STONY BROOK WATERSHED MANAGEMENT PLAN

MMI #3104-01-1

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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

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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

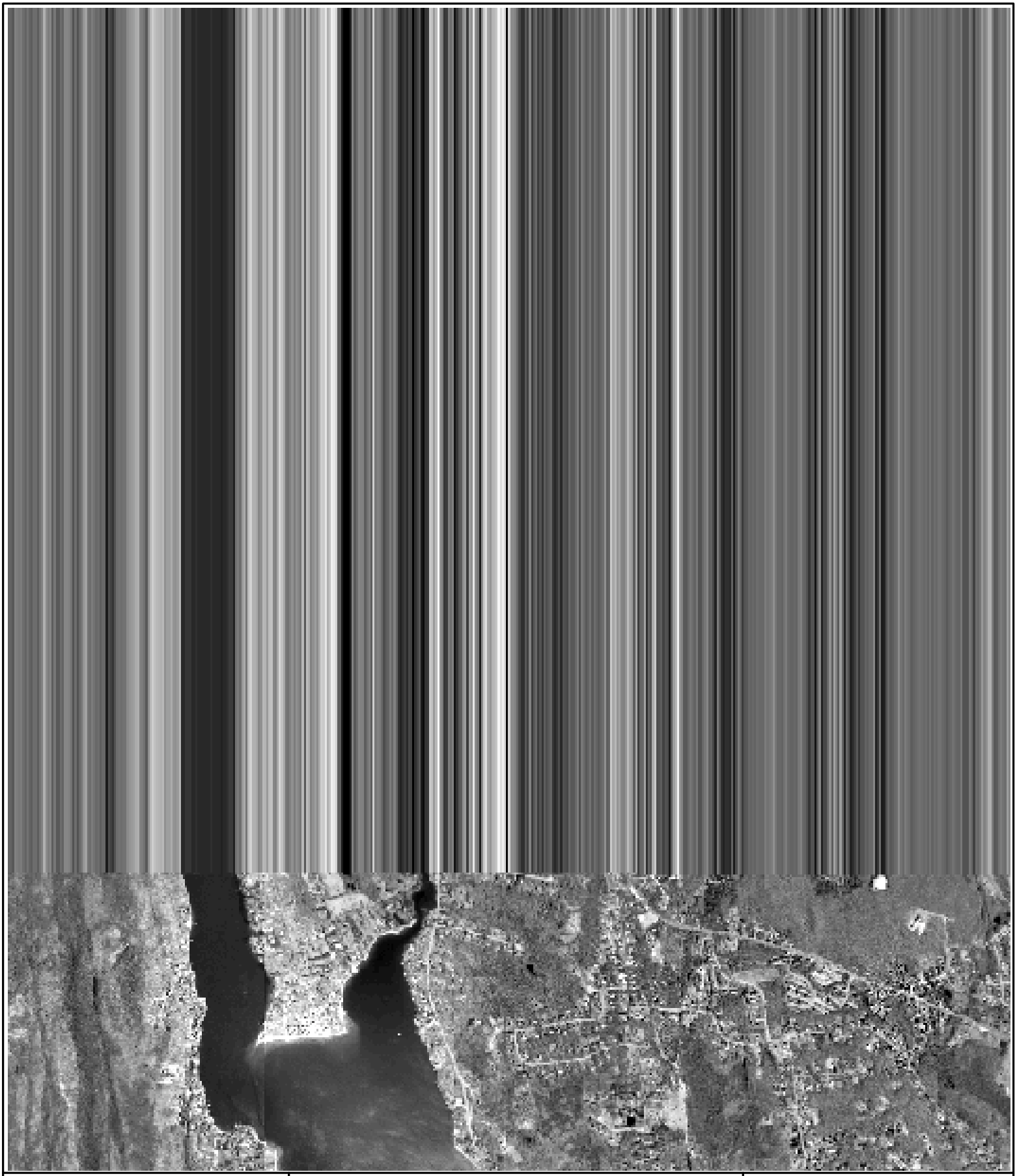
PFO = Palustrine Forested Wetlands; PSS = Palustrine Scrub-shrub Wetlands; PEM = Palustrine Emergent Marsh; POW = Palustrine Open Water

