including:

→ the relative importance (functions and values) of the wetland under consideration
→ the sensitivity of the wetland ecosystem to various types of disturbance
→ physical factors in the buffer area such as slope, soil permeability, soil erodibility, and the density and types of existing vegetation

In general, the longer it takes for runoff to reach the wetland or watercourse and the more dispersed it is, the more opportunity there will be to mitigate its potentially harmful effects.

There is no shortage of published recommendations for wetland buffer widths. Many sources suggest fixed-width buffers. These make regulatory review and permitting easier for both the Commission, municipal staff, and the public. This is a great advantage in determining what projects require permit review and when enforcement actions are warranted. Once a wetland boundary is determined in the field or provided on a resource map, there is little excuse for wetland impacts due to encroachment. However, with appropriate scientific study, there is a case to be made for variable-width buffers that refine a fixed-width upland review area. This separates the review zone from the buffer zone and offers a better opportunity to balance wetland protection with development potential.

The subject study has evaluated many of the factors described above on a wetland-by-wetland basis. It also recommends consideration of three wetland systems to be afforded additional protection as CWS. Detailed below are the recommendations for incorporating upland review areas and vegetated buffers into management practices for protection of wetland resources in the Stony Brook watershed. Also noted are areas in or adjacent to wetlands that would benefit from restoration efforts and other areas that merit additional scrutiny, particularly with regard to water quality.

5.9.2 Recommendations for Upland Review Areas and Natural or Enhanced Vegetative Buffers

The varying upland vegetated buffer distances and recommendations that are presented in this section have been developed to give the Waterford Conservation Commission the ability to provide upland protection zones for wetlands and watercourses. For all wetlands, the existing 100-foot upland review area is appropriate. In addition, extending the upland review area to 150 feet is recommended for those wetlands that contain a vernal pool and/or other high priority amphibian breeding habitat. The extended review area is consistent with the regulations where activities are likely to impact wetlands and watercourses beyond the 100-foot upland review area.

Maintenance of a vegetated upland buffer area between proposed development and the edge of a wetland and/or watercourse is recommended to protect the diversity of wetland communities, the integrity of instream habitats and channel characteristics, and to preserve water quality features including turbidity, dissolved oxygen, and temperature. The width of this vegetated buffer area should be determined based upon the following factors:

→ the quality of the wetland or watercourse, i.e., the functions and values it provides
→ water quality features
→ fishery resources
→ designation of critical wetland habitats
→ the sensitivity of the wetland to potential impacts from development
→ the merits, benefits, and particular risks of the proposal, including alternatives to the suggested action and available remedial measures

The following discussion provides suggested upland review areas from wetlands and/or watercourse resources along with suggested vegetated buffer limits. Factors for consideration when determining the appropriate upland vegetated buffer width are provided under each recommendation. The following upland vegetated buffer width recommendations are but one important measure for protecting wetlands and watercourses from adverse impacts associated with changes in adjacent land use. Other important measures for protecting wetlands and watercourses that should be considered include:

→ appropriate site planning given existing landscape variables
→ design, installation, monitoring, and maintenance of proper sediment and erosion control measures
→ design, installation, monitoring, and maintenance of stormwater control and treatment measures in keeping with the state's Stormwater Quality Manual
→ use of appropriate LID design practices

In areas where the existing conditions within the riparian buffer zone or upland vegetated buffer zone do not meet all of the suggested guidelines for the criteria below (for example, areas where slopes exceed 15%), then additional buffer widths may be warranted; or, additional protection measures may be implemented; or, supplemental plantings may be considered. Such a determination should be made by the Commission or its staff based upon a site-specific review and evaluation of the wetland factors discussed above in this section and the potential wetland "risks" of the proposed action. In no case should a steep, natural slope be deconstructed or any attempt be made to modify existing soils to satisfy the criteria below.

1. *Protection of the Stony Brook main stem and riparian zone (see map for limit): 100-foot review area and 100-foot upland vegetated buffer.*

   To maintain the Stony Brook main stem biodiversity, all 100-foot proposed riparian zones (vegetated buffer) should meet all of the following conditions:

   → Exhibit slopes less than 15%.
   → Existing upland tree canopy coverage within 50 feet of the wetland or watercourse, whichever is closer to the proposed development, should equal or exceed 90% (the other 50 feet may consist of a naturalized meadow, stormwater management basins, and/or shrub thicket).
   → Existing upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the wetland or watercourse edge should equal or exceed 70%.
   → The published K factor of upland soils bordering the wetland or watercourse should be less than 0.25.
   → The area under review should not be a primary corridor link between critical wetland systems as identified in this report.

2. *Protection of Critical Wetland Systems (CWS): 100-foot review area and 100-foot upland vegetated buffer*

   To maintain biodiversity within the Critical Wetland Systems, the proposed vegetated buffer should meet all of the following conditions:

   → Exhibit slopes less than 15%.
   → If presently forested, the existing upland tree canopy coverage within 50 feet of the CWS edge should equal or exceed 90%, (the other 50 feet may consist of a naturalized meadow, stormwater management basins, and/or shrub thicket).
   → Upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the CWS edge should equal or exceed 70%.
   → The published K value of upland soils bordering the CWS should be less than 0.25.
   → The area under review should not be a primary corridor link between Critical Wetland Systems as identified in this report.

3. *Protection of vernal pools and high priority breeding habitat for vernal pool obligate species: 150-foot review area and 100-foot forested vegetated buffer from the edge of the vernal pool or other breeding habitat.*

   For upland vegetated buffer limits that are greater than 100 feet and less than 150 feet from the edge of identified vernal pool or other high priority *breeding habitat for vernal pool obligate species*, all of the following conditions should be met:

   → No disturbance within 100 feet except that forest enhancement or restoration may be considered.
   → Limit disturbance (both temporary and permanent) in the zone between 100 feet to 150 feet. To the extent practicable, such disturbance should be targeted upon recently disturbed or other nonforested areas.

→ The use of Cape Cod curbing should be considered where disturbances are proposed within 100 feet to 150 feet as specified in Calhoun and Klemens 2002.

→ If stormwater quality basins are proposed within 100 feet to 150 feet of the vernal pool edge, the basin will be ringed with amphibian exclusion fencing as specified in Calhoun and Klemens 2002.

4. *Protection of first order streams: 100-foot review area and 50-foot to 100-foot vegetated buffer.*

   For upland vegetated buffer limits less than 100 feet from the watercourse, all of the following conditions should be met:

→ Exhibit slopes less than 15%.

→ If presently forested, the upland tree canopy coverage within 50 feet of the watercourse should be greater than 90%.

→ Upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the watercourse should equal or exceed 70%.

→ The published K value of upland soils bordering the watercourse should be less than 0.25.

5. *Protection of intermittent watercourses or other wetlands <u>without</u> watercourses, CWS or VPs: 100-foot review area and 50-foot vegetated buffer.*

   A proposed upland vegetated buffer within 50 feet of an intermittent watercourse or other wetland should meet all of the following conditions:

→ Exhibit slopes less than 15%.

→ If presently forested, the upland tree canopy coverage within 25 feet of the wetland should be greater than 90% (the other 25 feet may consist of a naturalized meadow, stormwater management basins, and/or shrub thicket).

→ Upland understory vegetation coverage (shrubs plus herbs, not lawn) within 50 feet of the wetland should equal or exceed 70%.

→ The published K factor of upland soils bordering the wetland should be less than 0.25.

In the determination of effective vegetated buffer widths, the Commission must also take into consideration the existing and proposed land use and type of alteration. Factors including changes to vegetation cover, soil disturbance, wildlife corridor connectivity, alterations of surface and ground water hydrology and discharges, pollutant loading to surface waters, and probable impacts to water quality and wetland functions should be evaluated.

5.9.3 <u>Recommendations for Potential Restoration of Disturbed Wetlands and/or Buffer Areas</u>

1. The eastern edge of the radio tower site wetland (Parcel 0224700) on Foster Road is overrun by *Phragmites* and has several areas of fill.

2. The power line cut through wetlands near I-95 and Cross Road is also infested by *Phragmites* (Parcels 0838200 and 0838000).

3. South of the tower site and behind the mixed commercial uses on Cross Road, there are several fill areas, some erosion problems, and an infestation of invasive species (Parcel 0146500).

4. The small farm operation (Parcel 0145400) on Cross Road just south of I-95 would benefit from implementation of several of the water quality improvement measures recommended by the USDA – NRCS.

5. The main stem of Stony Brook has several areas (Parcel 0840100) that would benefit from the restoration of a tree canopy to shade the brook and stabilize its banks.