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



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SCALE:

SHEET:

→ 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

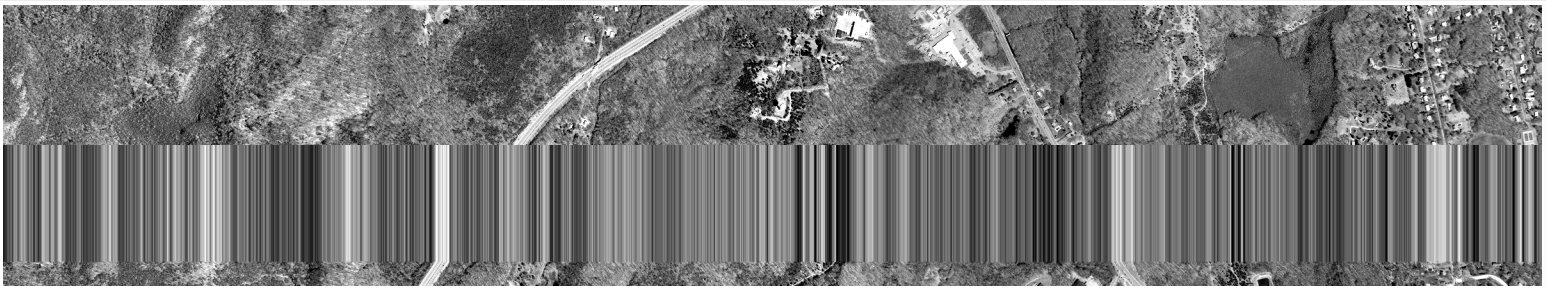
The Town of Waterford (the Town) has adopted a multifaceted approach to environmental planning in its community. The Town has retained Milone & MacBroom, Inc. (MMI) to conduct a comprehensive inventory and analysis of the water, wetland, and upland resources in the Stony Brook watershed and to evaluate 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



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- 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

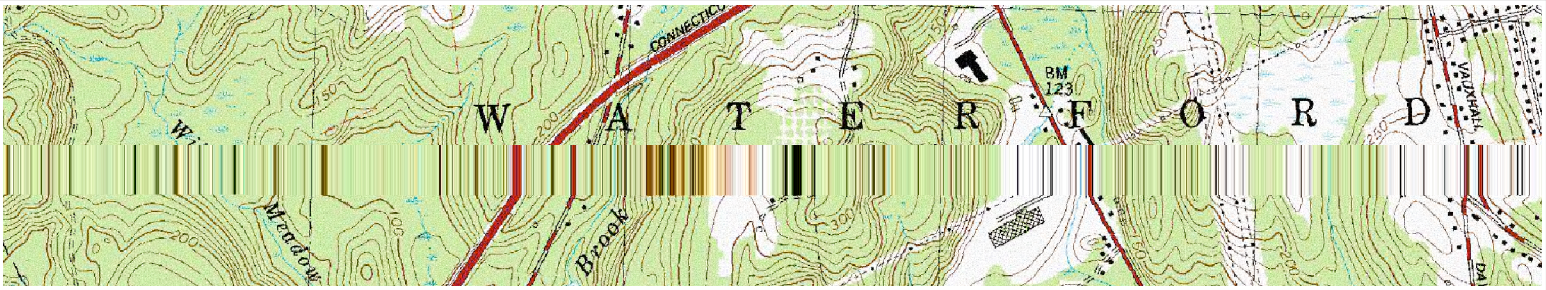
The Stony Brook watershed encompasses approximately 2.86 square miles (1,835 acres) and is located within the southwestern part of Waterford. The Stony Brook watershed is part of the Southeast Coast major basin and the Southeast Western Complex regional basin. The watershed is located within the Niantic 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.



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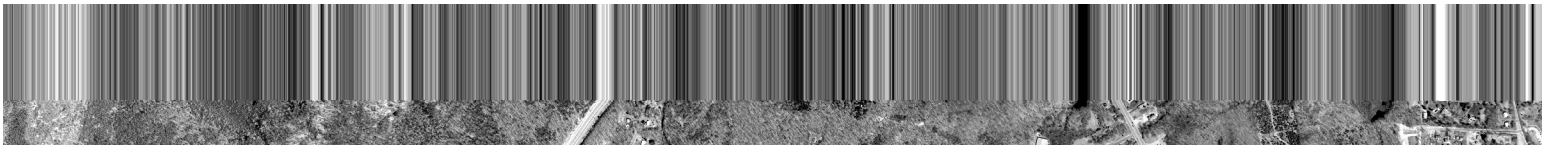

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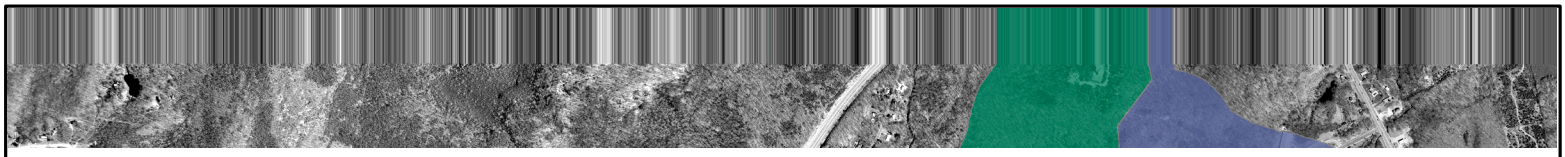

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Existing residential development occurs primarily south of Route 1 and along Cross Road. Geographically, land use and zoning within the watershed have been subdivided into the following sections: (1) parcels located north of I-95; (2) parcels located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

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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.

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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.

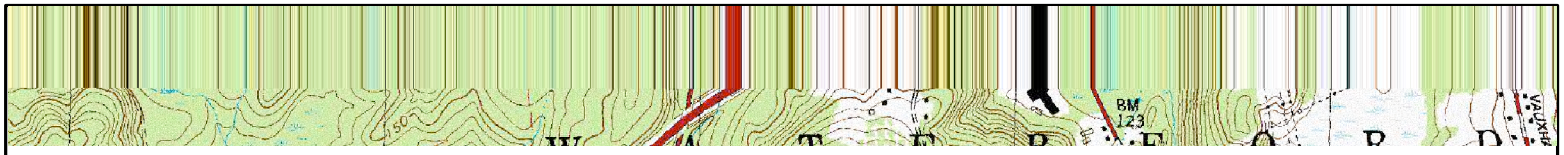
The southern portion of the watershed has a mix of residential properties and vacant parcels. Some large important wetland systems also exist within this part of the watershed. These systems provide valuable wildlife habitat to amphibians, birds, and reptiles. Keeny Cove, an important coastal resource, 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.



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3.0 WATERSHED HYDROLOGY AND HYDRAULICS

3.1 Subwatershed Delineation and Nomenclature

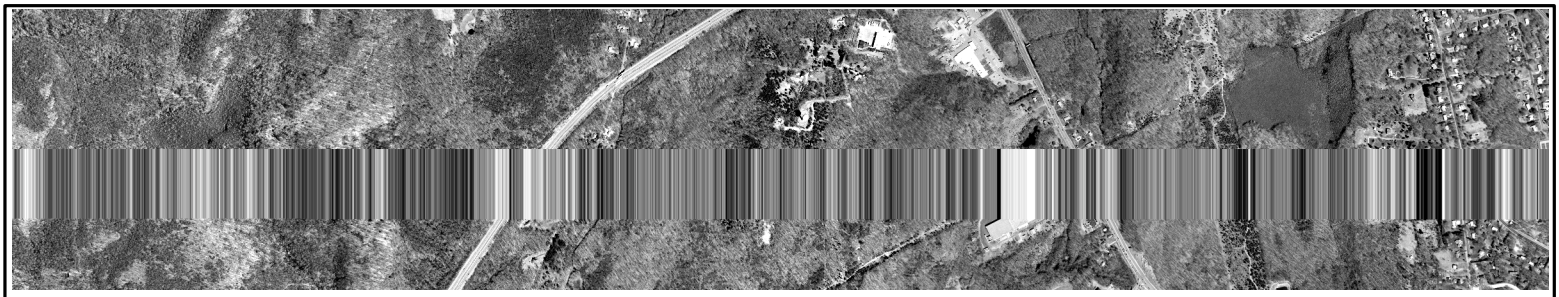
For the purposes of this analysis, the 2.86-square mile Stony Brook watershed was subdivided into nine subwatersheds, presented in Table 3-1 and depicted on Figure 3-1. Watersheds were numbered descending from north to south. This system is consistent with standard watershed hydrology modeling programs, 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.