5.9.4 Recommendations for Follow-up Investigations and/or Problem Areas

1. Red-tinged water draining from the eastern tributary into the main stem of Stony Brook just above I-95.

2. Red-tinged water draining from the wetland alongside the Post Road near the former auto salvage parcel.

3. Ending the ATV traffic and dumping at the tower site on Foster Road.

4. The out-of-use farm ponds and impoundments near Shawandassee Road are a potential source of pollutants to Keeny Cove.

5. ATV traffic is negatively impacting the wetlands on Parcels 0115100, 0839100, and 0224700.

6.0 WATERSHED MANAGEMENT AND LOW IMPACT DEVELOPMENT ANALYSIS

6.1 Introduction

Watershed management, stormwater management, and low impact development are integrally related and so have been grouped together for the purposes of this discussion. This report section describes watershed management, stormwater management, and low impact development principles, and explores their potential application in the Stony Brook watershed.

Traditional approaches to river management are often limited in scope, prohibitively expensive, and environmentally unsound. Such approaches have often included physical measures such as placing concrete or riprap along eroding banks or channelizing streams and rivers in underground piping. The concept of managing the watershed and river corridor to maintain the quality of the river system provides an alternate approach that allows each river function to be managed at an appropriate level.

Effective watershed management involves a multifaceted approach that encompasses land uses (past, present, and future); stream and wetland buffers; responsible development through adequate site selection, design, and maintenance; stormwater best management practices; control of nonstormwater discharges; control of destructive and unnatural erosion and sedimentation; and watershed stewardship programs that have the ability to span corporate boundaries and governmental divides.

Surface and ground water resources are best managed by considering three geomorphic and spatial scales (watershed, stream corridor, and river) as well as geospatial boundaries that are formed by municipal and state boundaries.

Watershed Planning and Regulation – The largest geographic planning element is that of a river's watershed, consisting of all land that contributes runoff to a specified point of interest. The importance of watershed scale planning is directly related to the river's hydrology and water quality. For example, it is difficult to have healthy streams if they are overwhelmed by frequent flood runoff and cumulative pollutants and sediment from upland activities. Stream management is thus dependent upon watershed land management.

Riparian Corridor Planning and Regulation – The second spatial scale to be addressed for comprehensive watershed management is the riparian corridor. This is a transition zone between uplands and waterbodies. It includes inland wetlands, floodplains, stratified drift ground water aquifers that are hydrologically connected to surface waters, and buffer zones.

River Planning and Regulation – The final spatial scale of concern is that of the actual stream channel that lies between the top of the stream banks.

Existing local, state, and federal programs do address all three spatial scales of watershed and watercourse management. However, the watershed level could benefit from stronger programs. The greatest weakness is in the lack of mandatory low impact drainage practices in contrast to "end-of-pipe" detention and sediment basin type practices. Waterford has an opportunity to do this at the local level through low impact development as described later in this section.

6.2 Stormwater Management

It is well documented that changes to the land's surface associated with land development and other activities can alter hydrologic conditions by modifying the way water moves over, through, and from the land. Watershed deforestation for lumber, firewood, charcoal, and farming was the first impact of colonial settlers. Subsequent drainage of wetlands, channelization, and gravel mining modified watershed runoff through the 19th century. During the 20th century, watershed modifications included increased impervious cover (often the result of construction of residential subdivisions, roads, retail stores, and the like) and storm drains with direct discharges to surface water bodies.

In broad classification, typical impacts to wetlands and water resources due to the alteration of hydrologic conditions associated with land development and other activities include (1) degraded water quality; (2) unnatural stream channel geomorphic changes; and (3) increased frequency and severity of flooding. All of these potential impacts may also impact aquatic systems and can result in habitat loss and degradation and decreased biodiversity.

The practice of stormwater management is intended to mitigate hydrologic impacts resulting from changes to the land's surface. On a watershed scale, the controls used to manage stormwater can be classified in the following three categories:

Land Use Controls involve the regulatory processes, including zoning, that govern land development and other activities.

Source Controls are intended to reduce potential pollutants at their source by identifying and either prohibiting or conditioning land uses or activities that are known to have a high risk to generate pollutants.

Treatment Controls are both nonstructural and structural practices that are designed to mitigate the impacts of hydrologic condition changes that have occurred or will occur as a result of land development or other activities.

Examples of each type of control are given in Table 6-1.

TABLE 6-1
Stormwater Management Controls

Land Use Controls	*Source Controls*	*Treatment Controls*
Stream Buffer Requirements	Public Education	Settling Practices
Floodplain Restrictions	Illicit Discharge Elimination	Infiltration Practices
Wetland Protection	Spill Prevention and Clean-up	Filtering Practices
Steep Slope Area Restrictions	Dumping Prevention	
Open Space	Materials Management	
Cluster Development	Street and Parking Area Cleaning	
Erosion and Sediment Control	Storm Drainage System Maintenance	

Stormwater controls commonly used in land development design can be categorized as storage controls, infiltration controls, or end-of-pipe controls (Ontario Ministry of the Environment, 2003). Some can be considered applicable to more than one category and some may provide multiple functions or benefits. Examples of these techniques are listed in Table 6-2.

TABLE 6-2
Controls Used in Land Development Design Practice

Storage Controls	*Infiltration Controls*	*End-of-Pipe Controls*
Rooftop Storage	Lot Grading to Create Ponding Areas	Oil/Grit Separators
Parking Area Storage	Roof Water Collection and Infiltration	Dry Ponds
Storm Sewer Storage	Vegetated Swales or Channels	Wet Ponds
Detention Facilities	Vegetated Buffer Areas	Constructed Wetlands
	Infiltration Storm Sewers	Filtering Practices
	Infiltration Basins or Structures	Infiltration Practices

Storage Controls are intended to reduce the increased peak discharge rates and timing modifications of stormwater runoff resulting from development by temporarily holding runoff and releasing it at prescribed rates of discharge.

Infiltration Controls are intended to mitigate the effects that changes to the land surface have on the water balance portion of the hydrologic cycle by directing stormwater runoff into the ground.

End-of pipe Controls are located at the end of a conveyance system (e.g., a storm sewer or channel) and treat stormwater runoff before discharging it either to the ground or to receiving surface waters. End-of-pipe controls can also provide storage and infiltration functions, peak discharge attenuation, stream channel protection, and overbank and extreme flooding protection.

6.3 Low Impact Development (LID)

In LID, land development design practices for stormwater management make use of creative site planning and design tools that are intended to preserve or reduce the changes to a site's hydrology rather than simply providing "end of pipe" treatment or highly engineered management systems. LID techniques and practices are intended to preserve natural systems and protect resources and their buffer areas through design of drainage systems that mimic natural systems. The following goals are common to LID:

→ protect existing vegetation
→ minimize changes in surface water drainage patterns
→ avoid excessive site grading
→ reduce the area of impervious and managed surface coverage
→ encourage the disconnection of impervious surfaces
→ promote temporary storage of stormwater runoff
→ promote infiltration of stormwater runoff
→ reduce or mitigate increases in the volume of stormwater runoff as well as changes in magnitude, frequency, and duration of stormwater discharges to receiving waters

The use of these planning and design tools can often times reduce or even eliminate the requirement for more costly and sometimes obtrusive storage, infiltration, or end-of-pipe structural practices for the management of stormwater runoff. They can also result in development proposals that better fit the existing characteristics of a site, are aesthetically pleasing, and protect the environment.

LID techniques have been integrated into land use regulatory programs in some creative jurisdictions throughout the Untied States. A wealth of literature and other application tools, including LID design practice manuals, can be found on the World Wide Web. The basic techniques can be categorized into site planning, hydrologic analysis, erosion and sediment control, integrated management practices, and public outreach practices. Specific LID techniques are described in greater detail in the ensuing text.

6.3.1 Site Planning for LID

The goal of LID site planning techniques is to maintain hydrologic functions while allowing full development of the property. The traditional approach to stormwater management is to drain water from the site as quickly and efficiently as possible. LID site planning begins by understanding the essential hydrologic functions of the site, including the streams, wetlands, buffer areas, floodplains, steep slopes, high permeability soils, and conservation zones. The remaining site area is the "development zone," the area where development activities will have the least impact on hydrologic function.

Successful LID requires the micromanagement of site watersheds and hydrology. This means addressing stormwater control on a lot-by-lot basis. "On-lot" stormwater management may include "microstorage," functional landscaping, open swale drainage systems, reduction in impervious cover, increased runoff travel time, and depression storage (Prince George's County Maryland, 1999).

Since the watershed areas and stormwater runoff volumes being managed are much smaller, the range of available management techniques increases. For instance, use of a rain garden would not be possible to control runoff from an 11-lot subdivision and associated roadway. However, placement of rain gardens on a lot-by-lot basis may be feasible.

Often the first step in LID planning is to assess local land use regulations to determine the site development requirements. In many Connecticut communities, zoning and subdivision regulations effectively preclude the use of LID techniques because hard and fast design requirements are mandated. For instance, one town in the greater Hartford area requires that all roads and parking lots have a minimum six-inch high curb. This regulation prevents the use of curbless roadway or parking lot designs that would increase sheet flow and infiltration. The following site design elements incorporate LID:

1. Reduce paved areas to the extent possible. This may include reducing the width of paved roadways and cul-de-sac diameters, eliminating on-street parking, promoting use of common driveways, or using narrower driveway widths (perhaps nine or 10 feet).
2. Use permeable pavement materials such as grass pavers, whenever possible.
3. Avoid compaction of high permeability soils.
4. Minimize the area dedicated for construction easements and stockpile areas.
5. To the extent possible, plan site activities to limit the removal of trees and vegetation.
6. Disconnect impervious areas. Do not connect roof drains and footing drains into a piped drainage system (consider drywells or other infiltration devices). Provide curbless roads to allow sheet flow.
7. Maintain existing topography to the extent possible. The intent is to maintain runoff travel distances, slopes, roughness, and channel shapes whenever possible.
8. Maximize the use of open drainage systems such as grass swales.
9. Alter front yard setbacks to move houses forward on a lot to reduce driveway lengths.

Once these elements have been incorporated, then hydrologic analysis should be completed and then storage and treatment technologies can be considered to address any increases in peak flow or water quality concerns that remain.

6.3.2 LID Techniques for Development

In assessing site designs that incorporate LID techniques, hydrologic analysis is a key consideration. Land use regulations often stipulate the design storm to be analyzed. In Waterford, no specific design storm is specified for analysis. Instead, Section 25 of the Waterford Zoning Regulations requires that stormwater systems be designed "to prevent the collection and stagnation of water and the protection of watercourses, streams, ponds, and wetlands from pollution, siltation and erosion." These requirements are flexible and allow development of sites to occur in a manner appropriate for the area, instead of forcing a "one size fits all" approach to stormwater management.

For sites using LID, a design storm must be selected to evaluate hydrologic conditions at the site. Table 6-3 lists the typical analysis applied when evaluating different design storms.

TABLE 6-3
Typical Design Storm Analyses

Design Storm Frequency	Typical Analysis and Evaluations That Should be Performed
First Flush (first one inch of runoff)	Stormwater Quality
2-Year Storm Event	Erosion and Sediment related impacts to receiving streams and wetlands
10-Year Storm Event	Conveyance Capacity
100-Year Storm Event	Flooding Potential

Once the predevelopment and postdevelopment hydrologic conditions are evaluated, specific site management practices can be incorporated as needed. The design considerations discussed earlier are intended to minimize site impacts, but some additional stormwater controls may be necessary. This is the point at which the designer begins to evaluate specific Best Management Practices (BMPs). The following is a list of preferred BMPs, specific to different zoning designations and land uses.

TABLE 6-4
Preferred Best Management Practices

Residential	***Retail/Industrial***	***Both***
Rain Gardens or Barrels	Pervious Parking	Grass Swales
Infiltration Basins or Trenches	Green Roof Storage	Deep Sump Catch Basins in Roads and Parking Areas
Dry Wells	Single Sidewalks	Hydrodynamic Separators
Reduced Roadway Widths	Reduction in Building Footprint	Oil/Water Separators
Curbless Roadways	Parking Lot Storage	Created Wetland Systems
Retention/Detention	Decentralized Parking	Bioretention Facilities
	Bioretention at Parking Lot Islands	Detention Basins

The selection of specific BMPs varies from site to site. Some applications, such as infiltration systems, may not be appropriate for all land uses or all sites. For instance, the use of infiltration basins or trenches at an industrial facility that houses hazardous chemicals may not be prudent regardless of the soil conditions. Once the appropriate BMPs have been selected, the postdevelopment hydrologic analysis can be reevaluated to determine if precondition runoff rates and volumes are preserved.

6.3.3 LID Application in the Stony Brook Watershed

The type and scope of LID techniques used in the Stony Brook watershed may vary from subwatershed to subwatershed and site to site depending, not only on the proposed land use, but on the geology and topography of the site. Other factors, such as depth to water and depth to bedrock, will also need to be a consideration. Table 6-5 presents a summary of BMPs that could be used within the Stony Brook watershed.

TABLE 6-5
Considerations of Use of LID BMPs

BMP Type	***Watershed Size***	***Space Requirements***	***Site Considerations***	***Maintenance***
Rain Barrels	Limited to roof area. Provide multiple barrels to accommodate larger roof areas.	Limited	None	Low
Infiltration Basins	Basins: 25 acres maximum; 10 acres recommended.	Varies with watershed size. Minimum 20 square feet.	Do not use at properties with high potential for sediment load. Keep minimum of 50' from slopes 15% or greater; bottom of unit >3' to water; 75' min from wells and septic. Basins require construction at the surface and may increase total land disturbances.	Moderate to high
Infiltration Trenches	Trenches: 5 acres maximum; 2 acres recommended.	Varies with watershed size. Minimum 20 square feet.	Do not use at properties with high potential for sediment load. Keep minimum of 50' from slopes 15% or greater; bottom of unit >3' to water; 75' min from wells and septic. Trenches can be constructed underground and may reduce land disturbances.	Moderate to high

TABLE 6-5 (Cont.)
Considerations of Use of LID BMPs

Dry Wells	< one acre	Varies with watershed size. Minimum 20 square feet.	Not for use where rooftop may contribute pollutants. Bottom of unit 3' above water, 4' above bedrock; 75' min from wells and septic.	Low
Pervious Pavement	Traffic volume <500 ADT	Not applicable	Min. infiltration of underlying soils 0.3 in/hr, but less than 5.0 in/hr; no use in aquifer recharge areas except in approved "clean" applications; no use on slopes greater than 15%; depth to water – 3' min. depth to bedrock – 4' min. 75' min from wells.	Moderate
Green Roof Storage	Generally limited to roof area	Varies with size of roof	Depending on materials used, structural considerations may be needed.	Low
Bioretention/Rain Gardens	5-10 acres; rooftop area for rain gardens	200 sq. ft. min; 25 sq. ft. rain garden.	Slopes 6% or less; 3' from bottom of structure to water.	Low
Grass Swales	As space permits for swale construction	2' min bottom width	Avoid steep slopes to prevent erosion.	Low
Oil/Water or Hydrodynamic Separators	<1 acre impervious cover	None. Below grade structure	None	Low
Created Wetlands	25 acre min.	Proportional to watershed size	Must intersect ground water if unlined; not appropriate for land uses generating large amounts of contamination; must have base flow into system; steep slopes not appropriate.	Moderate to high
Detention Basins	1 acre min.	Proportional to watershed size	Must intersect ground water if unlined and wet basin; not appropriate for land uses generating large amounts of contamination; must have base flow into system; steep slopes not appropriate.	Moderate

The percentage of imperviousness in a watershed is often linked to water quality impairment. In the absence of other overriding factors, at levels of imperviousness less than 10%, water quality and habitat is generally considered to be unimpaired, and species present are typically those that are sensitive to impairment. Between 10% and 25% imperviousness, water quality and habitat are often viewed as impaired; and at levels of over 25%, severe impairment is often observed. It is important to acknowledge that these are general trends and not hard and fast rules.

Topography is another important issue to consider when evaluating LID uses. Slopes through the central floodplain portion of the Stony Brook are relatively flat, at 0 to 3%. Some steeper slopes (e.g., rock outcrops) do exist in the western and northern parts of the watershed. These steeper slope areas may not be suitable for LID techniques, and all construction in general on slopes in excess of 15% should be carefully considered as they would be more prone to erosion.

Zoning within the Stony Brook watershed can be classified into three broad categories: residential, commercial, and industrial. For residential properties, any LID technique is appropriate, provided site soil conditions are suitable to the application. In industrial and commercial areas, the proposed use of the property must be considered before the appropriate LID activities can be determined. Typically, infiltration practices are of most concern since the use of infiltration trenches or basins has the potential to introduce pollutants directly to ground water if the site is not managed properly.

Table 6-7 is a summary of allowable land uses in the Stony Brook watershed, where LID practices such as infiltration should be carefully reviewed for potential stormwater impacts.

TABLE 6-7
Land Uses Where the Use of Infiltration Practices Should be Carefully Evaluated

Permitted or Special Permit Use of Concern
Public Utility Building or Structure
Shop
Printing and Publishing Facilities
Laboratory for Medical Research
Commercial Greenhouses and Garden Supply Centers
Service Stations
Car Washes
Laundry
Truck, Boat, and Automobile Repair Shops
Yard for Fuel, Lumber and Building Materials
Warehousing Facility and Distribution Center
Manufacturing Centers
Trucking Companies
Research and Testing Laboratory
Textile Dyeing Facilities
Septic Tank and/or Solid Waste Disposal Areas
Manufacture of Asphalt, Cement, Cinder Block Materials
Wholesale Storage of Petroleum, Oil, Chemicals, and Similar Materials

As previously indicated, LID practices can be incorporated into proposed developments in any zone, provided soil types and other site conditions are favorable for the proposed LID application. The most important consideration is the ability to capture and collect pollutants in the event of a release. For this reason, the use of infiltration in business and industrial zones needs to be carefully considered based on the proposed use of the property.

6.4 Areas Unsuitable for Septic Systems

The Town's existing sanitary sewer system mapping and other septic suitability publications were reviewed in evaluating this watershed's septic suitability, including the NRCS publication entitled *"Soil Potential Ratings Subsurface Sewage Disposal Systems for Single Family Residences"* dated April 2006. Portions of this watershed are already served by the municipal sewer system. Sanitary sewer locations and soil septic suitability ratings are provided in Figure 6-1.

Engineering,
Landscape Architecture
and Environmental Science

MILONE & MACBROOM®

99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

LOCATION:

MMI#:
MXD:
SOURCE:

DATE:
SCALE:

SHEET:

Parcels with frontage on the roads listed in Table 6-8 are either served by sanitary sewers or have the potential to be served today.

TABLE 6-8
Sanitary Sewer Service Areas

Route 1 (aka Boston Post Road)	Valerie Street
Shawandassee Road	Deborah Street
Oswegatchie Road	Raymond Lane
Niantic River Road	Foster Road
Fulmore Drive	East part of Waterford Parkway North
Locust Court	Sunnieside Court
Miss Vans Court	Sunniecrest Drive
Wilcox Court	Rockridge Road
Splithead Road	Marilyn Road
Stone Street	Pamela Way
Doyle Road	Brooks Street
Cross Road	

Parcels with frontage on Gurley Road, Waterford Parkway South, the western portion of Waterford Parkway North, and interior lots located north of I-95 are not located in close proximity to the existing sanitary system, but it may be feasible in the future for sanitary sewer lines to be extended to these roads and parcels.

The NRCS publication includes ratings of soil mapping units for subsurface sewage system suitability for a four-bedroom single-family house. Five soil characteristics are evaluated including slope, soil percolation rates, depth to seasonal high ground water, depth to bedrock, and flood susceptibility. Soils are rated as follows:

→ Extremely Low Potential Soils have multiple major limitations that are extremely difficult to overcome.

→ Very Low Potential Soils have major limitations that would require extensive design and site preparation.

→ Low Potential Soils have one or more limitations that would require extensive design and site preparation.

→ Moderate Potential Soils have significant limitations that are generally overcome by using commonly acceptable design criteria.

→ High Potential Soils have the best combination of characteristics or may have limitations that can be easily overcome using standard installation practices.

<u>*Extremely Low Potential Soils*</u> – In general, wetland soils have extremely low potential for septic suitability because of their seasonally high water table. Within the Stony Brook watershed, these soils would include the Scarboro series, Raypol series, Walpole series, Ridgebury series, Catden and Freetown complex, Ridgebury, Leicester, and Whitman soil complex, and Timakawa and Natchaug soils complex.

<u>*Very Low Potential Soils*</u> – The very low potential soils within the Stony Brook watershed are located within the northern part of the watershed where steep slopes and shallow bedrock are present. These soils belong to the Hollis-Chatfield rock outcrop complex.

<u>*Low Potential Soils*</u> – Low potential soils are located throughout the watershed and consist of a variety of soil types. The steeply sloped well drained Charlton-Chatfield complex is rated as low potential. The excessively drained Hinckley soil has a very high percolation rate and, therefore, has a rating of low potential. Also there are soils having low potential due to seasonally high water table including the Woodbridge series, Ninigret and Tisbury complex, Sutton series, and Sudbury series.

<u>*Moderate Potential Soils*</u> – Moderate potential soils are somewhat limited within this watershed. Small inclusions of these soils are found along the southeast, west, northwest, and northeast parts of the watershed. The moderate potential soils include the Canton

and Charlton complex and the Paxton and Montauk complex. The Canton – Charlton soils are limited by steep slopes and the Paxton-Montauk soils by low percolation rate.

High Potential Soils – High potential soils within this watershed are found within glacial till and stratified drift soils. The glacial till based soils include the low to moderately sloped Canton and Charlton complex and Narragansett series. The stratified drift soils include the Merrimac series, Agawam series, and Haven and Enfield soils complex.

Based on the soil septic suitability data, the Stony Brook watershed varies in the potential for subsurface septic systems. Approximately 54% of the watershed has soils rated low to extremely low potential. Some of the larger tracts of undeveloped land have predominantly low septic suitability ratings, and many either abut or include critical wetland systems. Having the ability to service future development within the watershed with sanitary sewers is extremely important for maintaining water quality within the Stony Brook main stem and critical wetland systems.

Theoretically speaking, a septic system is designed to work forever if the soils are good, the system is designed and constructed properly, and it is routinely maintained. However, not all septic systems work forever, whether it be from lack of maintenance, poor design and construction, or other contributing factors. Byproducts such as nitrates, nitrites, total Kjeldahl nitrogen, *e. coli*, and phosphorous can all degrade water quality within surface waters. The State Department of Public Health code precludes new septic systems from being constructed within 50 feet of a watercourse.

7.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

7.1 Summary of Findings

1. The Town of Waterford has placed a high priority on identifying, protecting, and managing its natural resources within the Stony Brook watershed. The Stony Brook watershed includes several large, valuable wetland and watercourse systems. The more than 306 acres of wetlands in the watershed represent several ecological categories including palustrine open water, forested, scrub-shrub, and emergent marsh/wet meadow systems. These wetland systems, in conjunction with their neighboring uplands, are critical in maintaining a clean and adequate supply of surface and ground water.

   The Stony Brook watershed is unusual in that the northern portion of the watershed is relatively undeveloped with large wetland systems that are natural and unfragmented while the central and southern portions of the watershed are more disturbed, developed, and fragmented. These differences in land use influence wetland cover types, water quality/quantity and wetland functions and values such as flood control, pollutant renovation, aesthetics, recreational opportunities, and wildlife habitat, among others.

   Wetland cover types north of the interstate are predominantly forested and scrub-shrub wetlands. South of the interstate, where anthropogenic disturbances are numerous, wetland cover types diversify from forested and scrub-shrub wetlands to include wet meadow, emergent marsh, and some open water wetlands. With the exception of a few wetlands such as (CWS-3) and Stony Brook itself, MMI observed that the overall wetland quality declines south of the interstate. Evidence of more recent disturbances (particularly commercial and residential development), invasive species colonization, and lower water quality all contribute to the decline of these wetlands. However, that is not to say that the wetlands south of the interstate do not still provide important functions and values that merit continued protection.

2. Based on the water quality data collected by the Town of Waterford from 1999 to 2006 and the rapid field water quality assessment performed by MMI in June 2007, Stony Brook appears, for the most part, to be meeting its Class A water quality designation. However, some data and field observations indicate that some water quality issues exist that warrant further investigation. In summary, Stony Brook has:

    a. Cool water temperatures.
    b. Slightly acidic pH.
    c. Low specific conductivity.
    d. Low chloride concentrations.
    e. High dissolved oxygen.
    f. Low *E. Coli* concentrations.
    g. Low phosphorus and nitrogen concentrations.
    h. Metals data suggests the potential for both acute and chronic toxicity to aquatic life due to high lead and copper concentrations. However, the data may be inaccurate due to the use of nonstandardized techniques with high detection limits. Further testing, after inspections, is likely warranted.

    Our field observations indicate some areas of departure from the Class A water quality. For example, the instream bioassessment data indicates a limited abundance and diversity of macroinvertebrates within Stony Brook. MMI also noted strong red-colored surface waters within the upper, eastern subwatersheds (tributaries T2 and T3) that appear to be excessive given the underlying watershed geology. Thus, there may be sources of contamination. These few instances of potential water quality problems warrant further study because Stony Brook is a high quality watercourse and provides an important fishery resource. It should be carefully protected and maintained through appropriate watershed management and careful land-use planning.

3. It is critical that management efforts extend beyond the banks and flowing water of Stony Brook. Upstream land uses can have significant hydrologic impacts such as increases or decreases in runoff volumes and peak discharge rates as well as nonpoint source pollution. Based on our field observations, Stony Brook does experience low-flow impairments, and it is important to maintain recharge capabilities within its watershed. Wetland filling that reduces the detention/retention capability in the watershed can increase water surface elevations at upstream properties and increase erosion downstream as water velocities increase in direct response to the loss in conveyance area. Loss of riparian buffers and/or wetlands can impact habitat quality and also increase water temperatures as shade-providing vegetation is removed as was observed south of I-95.

4. This study provides important mapping and analysis tools of critical environmental resources in the Stony Brook watershed. It provides a baseline of information from which good planning can follow. This is true for individual sites and projects as well as for broad-scale planning at the municipal, regional, or statewide level. It is difficult for planning boards, regulatory commissions, and local officials to fully evaluate the merit and/or potential impact of an action when it is out of context of the broader environment in which it is to take place.

5. MMI identified three critical wetland systems (CWS) within the Stony Brook watershed. These wetland systems include forested, scrub-shrub, and emergent wetlands, which provide important functions including preservation of biodiversity, flood flow alteration, and water quality protection and renovation. The critical resource areas within the Stony Brook watershed are presented in Table 7-1 and described further in Section 5.8.1.

TABLE 7-1
Critical Wetland Systems

Critical Wetland System	*Watershed ID*	*Size (acres)*	*Wetland I.D.*	*Dominant Wetland Cover Types*	*Important Functions*
CWS-1	SB-70 SB-90	40.2	SB-70-1 SB-90-4 SB-90-5	PFO and PSS	Biodiversity Nutrient retention Flood flow alteration Production export Fishery habitat
CWS-2	SB-70	64.3	SB-70-2 SB-70-3 SB-70-5	PFO, PSS, PEM	Biodiversity Flood flow alteration Nutrient retention
CWS-3	SB-30	5.0	SB-40-1	PFO, PSS, POW	Biodiversity Pollutant renovation

PFO = Palustrine Forested Wetlands
PSS = Palustrine Scrub-shrub Wetlands
PEM = Palustrine Emergent Marsh
POW = Palustrine Open Water

6. The Stony Brook watershed includes several large tracts of land that have been classified in this report as unfragmented natural areas. Each area is described in Section 5.8.2. Unfragmented natural areas are a critical component in the conservation of biodiversity on a local and regional scale, and they provide and protect essential water supplies. Virtually the entire Stony Brook watershed north of I-95 can be viewed as an unfragmented area of high resource value. Only narrow strips of development exist; and these are, for the most part, closely confined to Cross Road and the access road north of the highway.

   Similarly, the lands south of I-95 and north of the Post Road are largely undeveloped. As viewed here, the "natural" state of the fallow farm fields, farm ponds, and wooded hedgerows adds diversity to the landscape and provides opportunities for wildlife not found in the forested sections of the watershed. Additionally, they offer easier access and vantage points for public enjoyment.

   On a smaller scale, valuable undeveloped lands occur south of the Post Road. These include the high resource value wetlands near Oswegatchie School and beyond Fulmore Drive. The undeveloped woodlands that border these two wetland systems greatly increase the overall resource value, although on a more local scale than areas to the north.

7. Vernal pool obligate species such as spotted salamanders and wood frogs were found within numerous wetlands in the Stony Brook watershed. Based on the field investigations, there is a higher concentrations of breeding habitat north of I-95. This is most likely attributed to the fact that the wetland and upland habitats north of the interstate have remained natural and unfragmented. South of I-95, the occurrence of amphibian breeding habitat lessens due to the overall change in land use which is predominantly agricultural, residential, and commercial.

8. Effective watershed management within the Stony Brook watershed involves a multifaceted approach that encompasses land uses (past, present, and future); stream and wetland buffers; responsible development through adequate site selection, design, and maintenance; stormwater best management practices; control of nonstormwater discharges; and control of destructive and unnatural erosion and sedimentation.

9. Unchecked or unregulated development within a watershed like Stony Brook can have profound negative impacts on the surrounding environment in the form of changes to stream flow, flooding, erosion and sedimentation, and deteriorated water quality in streams, ponds, and wetlands. Many communities have attempted to address these issues through local zoning or subdivision regulations that prohibit increases in peak stormwater runoff rates. However, regulation is only one aspect of the zero-extra runoff concept. Of equal importance is consideration of the individual watershed(s) in which stormwater detention is proposed. Depending on the specific hydrology, detention could actually be detrimental to the watershed and even exacerbate downstream flooding impacts.

10. In low impact development, land development design practices for stormwater management make use of creative site planning and design tools that are intended to

preserve or reduce the changes to a site's hydrology, rather than simply providing "end of pipe" treatment or highly engineered management systems. Low impact development techniques and practices are intended to preserve natural systems and protect resources and their buffer areas through design of drainage systems that mimic natural systems. The selection of specific BMPs varies from site to site. Some applications, such as infiltration systems, may not be appropriate for all land uses or all sites.

7.2 Summary of Recommendations

1. Based upon field investigations of Stony Brook, the watercourse is susceptible to low flow impairment and should be managed to increase infiltration. Fortunately, the main stem (and much of the watershed below I-95) has a significant extent of stratified drift deposits along the watercourse, so that infiltration and recharge of the aquifers would be relatively easy. The Town may wish to require an assessment by developers of the feasibility of incorporating infiltration and recharge into the design of new development in areas underlain by stratified drift.

2. Any future regulations that control the quantity and timing of stormwater runoff should be carefully crafted to account for the complex hydrologic and hydraulic processes occurring in this watershed. In watersheds with alluvial streams, a zero increase in peak flow does not preclude channel erosion. Sensitive streams are also stressed by increased stormwater volume and flow duration, even if peak flows are equalized. Accordingly, each of these components should be considered in the development and application of stormwater management regulations.

   In addition, the Town should implement the use of more stringent stormwater treatment measures within this watershed. This can be accomplished through the Zoning Regulations by mandating that all proposed development within this watershed follow the guidelines set forth in the CTDEP 2004 Stormwater Quality Manual. For example, all proposed large-scale development within this watershed should be required to demonstrate a minimum 80% removal efficiency of suspended solids from stormwater before it is discharged into riparian uplands or into a wetland and/or watercourse.

3. The inventory, mapping, and habitat analysis conducted under this Watershed Management Plan should be utilized by the Town and its regulatory boards as an active reference tool in reviewing applications, to provide the basis for comparison in the review of the applicability and adequacy of current zoning designations, and to distinguish a hierarchy of protection for natural resources based on their function and value in their respective ecological communities.

4. This plan supports the Town's existing 100-foot upland review area along all wetlands and watercourses that have not been identified as having vernal pools and/or other amphibian breeding habitat. For wetland areas designated as having vernal pools and/or other amphibian breeding habitat, a 150-foot upland review area is recommended from the edge of the pool and/or breeding habitat.

   Maintenance of a upland vegetated buffer area between proposed development and the edge of a wetland is recommended to protect the diversity of the wetland plant communities, the integrity of instream habitats and channel characteristics, and to preserve water quality features including turbidity, dissolved oxygen, and temperature. Suggested buffer widths range between 50 and 100 feet based upon the quality of the wetland resource, the functions and values the resource provides, water quality and vulnerability to land use changes, fishery resources, critical wetland habitats, and the resource sensitivity to proposed development.

5. Guidance and suggestions are included in this plan for the promotion of LID in the Stony Brook watershed. The type and scope of LID techniques used may vary from subwatershed to subwatershed and site to site depending, not only on the proposed land use, but on the geology and topography of the site. Other factors such as depth

to water and bedrock and the presence of highly pervious soil layers are also considerations when evaluating LID application.

6. The Town may wish to consider a program to protect its unfragmented natural areas within the Stony Brook watershed through land acquisition, where possible, and through its land use planning processes. There are many benefits to maintaining unfragmented natural areas. Healthy, ecologically diverse systems that are unfragmented perform important natural, abiotic processes such as decomposition of organic matter, soil and sediment creation, filtration of ground and surface water, air cleansing, pollutant renovation, and nutrient retention. In addition, these unfragmented lands provide educational and recreational opportunities to the public such as bird watching, hiking, skiing, hunting, and fishing.

7. The Town should perform a full stream walk of tributaries T2 and T3 to visually identify the source or sources of discolored water. Perform additional chemical tests as needed to determine a suitable course of corrective action. Conduct additional stream sampling of metals, especially copper and lead, at select locations to determine the accuracy of earlier studies. The sampling should include an upstream-downstream comparison of copper concentrations in subwatershed SB-70 where an underground copper wire antennae at the old WNLC property is said to exist. A macroinvertebrate biomonitoring study should be conducted to support the continued water quality investigation. These organisms are sensitive to water quality parameters and changes, and they typically live in the stream for at least three years as larvae and thus serve as a long-term monitoring tool.

3104-01-1-s2209-1-rpt.doc

References

Calhoun, Aram J. K., Klemens, Michael W. 2002. *Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States*.

Cowardin, L.M., Carter, F.C., Golet, E.T., LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. US Government Printing Office. Washington D.C. GPO 024-010-00524-6. 103 pp.

The Connecticut Council on Soil and Water Conservation *Connecticut Guidelines for Soil Erosion and Sediment Control – 2002.*

CTDEP, 2002. Connecticut Water Quality Standards. Connecticut Department of Environmental Protection, Hartford, CT.

Dowhan, J.J. and Craig, R.J. 1976. Rare and Endangered Species of Connecticut and Their Habitats. State Geological and Natural History Survey of Connecticut. Report of Investigations No. 6.

Golet & Larson. 1974. Classification of Freshwater Wetlands in the Glaciated Northeast. Bureau of Sports Fisheries & Wildlife. F&W Service , US Dept. of Interior. Resource Publication 116.

State of Connecticut, Department of Environmental Protection Water Compliance Unit. 1987. Water Quality Classifications Map of Connecticut.

State of Connecticut, Department of Environmental Protection. 2007. Connecticut's Endangered, Threatened and Special Concern Species.

State of Connecticut, Department of Transportation's *Standard Specifications for Roads, Bridges and Incidental Construction* (Form 816), specifically Section 1.10 Environmental Compliance and "Best Management Practices."

USDA Natural Resources Conservation Service. 2006. Soil Potential Ratings Subsurface Sewage Disposal Systems for Single Family Residences.

USEPA, 2000. Nutrient Criteria Technical Guidance Manual Rivers and Streams. EPA-822-B-00-002. United States Environmental Protection Agency, Office of Science and Technology, Washington, DC.

US Army Corps of Engineers. 1993. The Highway Methodology Workbook with Function and Values Supplement. NEDEP-360-1-30.

APPENDIX A

Time of Concentration Computation Worksheets

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Stoney Brook	By: EPB	Date: 08/06/07	
Location: Waterford,CT	Checked:	Date:	
Circle one: ***Present*** Developed	Watershed: WS 10 - Existing Conditions		
Circle one: ***Tc*** T_t	Subwatershed: WS 10 - Existing Conditions		

Sheet flow (applicable to T_c only)

	Unit	Segment ID A-B	
1. Surface description (Table 3-1)		FRST	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300	
3. Flow Length, L (< 300ft)	ft.	300.0	
4. Two-year 24-hr rainfall, P_2	in.	3.40	
5. Land slope, s	ft./ft.	0.037	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.521	= 0.521

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	B-C	C-D	D-E	E-F	
7. Surface description		GRSS	FRST	GRSS	IMP	
8. Manning's roughness coeff., n		0.080	0.100	0.080	0.010	
9. Paved or unpaved		UNPVD	UNPVD	UNPVD	PVD	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.40	0.40	0.20	
11. Flow Length, L	ft.	191.0	1626.0	523.0	567.0	
12. Watercourse slope, s	ft./ft.	0.0314	0.0431	0.0260	0.0705	
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	1.79	1.68	1.63	13.53	
14. $T_t = \frac{L}{3600 * V}$	hr.	0.030	+ 0.269	+ 0.089	+ 0.012	= 0.399

Channel flow

	Unit	F-G	G-H	H-I	I-J	
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.00	0.00	0.00	0.00	
19. Wetted perimeter, P_w	ft.	0.00	0.00	0.00	0.00	
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.00	0.00	0.00	0.00	
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	0.00	0.00	0.00	0.00	
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.	0.000	+ 0.000	+ 0.000	+ 0.000	= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.					0.921

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project:	Stoney Brook	By:	EPB	Date:	08/06/07
Location:	Waterford,CT	Checked:		Date:	
Circle one:	***Present*** Developed	Watershed:	WS 10 - Existing Conditions		
Circle one:	***Tc*** T_t	Subwatershed:	WS 20 - Existing Conditions		

Sheet flow (applicable to T_c only)

		Segment ID	A-B	
1.	Surface description (Table 3-1)		FRST	
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300	
3.	Flow Length, L (< 300ft)	ft.	300.0	
4.	Two-year 24-hr rainfall, P_2	in.	3.40	
5.	Land slope, s	ft./ft.	0.040	
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.503	= 0.503

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C	C-D			
7.	Surface description		GRSS	FRST			
8.	Manning's roughness coeff., n		0.080	0.100			
9.	Paved or unpaved		UNPVD	UNPVD			
10.	Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.40			
11.	Flow Length, L	ft.	479.0	1306.0			
12.	Watercourse slope, s	ft./ft.	0.0543	0.0337			
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	2.36	1.48			
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.056	+ 0.244	+	+	= 0.301

Channel flow

		Segment ID	D-E	E-F	F-G	G-H	
15.	Channel Bottom width, b	ft.	3.00	4.00	5	3	
16.	Horizontal side slope component, z (z horiz:1 vert)	ft.	2.00	0.40	0.5	0.1	
17.	Depth of flow, d	ft.	0.10	0.30	0.4	0.4	
18.	Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.32	1.24	2.08	1.22	
19.	Wetted perimeter, P_w	ft.	3.45	4.65	5.89	3.80	
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.09	0.27	0.35	0.32	
21.	Channel slope, s	ft./ft.	0.0268	0.0214	0.0178	0.0100	
22.	Manning's roughness coeff., n		0.040	0.040	0.040	0.010	
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	1.25	2.26	2.48	6.97	
24.	Flow length, L	ft.	559.0	1307	675	51	
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.124	+ 0.161	+ 0.076	+ 0.002	= 0.363
26.	Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.					1.167

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Stoney Brook — By: EPB — Date: 08/06/07
Location: Waterford,CT — Checked: — Date:
Circle one: ***Present*** Developed — Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** T_t — Subwatershed: WS 10 - Existing Conditions

Sheet flow (applicable to T_c only)

	Unit			
Segment ID		**A-B**		
1. Surface description (Table 3-1)		FRST		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300		
3. Flow Length, L (< 300ft)	ft.	300.0		
4. Two-year 24-hr rainfall, P_2	in.	3.40		
5. Land slope, s	ft./ft.	0.007		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	1.011	=	1.011

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit									
Segment ID		**B-C**		**C-D**		**D-E**				
7. Surface description		FRST								
8. Manning's roughness coeff., n		0.100								
9. Paved or unpaved		UNPVD								
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40								
11. Flow Length, L	ft.	1015.0								
12. Watercourse slope, s	ft./ft.	0.0230								
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	1.23								
14. $T_t = \frac{L}{3600 * V}$	hr.	0.230	+		+		+		=	0.230

Channel flow

	Unit									
Segment ID		**E-F**		**F-G**		**G-H**				
15. Channel Bottom width, b	ft.	2.00		50.00		3				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	1.00		0.05		0.05				
17. Depth of flow, d	ft.	0.20		5.00		0.4				
18. Cross sectional flow area, A (assume trapazoidal)	ft.^{2}	0.44		251.25		1.21				
19. Wetted perimeter, P_w	ft.	2.57		60.01		3.80				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.17		4.19		0.32				
21. Channel slope, s	ft./ft.	0.0079		0.0100		0.0257				
22. Manning's roughness coeff., n		0.040		0.030		0.040				
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	1.02		12.90		2.78				
24. Flow length, L	ft.	380.0		211		974				
25. $T_t = \frac{L}{3600 * V}$	hr.	0.103	+	0.005	+	0.097	+		=	0.205
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.									1.446

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project:	Stoney Brook	By:	EPB	Date:	08/06/07
Location:	Waterford,CT	Checked:		Date:	
Circle one:	***Present*** Developed	Watershed:	WS 10 - Existing Conditions		
Circle one:	***Tc*** T_t	Subwatershed:	WS 20 - Existing Conditions		

Sheet flow (applicable to T_c only)

	Unit		
Segment ID		**A-B**	
1. Surface description (Table 3-1)		FRST	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300	
3. Flow Length, L (< 300ft)	ft.	300.0	
4. Two-year 24-hr rainfall, P_2	in.	3.40	
5. Land slope, s	ft./ft.	0.017	
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.715	= 0.715

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit					
Segment ID		**B-C**	**C-D**	**D-E**	**E-F**	
7. Surface description		FRST	FRST	FRST	FRST	
8. Manning's roughness coeff., n		0.100	0.100	0.100	0.100	
9. Paved or unpaved		UNPVD	UNPVD	UNPVD	UNPVD	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.40	0.40	0.40	
11. Flow Length, L	ft.	85.0	472.0	205.0	410.0	
12. Watercourse slope, s	ft./ft.	0.0353	0.0254	0.1073	0.0244	
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	1.52	1.29	2.65	1.26	
14. $T_t = \frac{L}{3600 * V}$	hr.	0.016	+ 0.102	+ 0.021	+ 0.090	= 0.229

Channel flow

	Unit					
Segment ID		**F-G**	**G-H**	**H-I**		
15. Channel Bottom width, b	ft.	2.00	3.00	5		
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	0.50	1.00	2		
17. Depth of flow, d	ft.	0.20	0.30	0.5		
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.42	0.99	3.00		
19. Wetted perimeter, P_w	ft.	2.45	3.85	7.24		
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.17	0.26	0.41		
21. Channel slope, s	ft./ft.	0.0166	0.0123	0.0066		
22. Manning's roughness coeff., n		0.040	0.040	0.040		
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	1.48	1.67	1.68		
24. Flow length, L	ft.	1328.0	1304	1214		
25. $T_t = \frac{L}{3600 * V}$	hr.	0.249	+ 0.217	+ 0.201		= 0.667
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.					1.611

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Stoney Brook — By: EPB — Date: 08/06/07
Location: Waterford,CT — Checked: — Date:
Circle one: ***Present*** Developed — Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** T_t — Subwatershed: WS 20 - Existing Conditions

Sheet flow (applicable to T_c only)

	Unit					
Segment ID		**A-B**				
1. Surface description (Table 3-1)		FRST				
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300				
3. Flow Length, L (< 300ft)	ft.	300.0				
4. Two-year 24-hr rainfall, P_2	in.	3.40				
5. Land slope, s	ft./ft.	0.007				
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	1.031				= 1.031

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit					
Segment ID		**B-C**	**C-D**	**D-E**		
7. Surface description		FRST	FRST	FRST		
8. Manning's roughness coeff., n		0.100	0.100	0.100		
9. Paved or unpaved		UNPVD	UNPVD	UNPVD		
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.40	0.40		
11. Flow Length, L	ft.	211.0	1306.0	356.0		
12. Watercourse slope, s	ft./ft.	0.0474	0.0540	0.0506		
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	1.76	1.88	1.82		
14. $T_t = \frac{L}{3600 * V}$	hr.	0.033 +	0.193 +	0.054 +		= 0.281

Channel flow

	Unit					
Segment ID		**E-F**				
15. Channel Bottom width, b	ft.	2.00				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	0.50				
17. Depth of flow, d	ft.	0.30				
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.65				
19. Wetted perimeter, P_w	ft.	2.67				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.24				
21. Channel slope, s	ft./ft.	0.0268				
22. Manning's roughness coeff., n		0.040				
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	2.36				
24. Flow length, L	ft.	2836.0				
25. $T_t = \frac{L}{3600 * V}$	hr.	0.333 +	+	+		= 0.333
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.					1.645

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project:	Stoney Brook	By:	EPB	Date:	08/06/07
Location:	Waterford,CT	Checked:		Date:	
Circle one:	***Present*** Developed	Watershed:	WS 10 - Existing Conditions		
Circle one:	***Tc*** T_t	Subwatershed:	WS 20 - Existing Conditions		

Sheet flow (applicable to T_c only)

	Unit			
Segment ID		**A-B**		
1. Surface description (Table 3-1)		FRST		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300		
3. Flow Length, L (< 300ft)	ft.	300.0		
4. Two-year 24-hr rainfall, P_2	in.	3.40		
5. Land slope, s	ft./ft.	0.017		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.715	=	0.715

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit									
Segment ID		**B-C**		**C-D**		**D-E**				
7. Surface description		FRST		FRST		FRST				
8. Manning's roughness coeff., n		0.100		0.100		0.100				
9. Paved or unpaved		UNPVD		UNPVD		UNPVD				
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40		0.40		0.40				
11. Flow Length, L	ft.	1853.0		1306.0		356.0				
12. Watercourse slope, s	ft./ft.	0.0543		0.0540		0.0506				
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	1.88		1.88		1.82				
14. $T_t = \frac{L}{3600 * V}$	hr.	0.273	+	0.193	+	0.054	+		=	0.521

Channel flow

	Unit									
Segment ID		**E-F**		**F-G**						
15. Channel Bottom width, b	ft.	2.00		4.00						
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	0.50		0.40						
17. Depth of flow, d	ft.	0.20		0.30						
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.42		1.24						
19. Wetted perimeter, P_w	ft.	2.45		4.65						
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.17		0.27						
21. Channel slope, s	ft./ft.	0.0078		0.0214						
22. Manning's roughness coeff., n		0.040		0.040						
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	1.01		2.26						
24. Flow length, L	ft.	772.0		704						
25. $T_t = \frac{L}{3600 * V}$	hr.	0.211	+	0.087	+		+		=	0.298
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.									1.533

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Stoney Brook — By: EPB — Date: 08/06/07
Location: Waterford,CT — Checked: — Date:
Circle one: ***Present*** Developed — Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** T_t — Subwatershed: WS 20 - Existing Conditions

Sheet flow (applicable to T_c only)

		Segment ID	A-B		
1.	Surface description (Table 3-1)		FRST		
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300		
3.	Flow Length, L (< 300ft)	ft.	300.0		
4.	Two-year 24-hr rainfall, P_2	in.	3.40		
5.	Land slope, s	ft./ft.	0.007		
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	1.031	=	1.031

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C								
7.	Surface description		FRST								
8.	Manning's roughness coeff., n		0.100								
9.	Paved or unpaved		UNPVD								
10.	Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40								
11.	Flow Length, L	ft.	152.0								
12.	Watercourse slope, s	ft./ft.	0.0132								
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.93								
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.046	+		+		+		=	0.046

Channel flow

		Segment ID	C-D		D-E		E-F				
15.	Channel Bottom width, b	ft.	2.00		3.00		3.00				
16.	Horizontal side slope component, z (z horiz:1 vert)	ft.	0.50		0.40		0.40				
17.	Depth of flow, d	ft.	0.20		0.30		0.30				
18.	Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.42		0.94		0.94				
19.	Wetted perimeter, P_w	ft.	2.45		3.65		3.65				
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.17		0.26		0.26				
21.	Channel slope, s	ft./ft.	0.0041		0.0023		0.0190				
22.	Manning's roughness coeff., n		0.040		0.040		0.040				
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	0.74		0.73		2.08				
24.	Flow length, L	ft.	1935.0		856		1209				
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.727	+	0.327	+	0.162	+		=	1.215
26.	Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.									2.292

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Stoney Brook — By: EPB — Date: 08/06/07

Location: Waterford,CT — Checked: — Date:

Circle one: **Present** Developed — Watershed: WS 10 - Existing Conditions

Circle one: **Tc** T_t — Subwatershed: WS 20 - Existing Conditions

Sheet flow (applicable to T_c only)

		Segment ID	A-B	
1.	Surface description (Table 3-1)		FRST	
2.	Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300	
3.	Flow Length, L (< 300ft)	ft.	300.0	
4.	Two-year 24-hr rainfall, P_2	in.	3.40	
5.	Land slope, s	ft./ft.	0.047	
6.	$T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.473	= 0.473

Shallow concentrated flow (assume hyd. radius = depth of flow)

		Segment ID	B-C				
7.	Surface description		FRST				
8.	Manning's roughness coeff., n		0.100				
9.	Paved or unpaved		UNPVD				
10.	Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40				
11.	Flow Length, L	ft.	1742.0				
12.	Watercourse slope, s	ft./ft.	0.0436				
13.	Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	1.69				
14.	$T_t = \frac{L}{3600 * V}$	hr.	0.286	+	+	+	= 0.286

Channel flow

		Segment ID	C-D	D-E			
15.	Channel Bottom width, b	ft.	2.00	7.00			
16.	Horizontal side slope component, z (z horiz:1 vert)	ft.	0.50	1.00			
17.	Depth of flow, d	ft.	0.20	0.50			
18.	Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.42	3.75			
19.	Wetted perimeter, P_w	ft.	2.45	8.41			
20.	Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.17	0.45			
21.	Channel slope, s	ft./ft.	0.0588	0.2400			
22.	Manning's roughness coeff., n		0.040	0.040			
23.	$V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	2.79	10.65			
24.	Flow length, L	ft.	918.0	100			
25.	$T_t = \frac{L}{3600 * V}$	hr.	0.091	+ 0.003	+	+	= 0.094

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 0.854

Worksheet 3: Time of Concentration (T_c) or Travel Time (T_t)

Project: Stoney Brook | By: EPB | Date: 08/06/07
Location: Waterford,CT | Checked: | Date:
Circle one: ***Present*** Developed | Watershed: WS 10 - Existing Conditions
Circle one: ***Tc*** T_t | Subwatershed: WS 20 - Existing Conditions

Sheet flow (applicable to T_c only)

	Unit	Segment ID A-B		Total
1. Surface description (Table 3-1)		FRST		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.300		
3. Flow Length, L (< 300ft)	ft.	300.0		
4. Two-year 24-hr rainfall, P_2	in.	3.40		
5. Land slope, s	ft./ft.	0.013		
6. $T_t = \frac{0.007(nL)^{0.8}}{P_2^{0.5}(s^{0.4})}$	hr.	0.781	=	0.781

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Unit	Segment ID B-C								Total
7. Surface description		FRST								
8. Manning's roughness coeff., n		0.100								
9. Paved or unpaved		UNPVD								
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40								
11. Flow Length, L	ft.	811.0								
12. Watercourse slope, s	ft./ft.	0.0074								
13. Average velocity, $V = \frac{1.49}{n}(d^{2/3})(s^{1/2})$	fps.	0.70								
14. $T_t = \frac{L}{3600 * V}$	hr.	0.324	+		+		+		=	0.324

Channel flow

	Unit	C-D		D-E		E-F				Total
15. Channel Bottom width, b	ft.	2.00		7.00		7.00				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	0.50		1.00		1.00				
17. Depth of flow, d	ft.	0.20		0.50		0.50				
18. Cross sectional flow area, A (assume trapazoidal)	$ft.^2$	0.42		3.75		3.75				
19. Wetted perimeter, P_w	ft.	2.45		8.41		8.41				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.17		0.45		0.45				
21. Channel slope, s	ft./ft.	0.0055		0.0046		0.0190				
22. Manning's roughness coeff., n		0.040		0.040		0.040				
23. $V = \frac{1.49}{n}(R^{2/3})(s^{1/2})$	fps.	0.85		1.48		3.00				
24. Flow length, L	ft.	725.0		3906		1209				
25. $T_t = \frac{L}{3600 * V}$	hr.	0.236	+	0.735	+	0.112	+		=	1.083

26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25) hr. 2.188

APPENDIX B

Stony Brook Water Quality Data

ok, Waterford Connecticut		
07 Observed by: JSC, RKS		
0 F, Light Breeze		
	Stream name	Site description
	Stony Brook mainstem	~100 m downstream from approximate source location
	Stony Brook mainstem	~20 m upstream from the rock wall and dirt road crossing
	Stony Brook mainstem	~80 m upstream from confluence of tributary T2/T3, which is ~270 m upstream from I-95 culvert
	Tributary T2	upstream of dirt road at the end of Foster Road
	Tributary T2/T3	eastern tributary ~100 m upstream from the confluence with mainstem, which is ~250 m upstream from the I-95 culvert
	Stony Brook mainstem	typical section ~130 m upstream of I-95 culvert
	Stony Brook mainstem	~20 m upstream of I-95 culvert
	Stony Brook mainstem	~140 m downstream of I-95 culvert next to farm field
	Stony Brook mainstem	upstream of confluence with tributary T4 from east
	Tributary T4	eastern tributary from mid-watershed farming areas ~60 m upstream from the confluence with mainstem
	Tributary T6 headwaters	wetland downstream of car dump
	Tributary T6	~270 m upstream of driveway
	Tributary T6	~10 m upstream of driveway culvert
	Tributary T7/T8	~5 m upstream of driveway culvert
-1	Tributary T6/T7/T8	~50 m from confluence with mainstem
	Stony Brook mainstem	~30 m downstream of confluence with tributary T6/T7/T8, which is ~160 m upstream of US Route 1
	Stony Brook mainstem	~30 m upstream of US Route 1 Bridge and breached dam
	Stony Brook mainstem	~50 m downstream of US Route 1 Bridge
	Stony Brook mainstem	~5 m upstream of Oswegatchie Road Bridge
	Stony Brook mainstem	~10 m downstream of Oswegatchie Road Bridge

	Temperature (deg C)	Disolved Oxygen (%)	Disolved Oxygen (mg/L)	Specific Conductance (microS)	Turbidity 1	Turbidity 2	Turbidity 3	Turbidity Average	Salinity (ppt)	Water Depth (cm)	Bankfull Depth (cm)	Bankfull Width (m)	Stream Type
	13.1	69	6.9	51.6	2.5	2.7	2	2.4		10			
	13.9	74	7.5	45.9	0.75	0.9	0.7	0.8		10	25	5.0	High Gradient
	14.8	96	9.7	39.9	0.68	0.71	0.7	0.7			50	7.0	High Gradient
1	16.3	22	2.0	68.8	2.5	2.8	3.2	2.8					
-1	15.4	79	7.9	139.1	1.3	1.28	1.32	1.3			55	4.5	High Gradient
	15.0	93	9.4	110.1	1	0.9	0.9	0.9			60	14.5	High Gradient
	15.0	70	7.0	114.4	1.3	1	1.1	1.1			76	10.0	
5	15.1	95	9.6	116.6	1.06	1.13	1.14	1.1			70	4.0	High Gradient
7	15.6	100	9.9	116.6	1	1	1	1.0					Low Graidient
1	15.8	77	7.6	123.4	2.9	2.9	2.3	2.7					
	15.0	6	0.5	122.6	50	50	55	51.7					
	14.7	102	10.2	119.7	0.8	0.6	0.75	0.7			34	4.9	Low Gradient
2	15.0	98	9.8	119.5	1.1	0.85	0.85	0.9					
-1	15.3	95	9.4	111.7	4.1	4.2	4	4.1					
T8-1	15.2	75	7.3	110.7	3.34	3.54	3.06	3.3					
	15.6	95	9.5	115.1	1.72	1.65	1.63	1.7			76	6.7	Low Gradient
	15.9	96	9.6	114.4	1.29	1.27	1.32	1.3					
0	14.7	18	1.8	270	15	13	13	13.7	0.1				
1	16.5	96	9.0	5000	2	1.9	1.9	1.9	2.8				
2	17.1	98	9.3	3566	2.2	2.3	2.8	2.4	1.9				

	RHA 1 Epifaunal Substrate/ Cover	RHA 2 Embeddedness / Pool Substrate	RHA 3 V/ D Regime / Pool Variability	RHA 4 Sediment Deposition	RHA 5 Channel Flow Status	RHA 6 Channel Alteration	RHA 7 Freq. Riffles / Channel Sinuosity	RHA 8 Bank Stability Left Bank	RHA 8 Bank Stability Right Bank	RHA 9 Vegetative Protection Right Bank	RHA 9 Vegetative Protection Left Bank	RHA 10 Riparian Zone Right Bank	RHA 10 Riparian Zone Left Bank	Total RHA Score out of 200	RHA (%)
	20	14	18	18	18	16	13	10	10	10	10	10	10	177	8
	20	19	18	20	19	20	19	10	10	10	10	10	10	195	9
1	19	19	16	17	19	15	17	10	10	10	10	10	10	182	9
	20	18	18	20	20	19	18	10	10	9	9	10	10	191	9
	10	9	11	13	18	13	15	10	10	5	10	3	5	132	6
	16	14	14	14	19	20	16	9	9	10	10	10	10	171	8
	15	11	10	15	18	20	18	9	9	10	10	10	10	165	8
1															
3-1															
	15	13	13	13	20	20	14	8	8	8	8	10	10	160	8

APPENDIX C

Wetland System Photographs

Stony Brook Watershed Management Plan
Wetlands Photo Log

SB-90 Headwater Wetland North of Power-line

SB-90 Headwater Wetland and Vernal Pool

SB-80 Western Tributary & Forested Wetland

SB-80 Stony Brook Main Stem above I-95

SB-70 Fill pile near headwater wetland

SB-70 Palustrine Forested Wetland Systems

SB-70 Palustrine Scrub Shrub Wetland System

SB-70 Palustrine Scrub Shrub and Emergent Marsh at Radio Tower Parcel

SB-70 Palustrine Wet Meadow and Emergent Marsh at Radio Tower Parcel

SB-60 Forested Wetlands abutting Former Auto Salvage Area

SB-60 Tributary and Forested Wetland

SB-50 Stony Brook Main Stem through farm fields

SB-50 Stony Brook Main Stem through Forested Wetlands

SB-50 Palustrine Wet Meadows and Emergent Marshes

SB-50 Manmade Pond

SB-40 Scrub Shrub Wetland near Stony Brook Drive

SB-40 Intermittent Watercourse and Forested Wetlands

SB-40 Stony Brook Main Stem north of Route 1

SB-30 Manmade Pond off Shawandasee Road

SB-30 Palustrine Scrub Shrub Wetlands

SB-20 Forested Wetlands

SB-20 Tributary to Keeny Cove