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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.

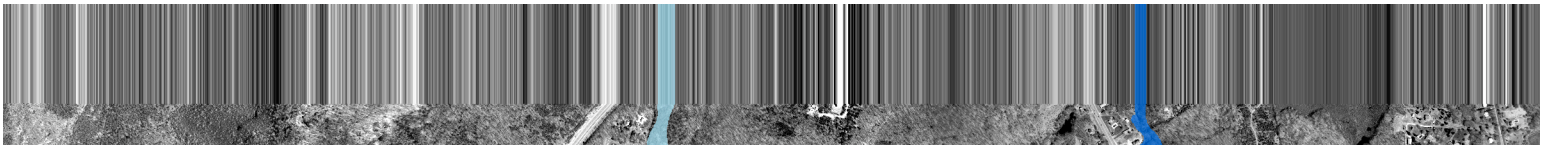

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TABLE 3-2
Peak Stream Flows in Pendleton Hill Brook and Stony Brook

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

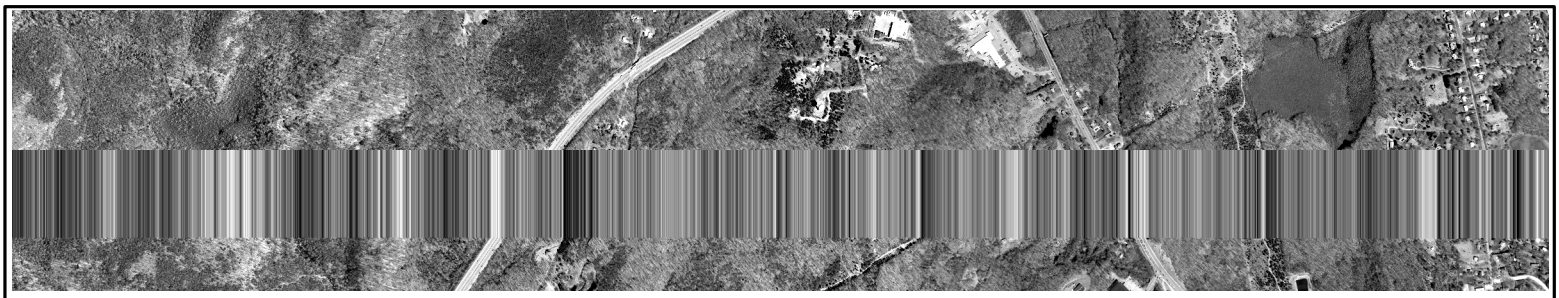
time period, while short time of concentration will result in more concentrated flows and a higher peak flow rate at the outlet.

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



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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
6-1	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
6-1	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°C	K_s = 45.9 µS
RHA = 89 %	Bankfull width = 5.0 m	DO = 74 % = 7.5 mg/l	Turbidity = 0.8 NTU

Stony Brook Main Stem Downstream of Dirt Road Crossing (SB-1A) – 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°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°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°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°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.

M-7 Stony Brook Main Stem Upstream of Confluence With Tributary T4 From East – 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

Tributary T4 - Eastern Tributary From Mid-Watershed Farming Areas ~ 60 Meters Upstream From the Confluence With Main Stem – 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

W-1 Tributary T7 Headwater Wetland Downstream of Auto Salvage Yard – 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°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°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°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°C	K_s = 270 µS
	DO = 18 % = 1.8 mg/l	Turbidity = 13.7 NTU

Tributary T10 - Western Tributary in Brook Street Neighborhood – 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.

M-11 Stony Brook Main Stem ~5 Meters Upstream of Oswegatchie Road Bridge – 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.

MILONE & MACBROOM

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.

MILONE & MACBROOM

LOCATION:

MMI#:

MXD:

SOURCE:

DATE:

SCALE:

SHEET: