Contract #12-05e

2016

Ekonk Brook Watershed-Based Plan

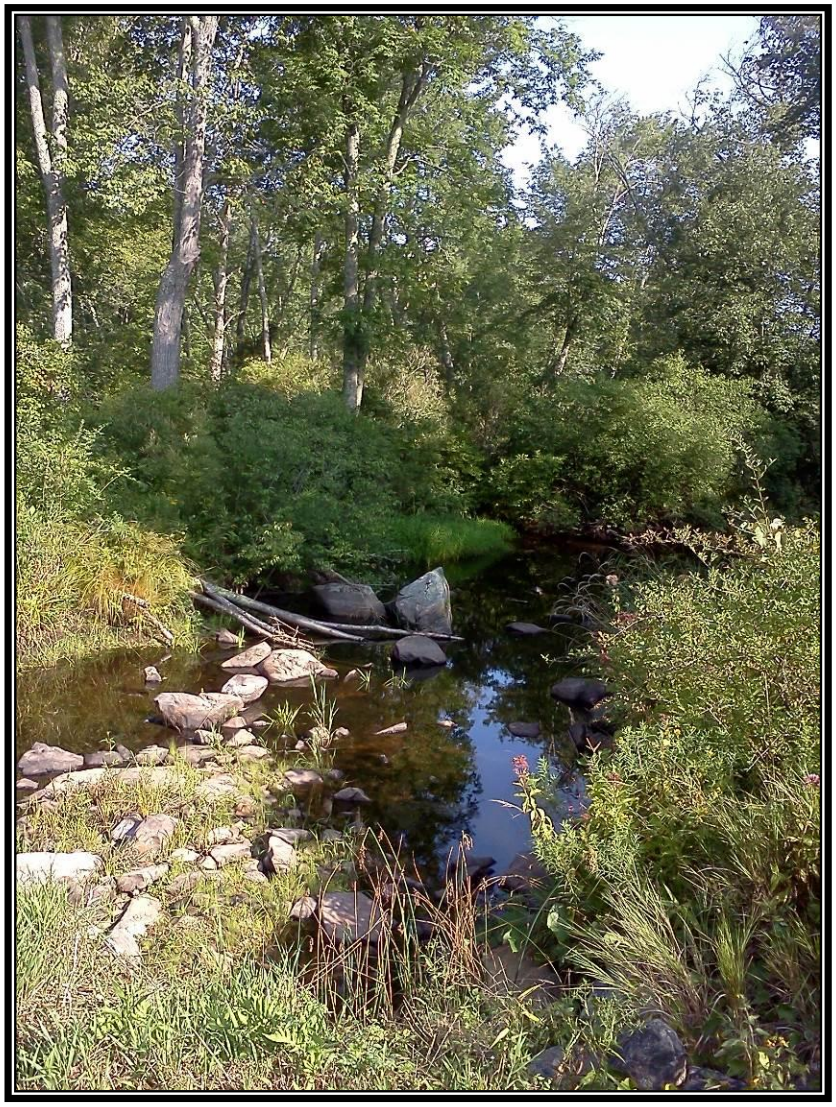


Photo by ECCD

This project is funded in part by CT DEEP through a US EPA Nonpoint Source grant under §319 of the Clean Water Act.

Eastern Connecticut Conservation District

www.ConserveCT.org/eastern

Prepared by the Eastern Connecticut Conservation District, Inc.

Cover Photo: Ekonk Brook upstream of the State Route 14 crossing (photo by ECCD 2013).

Table of Contents

Figures

Tables

Appendices

Acknowledgements

The preparation of a watershed based plan requires the efforts of multiple individuals who provide their time, knowledge and expertise. The Eastern Connecticut Conservation District would like to thank the following individuals whose assistance was invaluable to the preparation and development of this Plan:

Diane Angotta, South Windham, CT
Christopher Bellucci, CT DEEP, Bureau of Water Protection and Land Reuse
Raymond Covino, USDA Natural Resources Conservation Service
Steve DeMattei, US Environmental Protection Agency
Heather George, Town Clerk, Town of Sterling
Robert Groner, Norwich, CT
Neal Hagstrom, CT DEEP Inland Fisheries Division
Hermonot Family - Ekonk Hill Turkey Farm
Aristea Kinney, CT Department of Public Health
Dawn McKay, CT DEEP Wildlife Division
Gail Miller, Franklin, CT
Betsy Molodich, Betsy's Farm Stand
James Molodich, Molodich Farm, Inc.
Moosup Garden Apartments (A VestA Community)
Paul Shaffer, Norwich, CT
Lou Soja, Town of Plainfield Planning & Engineering Supervisor
Sterling Agriculture Commission
Paul Sweet, First Selectman, Town of Plainfield
Victoria Szamocki, ECCD Intern
Joe Tetreault, Town of Plainfield Highway Department
Eric Thomas, CT DEEP Watershed Management Program
Sharon van Dyke, Willimantic Waste Company
Steve Winnett, US Environmental Protection Agency, Region 1
Jeff Young, Town of Plainfield, Water Pollution Control Supervisor

Acronyms

CACIWC – Connecticut Association of Conservation and Inland Wetland Commissions
CEDC – Connecticut Economic Development Commission
CLEAR – Center for Land Use Education and Research
CNMP – Comprehensive Nutrient Management Plan
CLCC – Connecticut Land Conservation Council
CT DoAg – Connecticut Department of Agriculture
CT DOT – Connecticut Department of Transportation
CT RC&D – Connecticut Resource Conservation and Development Area
CWA – Clean Water Act
DPH – Connecticut Department of Public Health
ECCD – Eastern Connecticut Conservation District
FSA – Farm Service Agency
GHP – Good Housekeeping Practices
IC – Impervious cover
IDDE – Illicit Discharge Detection and Elimination
IPM – Integrated Pest Management
MS4 – Small Municipal Separate Storm Sewer System
NECCOG – Northeastern Connecticut Council of Governments
NEMO – Non-point Education for Land Use Officials
NDDH – Northeast District Department of Health
NOFA – Northeast Organic Farming Association
NPS – Nonpoint source pollution
NRCS – Natural Resources Conservation Service
NOAA – National Oceanic and Atmospheric Administration
OPM – Connecticut Office of Policy and Management
POCD – Plan of Conservation and Development
STEAP – Small Town Economic Assistance Program
TLGV – The Last Green Valley, Inc.
UCONN – University of Connecticut
USDA – United States Department of Agriculture
USEPA – United States Environmental Protection Agency
USGS – United States Geological Survey

1. Executive Summary

This Executive Summary provides an overview of the *Ekonk Brook Watershed-based Plan* (the Plan). It is intended to be used as a stand-alone guide to supplement the fuller watershed plan, and may be used as a reference document by watershed managers. The purpose of the Plan is to identify sources of fecal coliform bacteria that have degraded water quality in Ekonk Brook and to provide management recommendations to improve water quality so that Ekonk Brook can meet established water quality standards for its intended uses.

1.1. Introduction

Ekonk Brook is located in Plainfield, Connecticut. The Ekonk Brook watershed encompasses portions of the towns of Plainfield, Sterling and Voluntown. Despite the predominately rural character of the watershed, Ekonk Brook has been listed in several cycles of the Connecticut Department of Energy and Environmental Protection (DEEP) Integrated Water Quality Report to Congress, most recently in 2014, as impaired for recreational use due to levels of *Escherichia coli* (*E. coli*) that exceed state-established allowable limits for the designated recreational use. In order to address documented levels of bacteria in the stream, in 2011 DEEP prepared a Total Maximum Daily Load (TMDL) Analysis for Recreational Uses of the Ekonk Brook Sub-Regional Basin. The TMDL cites potential bacteria sources including failed septic systems, residential, agricultural and urban runoff, unregulated stormwater runoff, illicit connections to storm sewers, and animal waste.

In 2013, the Eastern Connecticut Conservation District (ECCD), in partnership with DEEP, the Towns of Plainfield and Sterling, and The Last Green Valley (TLGV) Volunteer Water Quality Monitoring Program, conducted a water quality investigation in order to quantify bacteria levels in Ekonk Brook and identify potential sources of the bacteria documented in the stream. The investigation included the collection and analysis of water samples from Ekonk Brook and its perennial tributaries, a field assessment of the watershed, and a desktop pollutant load analysis. The collected information was used to prepare this watershed-based plan. This Plan recommends management practices for watershed managers that address the documented areas of concern, with the goal of reducing bacteria loading to Ekonk Brook in order to meet Connecticut Water Quality Standards.

Funding to conduct this study and prepare this plan was provided in part by DEEP through a US Environmental Protection Agency (USEPA) Nonpoint Source Program grant under Section 319 of the Clean Water Act.

1.2. Document Overview

The purpose of this plan is to provide guidance and strategies for watershed managers that will serve to prevent further degradation and support the restoration of the quality of water in Ekonk Brook so that it meets the Connecticut water quality standards for its designated recreational use. This document utilizes the nine minimum elements identified by the US Environmental Protection Agency (USEPA) to be used in the preparation of a watershed plan for impaired waters.

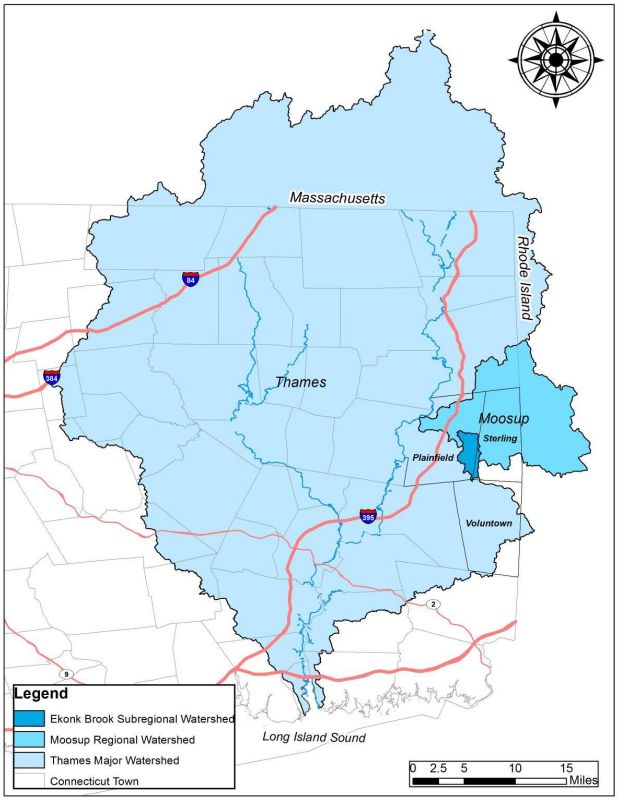
Because watershed planning is both a collaborative and participatory process, the Eastern Connecticut Conservation District engaged a variety of stakeholders to be involved in the development and implementation of this plan, including land owners, farmers and business owners. During the preparation of this plan, ECCD discussed the water quality resource concerns and solicited information from members of the public, including landowners, business owners and agricultural producers. Upon approval of this Plan, it will become incumbent upon these same stakeholders to adopt and implement the plan recommendations.

1.3. Watershed Description

Ekonk Brook (CT3503-00_01) is located in Plainfield, Connecticut. The Ekonk Brook watershed (CT-3503) is a 5.3 square mile sub-regional watershed that incorporates portions of the towns of Plainfield, Sterling and Voluntown. It is part of the Moosup regional and the Thames major watersheds, which discharge to Long Island Sound.

Ekonk Brook is located in a long, fairly narrow, north/south-oriented valley framed by gently rolling hills ranging in elevation from 575 to 670 feet. Bedrock in the Ekonk Brook watershed is comprised of quartzite, gneiss, granitic gneiss and schist of the Avalonian Terrane, a volcanic island arc which attached to the proto-Euramerican plate during the Devonian period, and which dates from the Proterozoic Z age, 570-800 million years ago.

Soils in the Ekonk Brook watershed are comprised of lodgement and melt-out tills,



Ekonk Brook watershed (dark blue) located within the Moosup sub-regional and Thames regionals basins.

with glaciofluvial and alluvial floodplain soils and muck soils in the lower elevations. These soils were deposited during and after the last glacial period in Connecticut, which ended approximately 12,000 years ago. Predominant soil types include Woodbridge fine sandy loams (23.8%), Ridgebury, Leicester and Whitman soils (17.5%), and Charlton-Chatfield Complex soils (11.8%). Wetland soils comprise approximately 23% of soils in the Ekonk Brook watershed. There are approximately 1,248 acres of farmland soils in the Ekonk Brook watershed, which comprise 37% of the soils in the watershed.

There are 6.62 miles of perennial streams in the Ekonk Brook watershed, including Ekonk Brook, Sterling Hill Brook, Davis Brook and several unnamed streams. Notable ponds in the watershed include the 12-acre Lockes Meadow Pond, which is the headwater for Ekonk Brook, and the 2.25-acre Stanton Pond, located southeast of Lockes Meadow Pond in the southern part of the watershed. Surface waters in the Ekonk Brook watershed, including Ekonk Brook, tributary streams, Lockes Meadow Pond and Stanton Pond, have surface water quality classifications of A. Designated uses in Class A surface waters include habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture. Groundwater within the watershed is classified as GA. Designated uses for Class GA groundwater include existing private and potential public or private supplies of water suitable for drinking without treatment; and base flow for hydraulically-connected surface water bodies.

The Ekonk Brook watershed is predominantly rural. Land cover in the watershed is dominated by undeveloped deciduous and coniferous forest (Center for Landuse Education and Research, 2010). Developed land (defined as residential, commercial and/or industrial development and associated paved surfaces), including rural residential, suburban and urban development as well as turf grass areas (lawns) comprises approximately 8.5% of the watershed. About 20% of the watershed is used for pasture, hay land and cropland. Approximately 88 acres, or 2.6% of the watershed, is comprised of wetlands and waterbodies. Approximately 17% (578.5 acres) of the Ekonk Brook watershed is under agricultural use. Agriculture is located primarily in the eastern portion of the watershed along Sterling Hill Road and Ekonk Hill Road (State Route 49) at the Plainfield /Sterling town line. Publicly accessible recreational opportunities in the Ekonk Brook watershed are available at the Pachaug State Forest. The state forest offers hiking and multi-use trails, including trails for off-road/ATV vehicles, horseback riding, winter use such as snowmobiling and cross-country skiing throughout the Pachaug State Forest.

1.4. Land Management Policies

Land management in Connecticut occurs on multiple administrative levels, from the state to regional to local levels. State planning is administered through the Office of Policy and Management, while regional planning is conducted by regional planning organizations such as councils of government. Local planning occurs via the preparation of municipal planning documents and is administered through land use boards or commissions. In order for land use

planning to be at its most effective, it is important for policies and goals to be aligned on local, regional and state levels.

State and regional planning documents include:

- *2013-2018 Conservation & Development Policies: The Plan for Connecticut*
- Connecticut Department of Transportation *Draft Stormwater Management Plan (February 2004)*
- The Last Green Valley, Inc. *Vision 2020 – The Next Ten Years*

Municipal planning documents include:

- Town of Plainfield *2008-2018 Plan of Conservation and Development*
- Town of Plainfield *Inland Wetland and Watercourses Regulations* (amended through Nov. 13, 2012)
- Town of Plainfield *Zoning Regulations* (amended through Oct. 1, 2014)
- Town of Plainfield *Subdivision Regulations* (amended through Apr. 1, 2013)
- Town of Sterling *2009 Plan of Conservation and Development*
- Town of Sterling *Inland Wetland and Watercourses Regulations* (amended through Mar. 29, 2012)
- Town of Sterling *Zoning Regulations* (amended through Apr. 4, 2015)
- Town of Sterling *Subdivision Regulations* (amended through Mar. 23, 2010)

1.5. Watershed Conditions/Water Quality Data

The 1972 Federal Clean Water Act requires all states to designate uses for all waterbodies within their jurisdictional boundaries, and to test waters to determine if they are meeting their designated uses. Ekonk Brook's designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Ekonk Brook has not been meeting its designated use for recreation due to periodic high levels of *Escherichia coli* (*E. coli*) from unknown sources.

The State of Connecticut Department of Energy and Environmental Protection *Water Quality Standards* (effective October 10, 2013) established water quality criteria for indicator bacteria (*E. coli*) for freshwater. For the purposes of this investigation, ECCD utilized the single sample criteria for *Freshwater – All other recreational uses* of 576 cfu/100ml and the maximum sample set geometric mean of less than 126 cfu/100 ml to evaluate water quality data collected from Ekonk Brook and tributaries.

From 2007 to 2009, CT DEEP collected water samples for bacteria content analysis from Ekonk Brook upstream of River Road in Moosup. This data was used to develop a fecal bacteria Total

Maximum Daily Load (TMDL) for Ekonk Brook (CT DEEP, 2011). The TMDL and the water quality data are included in Appendix A of this document.

In 2014, ECCD and volunteers from The Last Green Valley (TLGV) Volunteer Water Quality Monitoring Program collected water samples from eleven sites on Ekonk Brook and perennial tributaries. The sites were sampled twice weekly for four weeks in August and September, utilizing Quality Assurance Project Plan (QAPP) protocols in accordance with an approved monitoring plan. The water samples were analyzed by the State of Connecticut Department of Public Health Laboratory for fecal bacteria content. Due to a lack of precipitation during the sampling period, ECCD also collected one additional wet weather sample in October 2014.

Ekonk Brook watershed bacteria sampling results.

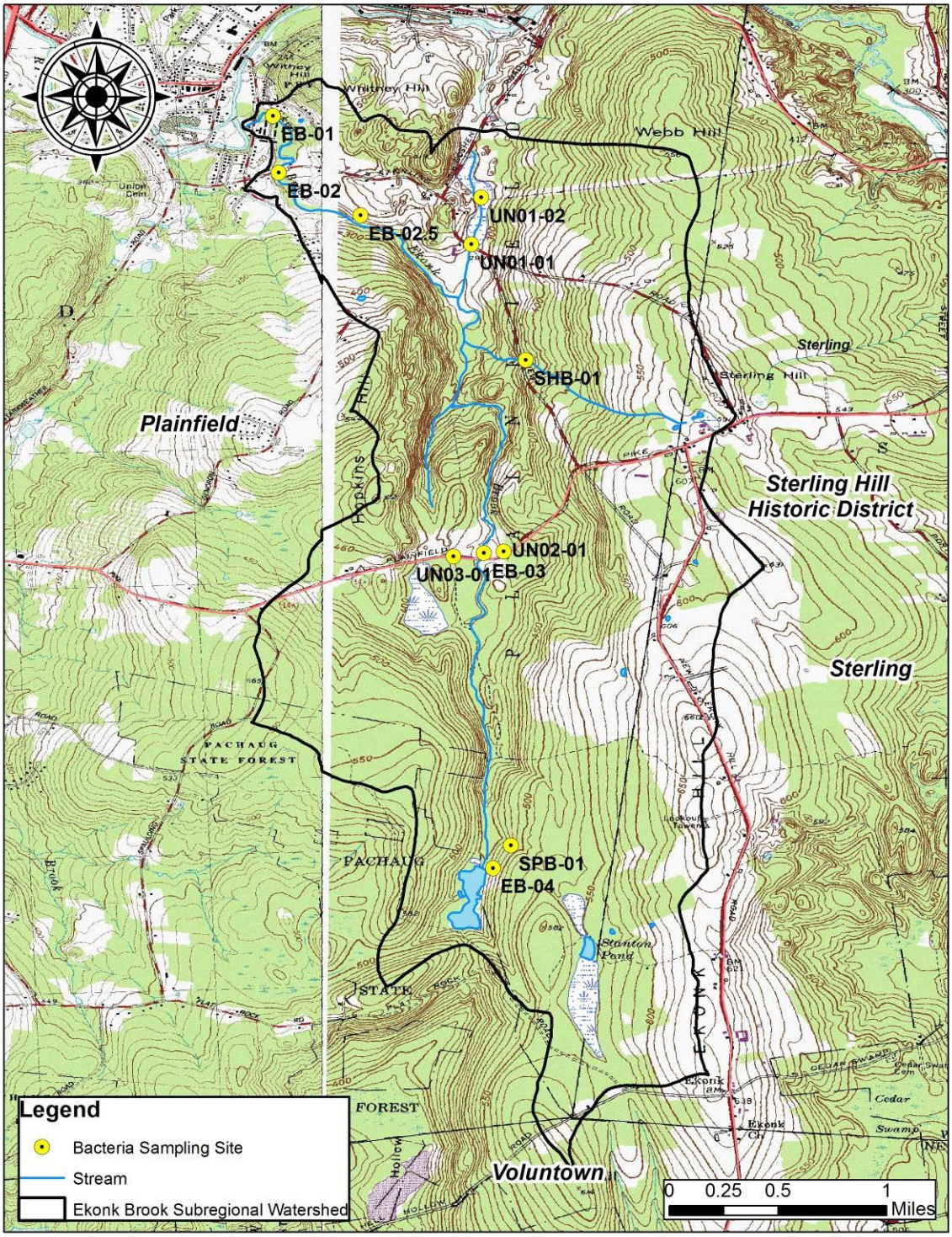
Sampling Site	Site Description	Geometric Mean (cfu/100 ml)
EB-01	Ekonk Brook – DEEP site #789/Moosup Garden Apts.	**772**
EB-02	Ekonk Brook @ 79 Sterling Hill Rd	117
EB-02.5*	Ekonk Brook near Northern Drive	**170** (n=2)
EB-03	Ekonk Brook US of Route 14A	80
EB-04	Lockes Meadow Pond near outlet	24
UN-01-01	Unnamed stream #1 at Sterling Hill Road	**659**
UN-01-02**	Unnamed stream #1 near Goshen Road	**434** (n=2)
SHB-01	Sterling Hill Brook DS Sterling Hill Road	41
UN-02-01	Unnamed stream #2 at Route 14A	**165**
UN-03-01	Unnamed stream #3 at Route 14A	**156**
SPB-01	Stanton Pond Brook in Pachaug State Forest	**204**
*Site added 8/21/14 to bracket bacteria levels upstream of UN-01-01		
** Site added 8/26/14 to bracket bacteria levels downstream of UN-01-01		
Bold denotes that the sample exceeded established indicator bacteria single sample and/or geometric mean criteria for that site.		

1.6. Pollutant Source Assessment

ECCD evaluated potential pollutant sources using the water quality data collected in 2014, and data collected by DEEP from 2007-2009. ECCD conducted a field assessment of the Ekonk Brook watershed to identify potential sources of bacteria and other common nonpoint source pollutants, including sediment and nutrients. ECCD also conducted a desktop pollutant load analysis to determine the annual loading of common nonpoint source (NPS) pollutants such as sediment, nutrients, and fecal bacteria.

Potential nonpoint sources of pollution (pollution that is not derived from a single discernible source or point) that were evaluated included urban/suburban stormwater runoff, agricultural

runoff, sewers and septic systems, and pet and wildlife waste. Point sources (pollution that is discharged from a single, identifiable point) that were evaluated included regulated discharges and hazardous waste.



Bacteria sampling sites in the Ekonk Brook watershed.

Possible sources of fecal bacteria and other NPS contaminants to Ekonk Brook and tributary streams.

Possible Source	Location	Pollutant(s)	Receiving Waterbody
Stormwater Runoff/ Outfalls	River Street & Gorman Road area, State Route 14A	Sediment, bacteria, nutrients, automotive chemicals, metals	Ekonk Brook, unnamed stream #2, unnamed stream #3
Sanitary Sewers/ Septic Systems	River Street & Gorman Road /Goshen Road & Sterling Hill Road areas	Bacteria, nutrients, pharmaceuticals, household chemicals	Ekonk Brook, unnamed stream #1
Agriculture/ Livestock/ Poultry	Sterling Hill Road & Ekonk Hill Road areas	Bacteria, nutrients, chemical fertilizers, herbicides/pesticides, vehicular chemicals	Stanton Pond Brook, Ekonk Brook, unnamed stream #1
Pets	Watershed-wide	Bacteria, nutrients	Ekonk Brook, unnamed stream #1
Wildlife/Waterfowl	Lockes Meadow Pond	Bacteria, nutrients	Ekonk Brook

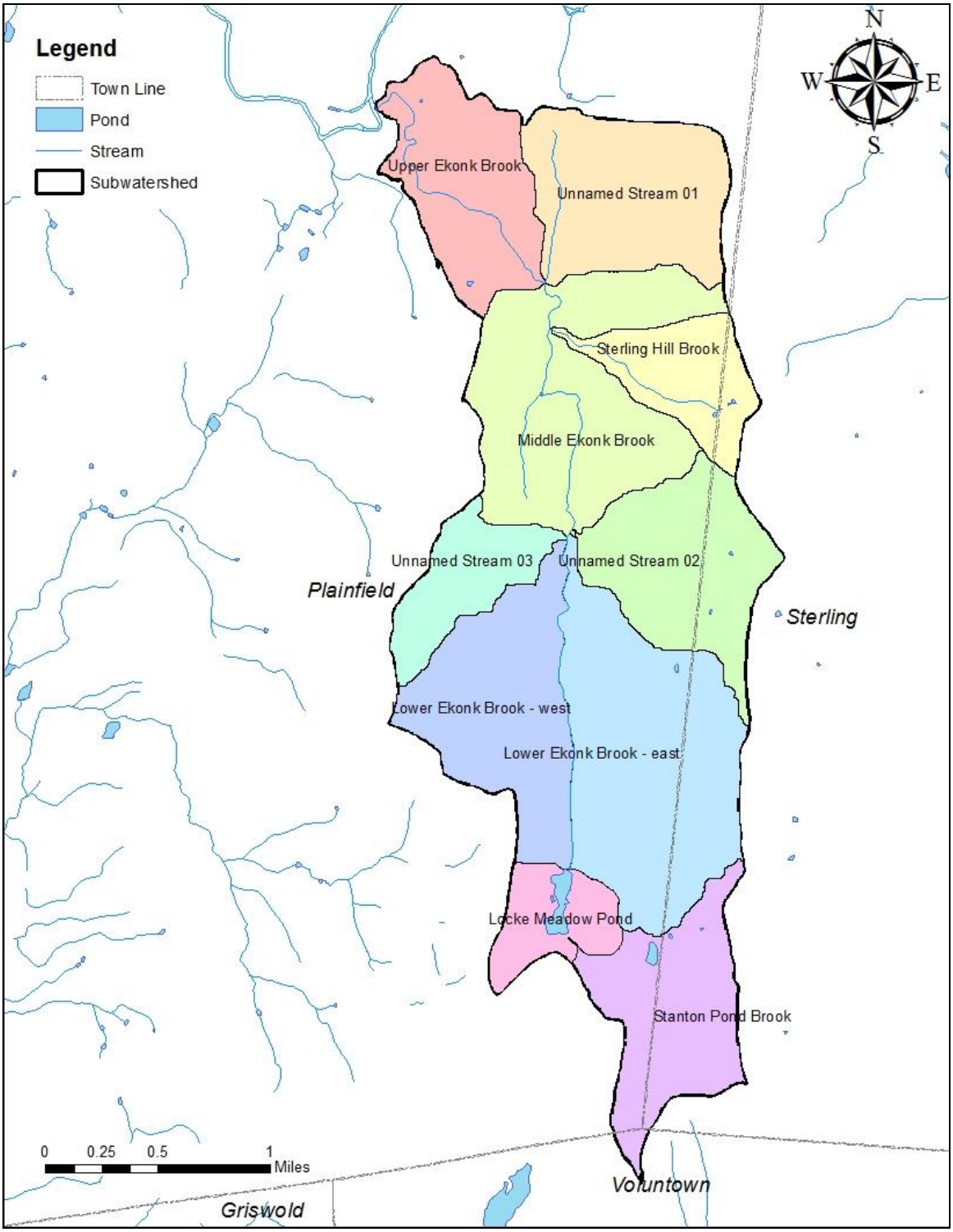
1.7. Pollutant Load Estimates

The estimation of pollutant loads is necessary in order to determine the pollutant load reductions that are required to restore the quality of an impaired waterbody. Where water quality measurements have been collected, it is possible to determine pollutant loading directly. Stream bacteria levels documented by ECCD in 2014 were previously presented in Section 1.5.

When no water quality data is available, the use of models can be used to estimate pollutant loading. ECCD used the Watershed Treatment Model (2013 "Off the Shelf" edition), developed by the Center for Watershed Protection, to estimate watershed pollutant loads. In order to facilitate the modeling process, the Ekonk Brook watershed was divided into ten subwatersheds. These ten watersheds correspond with the ECCD bacteria sampling sites. The subwatersheds are depicted in the figure below. Pollutant loads are presented in the following tables.

The identification of critical areas is important when considering where management practices are needed and aids in determining what types of best management practices (BMPs) will provide the greatest benefit. Critical areas are generally defined as areas that contain sensitive resources or that provide important or unique environmental functions or services. Critical areas identified in the Ekonk Brook watershed include:

- Upper Ekonk Brook subwatershed
- Unnamed stream 1 subwatershed



Ekonk Brook subwatersheds corresponding to bacteria sampling sites for pollutant modeling.

Ekonk Brook watershed modeled annual existing pollutant loads by source.

NPS Pollutant Source	TN (lb/year)	TP (lb/year)	TSS (lb/year)	Fecal Coliform (billion/year)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	1,557	230	36,338	67,596	273	16	18	10	46
MDR (1-4 du/acre)	44	6	1,019	1,896	8	0	0	0	1
HDR (>4 du/acre)	89	13	2,078	3,865	16	1	1	1	3
Roadway	465	54	28,539	19,413	78	5	4	8	13
Forest	4,945	487	243,719	29,246	363	51	39	64	20
Pasture	373	59	8,501	3,316	13	4	5	2	2
Cropland	2,074	403	57,536	22,439	88	21	32	15	15
Open Water	132	5	1,603	0	0	1	0	0	0
Land Use Total	**9,679**	**1,257**	**379,333**	**147,771**	**839**	-	-	-	-
Secondary NPS Sources									
Septic Systems	122	21	817	420	0	1	1	0	0
Stream Channel Erosion	0	0	116,119	0	0	0	0	23	0
Livestock	137	25	0	772	0	1	2	0	1
Load Reductions from Existing Practices	-223	-267	254	563	-14	-2	-17	0	0
Secondary Source Total	483	312	116,683	628	14	-	-	-	-
Total All Sources	**11,925**	**1,570**	**496,015**	**148,399**	**853**	-	-	-	-

Ekonk Brook subwatershed modeled annual existing pollutant loads (in pounds per year) and yields (pounds per acre per year).

Ekonk Brook Subwatershed	Existing Pollutant Loads (lbs/year)				Existing Pollutant Yields (lbs/ac/year)			
	TN	TP	TSS	Fecal Coliform (billion/yr)	TN	TP	TSS	Fecal Coliform (% of load)
Upper Ekonk Brook (327 acres)	1,549	266	56,274	31,507	4.7	0.8	172	96
Unnamed Stream 01 (375 acres)	1,478	226	57,221	23,043	3.9	0.6	153	61
Sterling Hill Brook (191 acres)	682	93	27,578	8,573	3.6	0.5	144	45
Middle Ekonk Brook (546 acres)	1,666	195	78,296	19,413	3.1	0.4	143	36
Unnamed Stream 02 (346 acres)	1,355	203	54,908	22,142	3.9	0.6	159	64
Unnamed Stream 03 (170 acres)	598	87	27,017	10,704	3.5	0.5	159	63
Lower Ekonk Brook -West (399 acres)	1,015	86	52,296	5,720	2.5	0.2	131	14
Lower Ekonk Brook -East (597 acres)	1,935	219	79,187	13,480	3.2	0.4	133	23
Stanton Pond Brook (323 acres)	1,235	165	45,351	12,233	3.8	0.5	140	38
Lockes Meadow Pond (136 acres)	412	30	17,887	1,584	3.0	0.2	132	12
Total Ekonk Brook (3,410 acres)	**11,925**	**1,570**	**496,015**	**148,399**	-	-	-	-

1.8. Watershed Goals and Objectives

The purpose and overall goal of this management plan is to reduce fecal bacteria loading from the sources identified in Section 5 of this document so that Ekonk Brook will meet Connecticut Water Quality Standards for its intended uses, and can be removed from CT DEEP's List of Impaired Waters. Whether or not this goal is met is dependent on the efforts of watershed managers to improve water quality conditions throughout the watershed.

Fecal bacteria load reductions required to allow Ekonk Brook to meet Connecticut water quality standards for the intended recreational use are based on *E. coli* concentrations documented by ECCD in watershed streams in 2014. The percent of reduction needed is derived from the Connecticut water quality standard for the sample set geometric mean of less than 126 cfu/100

ml for “Freshwater – All other recreational uses.” Required fecal bacteria reductions are presented in the table below.

Bacteria load reductions necessary to meet Connecticut Water Quality Standards for recreational activities in fresh water.

Sampling Site	Site Description	Geometric Mean (cfu/100ml)	% Reduction Needed
EB-01	Ekonk Brook – CT DEEP site #789 Moosup Garden Apartments	**772**	84%
EB-02	Ekonk Brook at 79 Sterling Hill Road	117	-
EB-02.5	Ekonk Brook near Northern Drive	**170**	26%
EB-03	Ekonk Brook upstream of Route 14A crossing	80	-
EB-04	Lockes Meadow Pond near pond outlet	24	-
UN-01-01	Unnamed stream #1 upstream of Sterling Hill Road crossing	**659**	81%
UN-01-02	Unnamed stream #1 at powerline crossing near Goshen Road	**434**	71%
SHB-01	Sterling Hill Brook downstream of Sterling Hill Road	41	-
UN-02-01	Unnamed stream #2 upstream of Route 14A crossing	**165**	24%
UN-03-01	Unnamed stream #3 downstream of Route 14A crossing	**156**	19%
SPB-01	Stanton Pond Brook at trail crossing in Pachaug State Forest	**204**	38%
Bold text indicates that the sample set exceeded the established geometric mean criteria of 126 colony forming units per 100 milliliters of water (cfu/100ml) for that sampling site.			

Pollutant loads for common nonpoint source (NPS) pollutants, including total nitrogen, total phosphorus, sediment, and fecal coliform, were modeled based on existing land uses, using the Watershed Treatment Model (CWP, 2013). In order to provide a baseline against which existing pollutant loads could be compared, pre-developed watershed loads were calculated for each of the subwatersheds, using a forested condition as a typical pre-development land cover for Connecticut. No net gain of wetlands was assumed, and an impervious cover of 1% was used to represent ledge and naturally barren land.
Recommended load reductions to bring NPS loads within the pre-developed load range of the Ekonk Brook watershed are presented in the table below.

Recommended NPS pollutant load reductions by subwatershed (see Table 7-2 for additional loading information, including pre-development loads).

Sub-watershed	TN Load Reduction (%)	TP Load Reduction (%)	TSS Load Reduction (%)
Upper Ekonk Brook	47	76	25
Unnamed Stream 1	36	66	34
Sterling Hill Brook	30	59	10
Middle Ekonk Brook	18	44	9
Unnamed Stream 2	26	66	37
Unnamed Stream 3	29	61	37
Lower Ekonk Brook – west	2	7	1
Lower Ekonk Brook – east	23	46	25
Stanton Pond Brook	33	60	29
Lockes Meadow Pond	1	4	0

1.9. Watershed Best Management Practices

Best management practices (BMPs) are control measures that are used to "manage the quantity and improve the quality of stormwater runoff" (US EPA, 2012), typically caused by changes in land use. This plan outlines management strategies that, if implemented, are intended to improve the quality of surface waters in the Ekonk Brook watershed by reducing the loading of bacteria and other nonpoint source (NPS) pollutants as enumerated in Sections 6 and 7. A variety of management strategies are provided to target the pollutant sources that are identified in Section 5. Management strategies include short and long-term, non-structural and structural controls and actions that vary in relative effort and cost, and that can be adopted and implemented by a wide variety of stakeholders. Management recommendations are intended to address and reduce existing pollutant loads and prevent future sources of pollutant loading to waterbodies in the Ekonk Brook watershed. Each of the strategies listed below is described in greater detail in Section 8 of this plan.
Recommended Best Management Practices include:

- Establishment of a watershed management team

- Review of municipal land-use regulation and policies by municipal staff and land-use commissions
- Adoption of stormwater best management practices by state, municipal and watershed property/business owners/stakeholders
- Implementation of municipal sewer best management practices by municipalities
- Adoption of septic systems best management practices by property owners
- Implementation of agricultural best management practices by agricultural producers
- Adoption of pet waste best management practices by residents
- Adoption of wildlife/waterfowl best management practices by residents and stakeholders

1.10. Financial and Technical Assistance Needed

Most, if not all, of the management practices provided in Section 8 will require some financial investment. Watershed municipalities have local funding options, including bonding, capital improvement budgets, and department budget line items that can be utilized to fund water quality improvement implementations and municipal outreach efforts. Funds and support may be available in the form of donations and in-kind services provided by local businesses, community and environmental organizations, and local volunteers. Financial assistance in the form of grants and cost-sharing is available from multiple sources, including federal, state, and local sources.

The planning, design and execution of complex water quality improvement projects may require expertise that small towns, watershed groups and civic organizations do not have access to. As a result, assistance from organizations or agencies that have the technical capacity will be critical to the successful implementation of the management recommendations.

Organizations that may provide financial and technical assistance to project managers and watershed stakeholders are listed in the tables below.

Potential sources of funding for watershed plan implementations

Funding Source	Award Amount	Contact Information
CT DEEP CWA §319 Grant Program	Varies by project	Eric Thomas (860) 424 -3548
Website: www.ct.gov/dep/cwp/view.asp?a=2719&q=325588&depNav_GID=1654		
CT DEEP Clean Water Fund		Susan Hawkins (860) 424-3325
Website: www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654		
CT DEEP Open Space and Watershed Land Acquisition Grant Program	40-60% of fair market value	Dave Stygar (860) 424-3016
Website: www.ct.gov/deep/cwp/view.asp?A=2687&Q=322338		
Ct Dept of Agriculture Environmental Assistance Prgm	Varies by practice	(860) 713-2511
Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398986		
Ct Dept of Agriculture Agriculture Viability Grant	Varies by project	(860) 713-2500
Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398982		
Ct Dept of Agriculture Farmland Restoration Program	Varies by project	Cam Weimer/Lance Shannon (860) 713-2511
Website: www.ct.gov/doag/cwp/view.asp?a=3260&Q=498322&PM=1		
CT DECD Small Cities Program	Varies by town	Jim Watson (860) 270-8182
Website: www.ct.gov/doh/cwp/view.asp?a=4513&q=530474		
CT OPM Regional Performance Incentive Program		Sandy Huber (860) 418-6293
Website: www.ct.gov/opm/cwp/view.asp?q=487924		
CT OPM Small Town Economic Assistance Program	Varies by project	Barbara Rua (860) 418-6303
Website: www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793		
Community Foundation of Eastern Connecticut	Varies by program	Jennifer O'Brien (860) 442-3572
Website: www.cfect.org/		
US EPA Healthy Communities Grant Program		Jennifer Padula (617) 918-1698
Website: www.epa.gov/region1/eco/uep/hcgp.html		
NOAA Coastal Management Programs		
Website: http://coastalmanagement.noaa.gov/funding/welcome.html		
US EPA Five Star Restoration Grant Program	$20,000 average	Myra Price (202) 566-1225
Website: www.epa.gov/owow/wetlands/restore/5star		
NFWF Long Island Sound Futures Fund	Varies by project	Lynn Dwyer lynn.dwyer@nfwf.org
Website: www.nfwf.org/		
NRCS Agricultural Conservation Easement program		Ray Covino (860) 779-0557 x102
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/easements/acep/		
NRCS Environmental Quality Incentives Program	$450,000 over 6 yrs	Ray Covino (860) 779-0557 x102
Website: www.ct.nrcs.usda.gov/programs/eqip/eqip.html		
NRCS Conservation Stewardship Program (CSP)	$200,000 over 5 yrs	Ray Covino (860) 779-0557 x102
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/financial/csp/		
NRCS Agricultural Management Assistance Program	$50,000/yr	Ray Covino (860) 779-0557 x102
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ct/programs/financial/?cid=nrcs142p2_011027		
Rivers Alliance of CT Watershed Assistance Small Grants Program	$5000, 40% non-federal match	Rivers Alliance of CT (860) 361-9349
Website: www.riversalliance.org/watershedassistancegrantrfp.cfm		

Agencies and organizations that may provide technical assistance.

Agency/Organization	Type of Assistance Available
CT Department of Agriculture	Technical assistance/permitting
CT DEEP	Water quality, technical assistance
CT Department of Transportation	Maintenance of State highways/stormwater systems and maintenance facilities
CT Resource Conservation & Development Council	Farm energy program, soil health education
Eastern CT Conservation District	Water quality investigation, BMP implementations, technical and resource assistance
Northeast District Department of Health	Review and approval of septic systems, repairs
Local Businesses/Associations	Potential funding and partnership opportunities
Local Councils of Government	Regional land use planning support and assistance
The Nature Conservancy	Outreach/education, technical assistance
Town of Plainfield – including staff and land use commissions	Enforcement of land use regulations, site plan review/permitting, public utilities maintenance
Town of Sterling – including staff, land use commissions	Enforcement of land use regulations, site plan review/permitting, public utilities maintenance
USDA/Natural Resources Conservation Service (NRCS)	Technical assistance/cost-share funding for agricultural BMPs
USDA Farm Service Agency (FSA)	Technical/financial assistance for agricultural producers
University of Connecticut –Center for Land Use Education and Research (CLEAR)	Technical assistance/implementation of LID/GI
University of Connecticut - Nonpoint Education for Municipal Officials (NEMO)	NPS education and support for municipal land use organizations
University of Connecticut Cooperative Extension Service	Technical assistance/education/outreach for land use and agricultural practices

1.11. Education and Outreach

The objective of a successful outreach and education campaign is to raise awareness of the water quality issues associated with an impaired waterbody, in order to create an educated populace that understands the issues of nonpoint source pollution, its effects on water quality, and actions that can be taken to address the problem. The table below provides potential outreach topics as well as potential partners to assist with outreach. By successfully engaging and educating the public, including watershed property and business owners, municipal staff and land use commissioners, this plan should lead to behavioral change that should result in the adoption of land use practices that will be supportive of good water quality in Ekonk Brook and the watershed as a whole.

Public education and outreach topics and potential outreach partners.

Outreach & Education Topic	Target Audience	Potential Outreach Partner(s)
Agricultural BMPs, including soil health, tillage practices, and cover cropping	Agricultural producers	NRCS, UConn Cooperative Extension System, ECCD, Agricultural Commissions, CT RC&D
Agricultural Nutrient Management	Agricultural producers & private farm owners	ECCD, NRCS, UConn Cooperative Extension System
Farm Energy Efficiency	Agricultural producers	CT RC&D Council
Homeowner Lawn, garden and stormwater BMPS	Residents/property owners	ECCD, UConn Cooperative Extension System
Implementation of MS4 program	Municipalities/DPWs	CT DEEP Stormwater Management, DPWs, CT NEMO
Land use commissioner roles and responsibilities	Land use staff and commissions	CT NEMO, CLEAR, CACIWC, municipal land use commissions
Low impact development (LID)/ Green Infrastructure (GI)	Land use staff and commissions/DPWs	CT NEMO, CLEAR, DEEP, ECCD
Municipal "Good Housekeeping" Public Works practices	Municipalities/DPWs	CT DOT, DPWs
Open space planning, Acquisition and management	Land use staff and commissions	CT DEEP, CT NEMO, CLCC, local land trusts, TLGV
Organic lawn/garden care	Residents/property owners	UConn Cooperative Extension System, NOFA
Pet waste management	Residents/property owners	Towns of Plainfield and Sterling, Northeast District Department of Health, veterinarians, pet stores
Rain Gardens and Native Plants	Residents/property owners Land use staff and commissions	CT NEMO, UConn Extension, ECCD, area plant nurseries, garden clubs and beautification committees
Recycling	Residents/property owners	WPCA, municipalities, waste mgmt. companies
Septic System BMPs for Homeowners	Residents/property owners	Local Health District, CT Dept. of Health, local septic services companies
Trash/litter management	Residents/property owners	Local Conservation Commissions, DPWs, waste mgmt. companies
Understanding Non-Point Source (NPS) Pollution	Residents/property owners Land use staff and commissions	CT NEMO, municipal Conservation Commissions, DEEP
What not to flush down drains	Residents/property owners	WPCA, Northeast District Department of Health, ECCD

1.12. Monitoring and Assessment

The monitoring of water quality conditions is an essential component of any watershed management plan. The on-going collection of water quality data allows watershed managers to assess whether water quality improvement measures are having the intended effect, or whether adjustments need to be made within the adaptive management framework. Water quality monitoring should be coordinated with the implementation of management measures in order to determine if the management measure goals (e.g. a reduction in the amounts of indicator bacteria) are being achieved.

The following items should be included as part of the monitoring and assessment component of watershed plan implementations as they are undertaken:

- coordination of monitoring activities among the watershed project partners;
- continuation of CT DEEP Ambient Water Quality Probabilistic Bacteria Monitoring program Ekonk Brook at station #789, as part of the five-year rotational basin assessments;
- collection of pre- and post-implementation water quality data to determine the effectiveness of the BMP in reducing pollutant loading, if existing data is not available;
- comparison of post-BMP water quality monitoring data to bacteria TMDL targets to determine if bacteria load reductions have been achieved; and
- comparison of post-BMP implementation data collection to NPS pollutant load targets to determine if NPS pollutant load reductions have been achieved.

1.13. Implementation Effectiveness

As implementations are undertaken and completed, water quality data should continue to be collected, evaluated and compared to the desired water quality goals to determine if the implementations are achieving the desired results. Implementation should be considered complete when the targets are reached or exceeded.

If implementations are not as effective as planned, e.g., implementation milestones are not being met, or progress is not being made toward reducing pollutant loads, watershed stakeholders should review the implementation program. If it is determined that the implementation of goals and objectives are not resulting in a positive water quality change, watershed team members may need to make adjustments or revisions to the watershed plan.

1.14. Next Steps

Addressing Ekonk Brook's water quality issues will be a long term effort. It will take the actions of many individuals, community leaders and decision makers to address current water quality

issues and reduce the levels of fecal bacteria and other NPS pollutants currently entering Ekonk Brook.

Following the acceptance of the Ekonk Brook Watershed-based Plan by CT DEEP, this Plan should be distributed to all watershed stakeholders for implementation, including but not limited to the watershed municipalities, Council of Government, local health districts, local utilities (including the Plainfield Water Pollution Control Authority), NGOs, CT Department of Transportation, agricultural producers, and business and land owners. It will be incumbent upon all watershed stakeholders to review, understand and adopt the plan recommendations in order for water quality improvements to be achieved.

The plan should be made available to the general public via postings on the CT DEEP, ECCD and Towns of Plainfield and Sterling municipal websites. Efforts should be made to publicize the watershed plan in order to raise public awareness of water quality issues associated with the lower Ekonk Brook, and steps being taken to improve water quality.

The Eastern Connecticut Conservation District intends to remain an active participant and central point of contact as implementations recommended by this Watershed-Based Plan are undertaken.

Any comments or questions regarding this plan should be directed to:

Eastern Connecticut Conservation District
238 West Town Street
Norwich, CT 06360
(860) 887-4163 ext. 400

2. Introduction

The Ekonk Brook watershed (CT-3503) is a sub-regional watershed located in eastern Connecticut. It is part of the Moosup regional and the Thames major watersheds, which ultimately discharge to Long Island Sound. Long Island Sound is part of the United States National Estuary Program and is designated an estuary of national significance. The Ekonk Brook watershed is 5.3 square miles in size and is located primarily in the towns of Plainfield and Sterling. A small portion of the watershed (approximately 10 acres) is located in the town of Voluntown.

Ekonk Brook (CT3503-00_01) is a 4.5 mile-long second order stream that flows north from its headwaters at Lockes Meadow Pond in the Pachaug State Forest to the Moosup River in the Moosup section of Plainfield (Fig. 2-1). This high quality stream, with surface water quality classified as A and stream flow classified as Class 1 by the Connecticut Depart of Energy and Environmental Protection (CT DEEP), is an important resource to the residents of Plainfield.

Figure 2-1. Ekonk Brook (lower right corner of image) can be seen flowing into the Moosup River in this 1889 Bird's Eye View map of Moosup, CT (from Connecticut History Online).

The brook is flanked by large tracts of undeveloped land, including flood plains and flood plain forests, which, in Connecticut, are critical habitats for flood-plain-dependent plant and animal species; core forest (intact forest land greater than 250 acres in size); large blocks of wetland soils (greater than 25 acres); and prime and important farmland soils. The watershed is home

to several plant and animal species that are listed by the State as rare, threatened or endangered. Ekonk Brook is a cold water stream and as late as 2002, supported native brook trout (N. Hagstrom, CT DEEP Inland Fisheries Division, personal communication). The brook is also stocked annually with brown trout by the DEEP Inland Fisheries Division to support recreational fishing.

Despite the predominately rural character of the watershed, Ekonk Brook is impaired for recreational use due to levels of *Escherichia coli* (*E. coli*) that exceed state-established allowable limits for the designated recreational use. *E. coli* is a bacterium that is found in the gut of warm blooded animals. While most species of *E. coli* are not harmful, their presence may indicate the presence of other pathogens, such as Salmonella, Hepatitis A, cryptosporidium and Giardia, that may present a health risk to humans. In order to address documented levels of bacteria in the stream, DEEP prepared a Total Maximum Daily Load (TMDL) Analysis for Recreational Uses of the Ekonk Brook Sub-Regional Basin in 2011. The TMDL cites potential bacteria sources including failed septic systems, residential, agricultural and urban runoff, unregulated stormwater runoff, illicit connections to storm sewers, and animal waste.

In 2013, the Eastern Connecticut Conservation District, in partnership with CT DEEP, the Towns of Plainfield and Sterling, and The Last Green Valley, Inc. conducted a water quality investigation in order to quantify bacteria levels in Ekonk Brook and identify potential sources of the bacteria documented in the stream. The investigation included the collection and analysis of water samples from Ekonk Brook and its perennial tributaries, a field assessment of the watershed, and a desktop pollutant load analysis. The collected information was used to prepare this watershed-based plan. This plan recommends management practices for watershed managers that address the documented areas of concern, with the goal of reducing nonpoint source (NPS) pollution to Ekonk Brook, in order to meet Connecticut Water Quality Standards.

2.1. Document Overview

2.1.1. Watershed Management Plan Purpose and Process Used

A watershed management plan is "a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, actions, participants, and resources related to developing and implementing the plan (US Environmental Protection Agency, 2008)." Watershed planning is an iterative and adaptive process that evaluates the multiple existing and potential uses of a watershed, from residential, commercial or industrial development to drinking water protection, agriculture, forest planning, wildlife and open space management (Fig. 2-2). The watershed planning process takes into consideration the need for "mid-course corrections" – the periodic review and modification of goals and targets as plan recommendations are implemented and evaluated, and as new information or technologies that may further the goals of the plan become available.

The purpose of this document is to provide guidance and strategies for watershed managers that will serve to prevent further degradation and support the restoration of the quality of water in Ekonk Brook so that it meets the Connecticut water quality standards for its designated recreational use. This document utilizes the nine minimum elements identified by the US Environmental Protection Agency (USEPA) to be used in the preparation of a watershed plan for impaired waters. These elements include:

- Identification of the impairment and pollutant sources
- Description of management measures to achieve load reductions
- Estimate of load reductions expected from proposed management measures
- Technical and financial assistance needed to implement management measures
- Education and outreach required to achieve management goals
- Implementation schedule
- Interim measurable milestones
- Water quality improvement evaluation criteria
- Water quality monitoring component

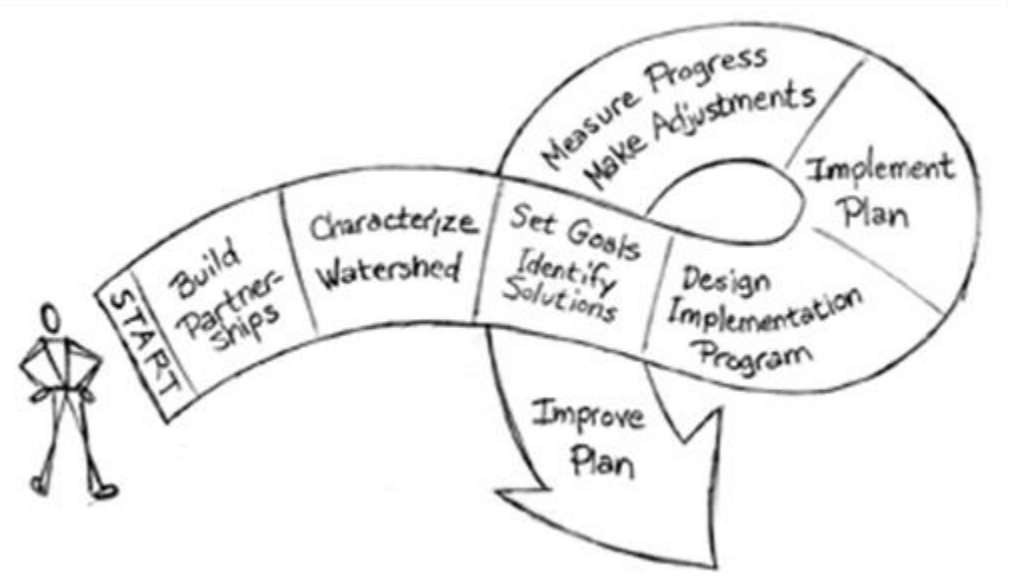


Figure 2-2. This graphic from the USEPA *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* depicts the watershed planning process (USEPA 2008).

The Ekonk Brook watershed planning process was conducted in several phases. The first phase involved a review of existing watershed conditions and water quality data (including a review of the 2011 CT DEEP Ekonk Brook Bacteria TMDL), and the collection

of additional water quality data. Based on existing conditions and available water quality data, ECCD, in consultation with CT DEEP, prepared a water quality monitoring plan, and in the summer of 2014, collected water samples from Ekonk Brook and its perennial tributaries. The water samples were analyzed by the CT Department of Public Health for bacteria content. The second phase, a field assessment of the Ekonk Brook watershed, was conducted to visually identify possible contaminant sources based on the results of the bacteria collection. The final phase, a desktop pollutant load analysis, was conducted using the Center for Watershed Protection's Watershed Treatment Model. This analysis predicted annual loads (in pounds per acre) for various common NPS pollutants based on land use and land cover within the Ekonk Brook watershed.

The following pages will provide a description of the watershed, including the current watershed condition. Potential pollution sources are identified and assessed, and the impacts to water quality are estimated. Goals and objectives to reduce the pollution load have been developed, and management strategies, including an implementation timeline, to meet those goals are outlined.

2.1.2. Issues Facing the Watershed

Current issues facing the Ekonk Brook watershed are associated with the management of stormwater runoff. Stormwater runoff contains numerous contaminants associated with nonpoint source pollution (NPS). Nonpoint source pollution is pollution that is mobilized and conveyed by stormwater each time it rains or snows. These contaminants are ubiquitous in our modern environment and include sediment; nutrients from fertilizers, animal manure and pet waste; bacteria and pathogens from human and animal waste; petroleum and other automotive chemicals from gasoline and diesel-powered vehicles; household and industrial chemicals and cleaning agents; and herbicides and insecticides. The bacteria documented in Ekonk Brook are associated with both stormwater runoff and other sources, and will require the application of various types of management practices to ameliorate.

Future issues facing the Ekonk Brook watershed include the potential for future development. At present, the Ekonk Brook watershed is not highly developed. With the exception of the Moosup Garden Apartments complex on Gorman Street, which is RA - 19 (residential, 19,000 square foot minimum lot size), the watershed is zoned RA-60 (residential district, 60,000 square foot minimum lot size). A build-out analysis of the Ekonk Brook watershed was not done as part of this investigation. However, within typical constraints such as the presence of steep slopes and wetland soils, substantial potential for residential development exists. The Plainfield Plan of Conservation and Development recognizes the link between land development and water quality and cites the need to "…preserve major portions of the Town, in their natural or nearly natural state, thereby preserving the Town's scenic resources, wildlife habitat and natural resources…" and to "… maintain water quality."

The link between stream water quality and impervious cover is well documented in the scientific literature. Numerous studies (Schueler 2003, Bellucci et al 2008) have demonstrated that stream water quality and biological habitat integrity decrease as imperviousness associated with the built environment increases. Water quality impacts have been documented in areas of the Ekonk Brook watershed that are more developed, particularly in the stream reaches nearer the village of Moosup. Current water quality issues may be associated with agricultural activity, older sewer infrastructure, septic systems in areas of high water tables, and nonpoint source pollution associated with stormwater runoff from more urban areas of the watershed. Future development within the Ekonk Brook watershed should incorporate low impact development (LID) or green infrastructure (GI) practices, which mimic pre-development hydrological conditions. Stormwater management practices that capture and infiltrate or otherwise treat stormwater runoff should be utilized where practical to prevent the degradation of the generally high water quality the watershed currently enjoys.

2.1.3. Watershed Management Team

Watershed planning is both a collaborative and participatory process. An effective watershed planning process often is supported by the active engagement of a local watershed team. A well-balanced watershed management team should consist of a variety of members of the community, and may include municipal officials and commissioners, business owners, landowners, environmental and civic organizations, as well as any other organizations, agencies or individuals with a stake in the preservation and improvement of water quality in the watershed (Table 2-1).

In order to ensure successful implementation of a watershed-based plan, the Eastern Connecticut Conservation District engaged a variety of stakeholders in the development of this Plan, including land owners, farmers and business owners. These stakeholders were variously involved with the water quality investigation, the development of this watershed plan, and the identification of potential implementation measures. Once the watershed plan has been approved, it will be incumbent upon the stakeholders to adopt the Plan and implement the management recommendations contained therein. Watershed management team implementation recommendations are more fully described in Section 8.1 of this document.

2.1.4. Public Participation

The participation of an engaged and committed public is critical to the successful implementation of a watershed plan. Members of the community are familiar with the watershed and may have specific resource concerns. When community members are involved from the beginning of the planning process and are satisfied their concerns are being addressed, they are more likely to support the development and implementation of the management plan. During the preparation of this plan, ECCD discussed the water quality resource concerns and solicited information from members of the public, including landowners, business owners and agricultural producers.

As plan implementations are initiated by the Watershed Management Team, it is recommended that public outreach is conducted to make watershed residents, business owners and other stakeholders aware of the watershed plan and its intended purpose, and also to gain the support and participation of those same stakeholders.

Table 2-1. Suggested Watershed Management Team

Ekonk Brook Watershed Management Partners	Role/Responsibility
Eastern Connecticut Conservation District	Project management, water quality monitoring team leader, education and outreach, watershed-based plan development
CT Department of Energy and Environmental Protection – Bureau of Water Protection and Land Reuse	Project funding, oversight and guidance, water quality/resource data and management
University of Connecticut Extension System	Outreach/education, technical support
US Environmental Protection Agency	Project funding through Clean Water Act §319 program, QAPP approval
USDA - NRCS	Technical and financial assistance to agricultural producers
Northeast Connecticut Council of Governments	Regional planning, technical advisory
Northeast District Department of Health	Water quality protection, septic system inspection/installation, education
The Last Green Valley, Inc.	Water quality data collection through the Volunteer Water Quality Monitoring program
Town of Plainfield (staff, elected officials and land use commissions)	Project information and support, land use regulations, data review
Town of Sterling (staff, elected officials and land use commissions)	Project information and support, land use regulations, data review
Town of Voluntown ((staff, elected officials and land use commissions)	Project information and support, land use regulations, data review
Local agricultural producers	Information related to agricultural land use and practices
Watershed residents	Conformance with local regulations, adoption/implementation of BMPs

3. Watershed Description

3.1. Physical and Natural Features

The Ekonk Brook watershed (CT3503) is located in eastern Connecticut, in the towns of Plainfield, Sterling and Voluntown. Approximately 83% of the watershed is located in the town of Plainfield, while 16.6% and 0.4% of the watershed is located in the towns of Sterling and Voluntown, respectively (Table 3-1).

Table 3-1. Land area of Ekonk Brook watershed in each of the watershed towns.

Town	*Acres*	*Square Miles*	*% of Watershed*
Plainfield	2833.3	4.4	83
Sterling	565.7	0.9	16.6
Voluntown	10.8	0.02	0.4
Total	3409.8	5.32	100

3.1.1. Watershed Boundaries

The Ekonk Brook sub-regional watershed encompasses a land area of 5.32 square miles (Fig. 3-1) and is part of the Moosup regional watershed (CT3500) and the Thames major watershed (CT3000). The watershed is bounded on the north by Whitney Hill in the village of Moosup, on the east by a series of hills including Webb Hill, Sterling Hill, and Ekonk Hill, on the south by Bare Hill, and on the west by Hopkins Hill and several unnamed hills located within the boundaries of Pachaug State Forest. Ekonk Brook is nested within the lower Moosup River watershed (HUC 011000010503). Hydrologic unit codes (HUC) are designators within a hierarchical cataloging system developed by the US Geological Survey to identify hydrologic units (watersheds) throughout the US. The HUC system is based on major river systems, with nested regional, sub-regional and smaller units contained within.

3.1.2. Topography/Elevation

Ekonk Brook is located in a long, fairly narrow, north/south-oriented valley framed by gently rolling hills ranging in elevation from 575 to 670 feet (Fig. 3-2). The eastern boundaries tend to be higher than the west, with the maximum elevation of 670 feet at Ekonk Hill. Maximum elevation on the west side of the watershed is approximately 575 ft. Slopes range from 6 to 11.5% from the valley floor to the hilltops forming the watershed boundaries. There are locations where slopes of the valley walls are very steep, particularly on the eastern slopes of Hopkins Hill, in the northwest part of the watershed. The elevation relief of Ekonk Brook from Lockes Meadow Pond to the outlet at the Moosup River is 230 feet, a gradient of 0.01 foot/foot.

3.1.3. Climate/Precipitation

Southern New England, including eastern Connecticut, has a humid continental climate characterized by cold winters and hot summers. Temperature ranges from 20º F to 90º

F are typical, and short duration temperature extremes ranging from 0º F to 100º F are not uncommon. Eastern Connecticut receives approximately 42-46 inches of precipitation each year. Precipitation is distributed relatively evenly throughout the year and falls as either rain or snow. Changes in weather patterns due to global climate change have been noted in Connecticut. These changes include an increase in rainfall versus snowfall in the winter, which may result in more surface runoff due to frozen ground conditions and less spring snowmelt; decreased precipitation during the hotter summer months, resulting in lower groundwater levels and decreased stream and river baseflow; and an increase in rainstorm intensity, resulting in greater potential for storm runoff and flash flooding.

3.1.4. Geology and Soils

Bedrock in the Ekonk Brook watershed is comprised of fractured crystalline rock, including quartzite, gneiss, granitic gneiss and schist of the Avalonian Terrane, which dates from the Proterozoic Z age, 570-800 million years ago. The Avalonian Terrane was a volcanic island arc which attached to the proto-Euramerican plate during the Devonian period, approximately 420 million years ago. Bedrock geology of the Avalonian Terrane in the Ekonk Brook watershed is composed of the Plainfield Formation, interlayered thinly bedded quartzite, mica, schist and dark grey gneiss; the Hope Valley Alaskite Gneiss Formation, a light pink to grey, medium to coarse-grained granitic gneiss; and the Scituate Granite Gneiss Formation, a light pink to grey, medium to coarse-grained lineated granitic gneiss (CT DEP, 1985).

Soils in the Ekonk Brook watershed are comprised of lodgement and melt-out tills, with glaciofluvial and alluvial floodplain soils and muck soils in the lower elevations (Fig. 3-3). These soils were deposited during and after the last glacial period in Connecticut, which ended approximately 12,000 years ago. Predominant soil types include Woodbridge fine sandy loams (23.8%), Ridgebury, Leicester and Whitman soils (17.5%), and Charlton-Chatfield Complex soils (11.8%). Woodbridge fine sandy loams are “very deep, moderately well drained, gently sloping soil on tops of hills, on side slopes, and on toe slopes within uplands (USDA, 2003).” Ridgebury, Leicester and Whitman soils are “poorly drained and very poorly drained soils in depressions and drainage-ways on uplands and in valleys (USDA, 2003).” Charlton-Chatfield Complex soils are “gently sloping to very steep, well drained and somewhat excessively drained, loamy soils located on glacial till uplands (USDA, 2003).”

The Connecticut Inland Wetlands and Watercourses Act (sections 22a-36 through 22a-45 of the General Statutes of Connecticut) defines wetland soils as soils that are poorly drained, very poorly drained, alluvial and floodplain. Wetland soils comprise approximately 23% of soils in the Ekonk Brook watershed (Table 3-2 and Fig. 3-4).

Table 3-2. Connecticut Wetland Soils

Symbol	*Soil Type*	*Soil Class*	*Acres*	*% Watershed*
2	Ridgebury fine sandy loam	Poorly Drained and Very Poorly Drained Soils	21.6	0.6
3	Ridgebury, Leicester, and Whitman soils, extremely stony	Poorly Drained and Very Poorly Drained Soils	596.7	17.5
13	Walpole sandy loam	Poorly Drained and Very Poorly Drained Soils	13.6	0.4
15	Scarboro muck	Poorly Drained and Very Poorly Drained Soils	13.5	0.4
17	Timakwa and Natchaug soils	Poorly Drained and Very Poorly Drained Soils	16.7	0.5
18	Catden and Freetown soils	Poorly Drained and Very Poorly Drained Soils	9.2	0.3
100	Suncook loamy fine sand	Alluvial and Floodplain Soils	2.5	0.1
102	Pootatuck fine sandy loam	Alluvial and Floodplain Soils	11.1	0.3
103	Rippowam fine sandy loam	Alluvial and Floodplain Soils	98.6	2.9
		Total	783.4	23.0

The US Department of Agriculture Natural Resources Conservation Service has identified prime and statewide important farmland soils (Table 3-3). These are soils that have physical and chemical characteristics that render them suitable for the production of crops. There are approximately 1,248 acres of farmland soils in the Ekonk Brook watershed, which comprise 37% of the soils in the watershed (Table 3-4). Of those, 337 acres (10%) are Statewide Important Farmland Soils and 911 acres (27%) are Prime Farmland Soils (Fig. 3-5).

Table 3-3. USDA description of farmland soil classes

Prime Farmland Soils:
Soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oil seed crops, and are also available for these uses (the land could be cropland, pastureland, range-land, forestland, or other land, but not urban built-up land or water). It has the soil quality, growing season and moisture supply needed to economically produce sustained high yields or crops when treated and managed, including water management, according to acceptable farming practices

Statewide Important Farmland Soils:
Soils that fail to meet one or more of the requirements of prime farmland, but are important for the production of food, feed, fiber, or forage crops. They include those soils that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods.

- CT ECO, 2015

Table 3-4. Description of prime and important farmland soils found in the Ekonk Brook watershed.

Symbol	*Soil*	*Farmland Class*	*Acres*	*% Watershed*
2	Ridgebury fine sandy loam	Prime Farmland Soils	16.0	0.5
13	Walpole sandy loam	Prime Farmland Soils	30.0	0.9
100	Suncook loamy fine sand	Prime Farmland Soils	35.9	1.1
102	Pootatuck fine sandy loam	Prime Farmland Soils	112.7	3.3
103	Rippowam fine sandy loam	Prime Farmland Soils	507.4	14.9
23A	Sudbury sandy loam, 0 to 5 percent slopes	Prime Farmland Soils	13.8	0.4
34B	Merrimac sandy loam, 3 to 8 percent slopes	Prime Farmland Soils	195.5	5.7
38A	Hinckley gravelly sandy loam, 0 to 3 percent slopes	Statewide Important Farmland Soils	44.6	1.3
38C	Hinckley gravelly sandy loam, 3 to 15 percent slopes	Statewide Important Farmland Soils	13.6	0.4
45A	Woodbridge fine sandy loam, 0 to 3 percent slopes	Statewide Important Farmland Soils	2.5	0.1
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	Statewide Important Farmland Soils	99.1	2.9
45C	Woodbridge fine sandy loam, 8 to 15 percent slopes	Statewide Important Farmland Soils	8.1	0.2
60B	Canton and Charlton soils, 3 to 8 percent slopes	Statewide Important Farmland Soils	93.6	2.7
60C	Canton and Charlton soils, 8 to 15 percent slopes	Statewide Important Farmland Soils	60.0	1.8
84B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes	Statewide Important Farmland Soils	2.7	0.1
84C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes	Statewide Important Farmland Soils	12.5	0.4
		total	1248.1	36.6

3.1.5. Vegetation

The Ekonk Brook watershed is located in the Eastern Broadleaf Forest Province (US Forest Service). Vegetation in the Ekonk Brook watershed is comprised primarily of tall, cold-deciduous broadleaf forests, including oak-hickory, maple-beech-birch, and aspen-birch forest groups in upper elevations and elm-ash-red maple forest groups in lower elevations (USDA, 2004). Coniferous species include scattered white pine stands in upland areas, and hemlocks along stream corridors and in forested wetlands.

3.1.6. Exotic/Invasive Species

Common non-native invasive plant species, including bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), common reed (*Phragmites australis*), and Japanese Knotweed (*Fallopia japonica*), were noted in disturbed areas, roadsides and along

stream corridors. No invasive animal species were noted during the water quality investigation; however, that does not preclude their presence or absence. Non-native species can be detrimental to native plants and wildlife. Non-native species are considered invasive when they exhibit qualities that allow them to out-compete native species, which can result in the colonization of an area and displacement of native species. Invasive species can affect the availability of resources necessary to native species, alter the food web, and can be expensive to manage and eradicate.

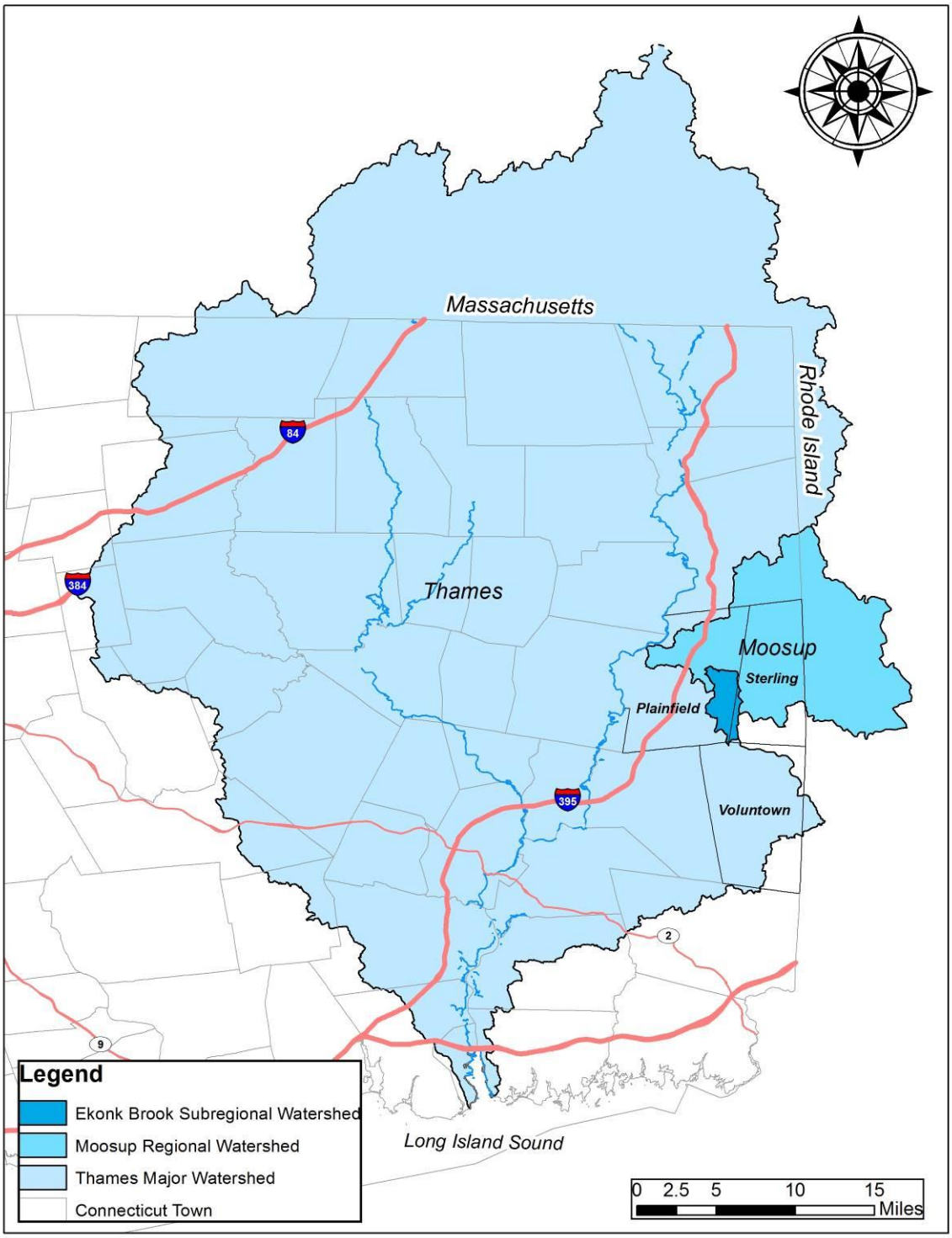


Figure 3-1. Ekonk Brook watershed (dark blue), located in Plainfield, Sterling and Voluntown, CT., nested in the Moosup regional and Thames major watersheds (CT DEEP, 2009).

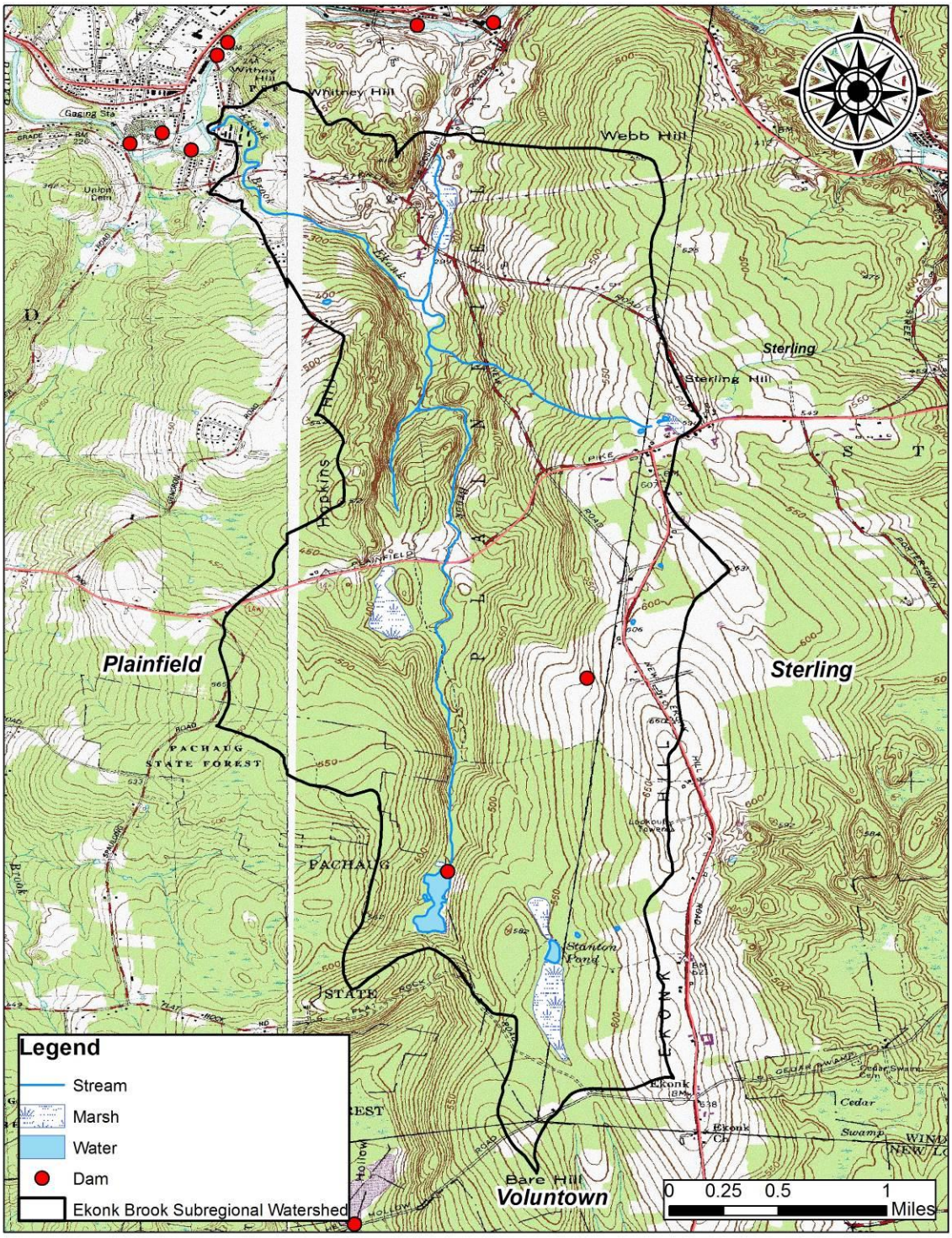


Figure 3-2. Topography and hydrography of the Ekonk Brook watershed (USGS,1999 and CT DEEP, 2009).

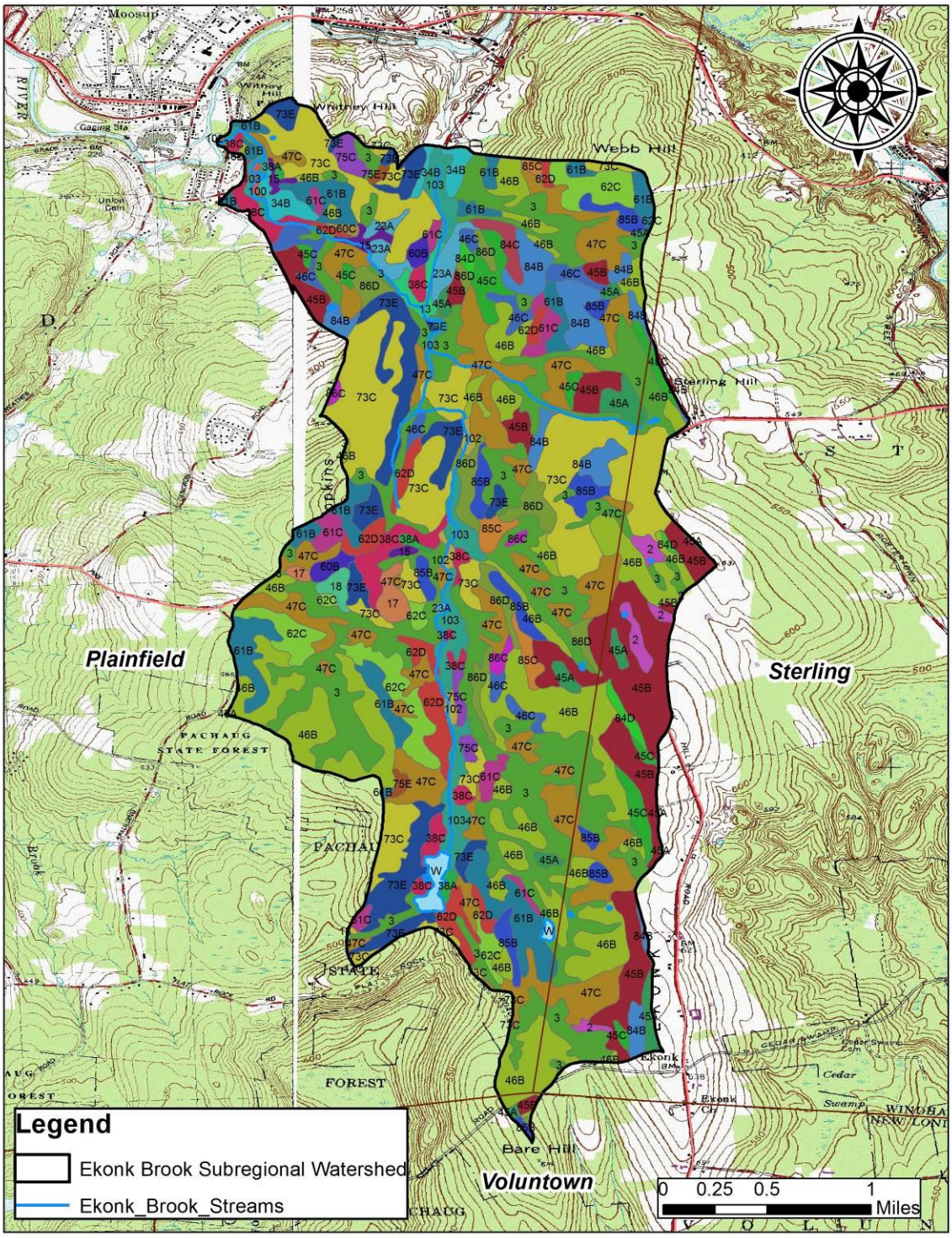


Figure 3-3. Soils in the Ekonk Brook watershed (USDA-NRCS Soil Survey, 2009).

Table 3-5. Description of soils in the Ekonk Brook watershed (SSURGO, 2009).

Symbol	*Soil Description*	*Acres*	*% Watershed*
2	Ridgebury fine sandy loam	21.6	0.6
3	Ridgebury, Leicester, and Whitman soils, extremely stony	596.7	17.5
13	Walpole sandy loam	13.6	0.4
15	Scarboro muck	13.5	0.4
17	Timakwa and Natchaug soils	16.7	0.5
18	Catden and Freetown soils	9.2	0.3
100	Suncook loamy fine sand	2.5	0.1
102	Pootatuck fine sandy loam	11.1	0.3
103	Rippowam fine sandy loam	98.6	2.9
23A	Sudbury sandy loam, 0 to 5 percent slopes	30.0	0.9
34B	Merrimac sandy loam, 3 to 8 percent slopes	28.5	0.8
38A	Hinckley gravelly sandy loam, 0 to 3 percent slopes	8.1	0.2
38C	Hinckley gravelly sandy loam, 3 to 15 percent slopes	68.0	2.0
45A	Woodbridge fine sandy loam, 0 to 3 percent slopes	46.8	1.4
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	238.9	7.0
45C	Woodbridge fine sandy loam, 8 to 15 percent slopes	59.2	1.7
46B	Woodbridge fine sandy loam, 2 to 8 percent slopes, very stony	445.5	13.1
46C	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony	45.8	1.3
47C	Woodbridge fine sandy loam, 2 to 15 percent slopes, extremely stony	367.2	10.8
60B	Canton and Charlton soils, 3 to 8 percent slopes	13.8	0.4
60C	Canton and Charlton soils, 8 to 15 percent slopes	2.7	0.1
61B	Canton and Charlton soils, 3 to 8 percent slopes, very stony	163.8	4.8
61C	Canton and Charlton soils, 8 to 15 percent slopes, very stony	41.4	1.2
62C	Canton and Charlton soils, 3 to 15 percent slopes, extremely stony	99.6	2.9
62D	Canton and Charlton soils, 15 to 35 percent slopes, extremely stony	72.9	2.1
73C	Charlton-Chatfield complex, 3 to 15 percent slopes, very rocky	401.6	11.8
73E	Charlton-Chatfield complex, 15 to 45 percent slopes, very rocky	156.4	4.6
75C	Hollis-Chatfield-Rock outcrop complex, 3 to 15 percent slopes	19.7	0.6
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	6.3	0.2
84B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes	95.0	2.8
84C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes	12.5	0.4
84D	Paxton and Montauk fine sandy loams, 15 to 25 percent slopes	12.3	0.4
85B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes, very stony	70.0	2.1
85C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes, very stony	21.4	0.6
86C	Paxton and Montauk fine sandy loams, 3 to 15 percent slopes, extremely stony	9.3	0.3
86D	Paxton and Montauk fine sandy loams, 15 to 35 percent slopes, extremely stony	75.7	2.2
W	Water	14.2	0.4

Total	3409.8	100.0

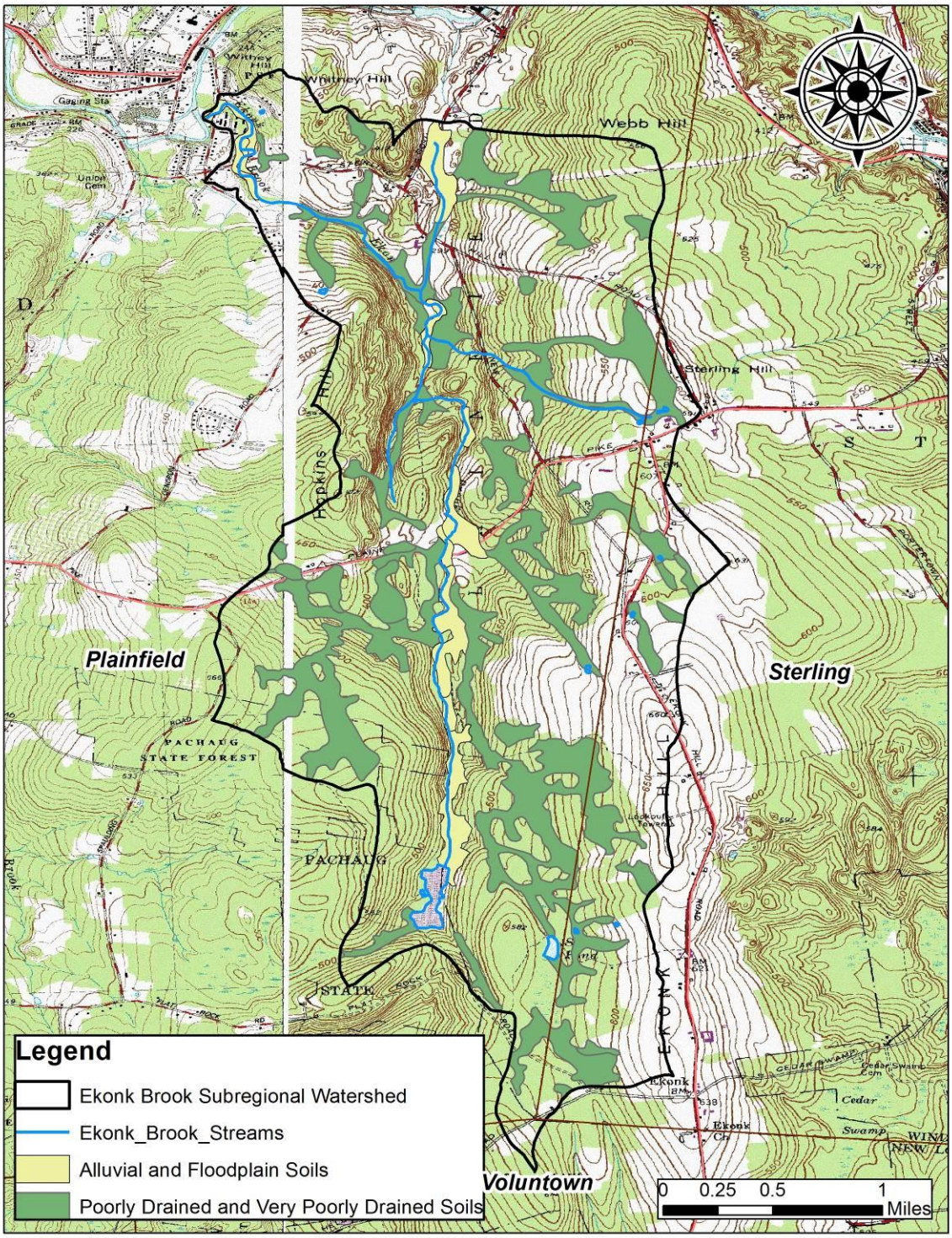


Figure 3-4. Location of wetland soils in the Ekonk Brook watershed as defined by Connecticut General Statutes (USDA-NRCS Soil Survey, 2009).

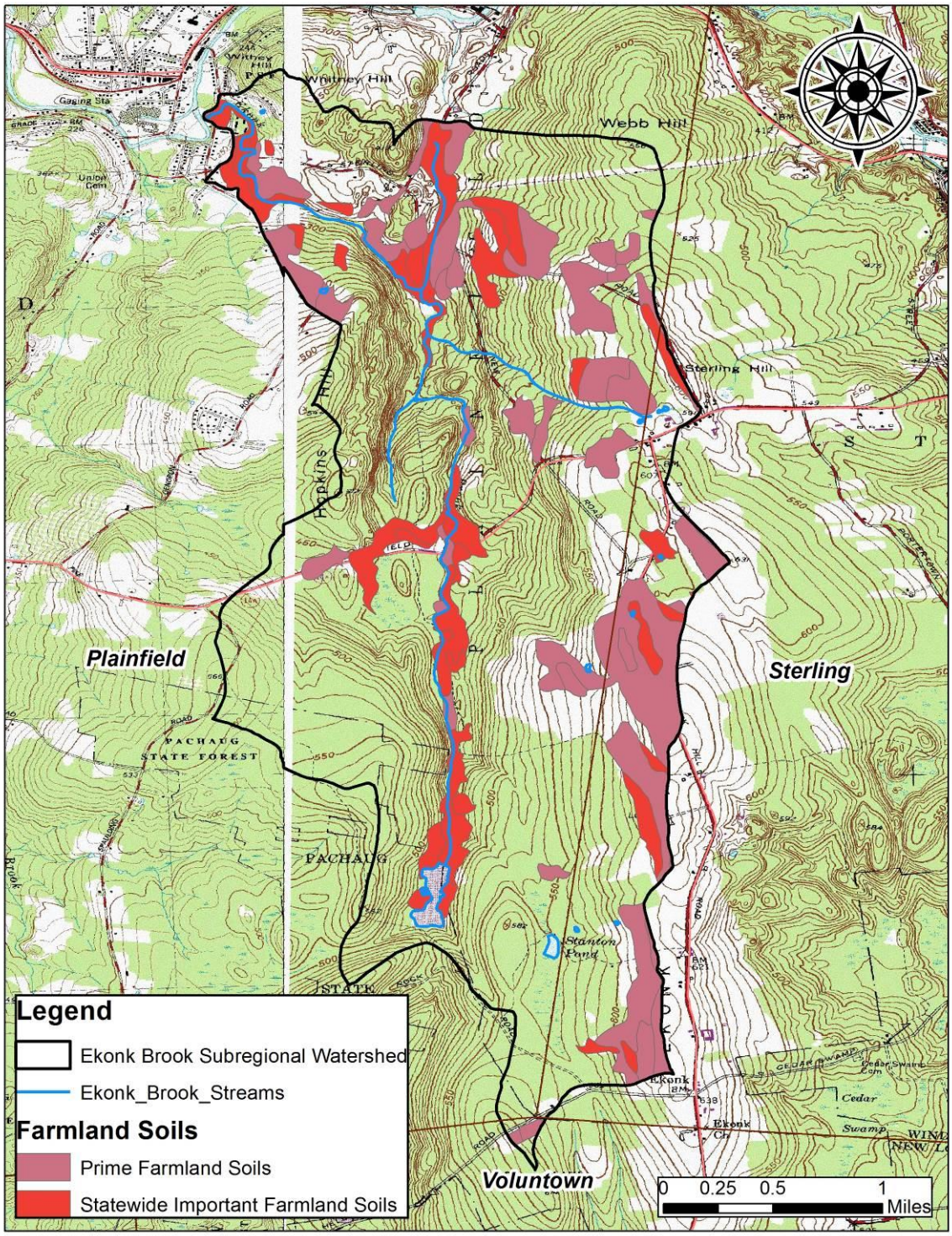


Figure 3-5. Location of prime and statewide important farmland soils in the Ekonk Brook watershed (USDA-NRCS Soil Survey, 2010).

3.2. Water Resources

3.2.1. Hydrology

There are 6.62 miles of perennial streams in the Ekonk Brook watershed (Fig. 3-2). Ekonk Brook, which has its headwaters at Lockes Meadow Pond, a pond/shallow open marsh in Pachaug State Forest at the south end of the watershed, is the primary watercourse located in the watershed. The 4.5 mile-long Ekonk Brook discharges to the Moosup River just west of River Street in Moosup. Sterling Hill Brook is a 0.91 mile-long watercourse that flows to Ekonk Brook from Sterling Hill in the eastern half of the watershed. A 0.7 mile-long unnamed stream originating in the Goshen Road area flows under Sterling Hill Road before merging with Ekonk Brook. The 0.5 mile-long Davis Brook flows north to Ekonk Brook from near State Route 14A, in the mid-part of the watershed.

Notable ponds in the watershed include the 12-acre Lockes Meadow Pond and the 2.25-acre Stanton Pond, located southeast of Lockes Meadow Pond in the southern part of the watershed. Additional small farm ponds of 1 acre or less are scattered throughout the watershed.

3.2.2. Surface and Groundwater Resources

The State of Connecticut is required through Section 303 of the Federal Water Pollution Control Act (better known as the Clean Water Act) to assess surface and ground waters within the state and assign water classifications based on designated uses. Water quality classifications serve to establish designated uses for surface and ground waters and identify criteria necessary to support those uses. Designated uses may include public water supplies, support of fish and other aquatic wildlife, agricultural and industrial purposes, recreation and navigation.

Surface waters in the Ekonk Brook watershed, including Ekonk Brook, tributary streams, Lockes Meadow Pond and Stanton Pond, have surface water quality classifications of A (Fig. 3-6). Designated uses in Class A surface waters include habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture. Permitted discharges to a Class A water may include discharges from public or private drinking water treatment systems, dredging activity and dredge material dewatering operations, including the discharge of dredged or fill material and clean water discharges (State of CT Department of Environmental Protection Water Quality Standards, 2011).

Groundwater throughout most of the Ekonk Brook watershed is classified as GA (Fig. 3-7). Designated uses for Class GA groundwater include existing private and potential public or private supplies of water suitable for drinking without treatment and base flow for hydraulically-connected surface water bodies. A small portion of the watershed (approximately 19 acres) in the Moosup section of Plainfield is classified as GAA.

Designated uses for Class GAA groundwater includes existing or potential public supply of water suitable for drinking without treatment and baseflow for hydraulically-connected surface water bodies.

3.2.3. Wetlands and Floodplains

Wetlands are low-lying areas in the landscape where water is at or near the ground surface. Wetlands are characterized by the presence of hydric soils (Table 3-6), which are soils that have been saturated for extended periods of time and which have developed physio-chemical characteristics in the upper soil layers related to anaerobic conditions (NRCS, 2015). Wetlands support specific plant and animal communities, including hydrophytes, plants that are adapted to the prolonged presence of water. Wetlands are important in that they provide both water quality and flood management ecosystem services. Wetlands capture and store rainwater, slowly infiltrating it into the ground and replenishing groundwater supplies. Wetlands provide water quality renovation by filtering sediment, nutrients and other water-borne pollutants as water infiltrates into the water table, where it becomes available for withdrawal by private drinking water wells. This is especially important in rural areas where many residents rely on wells for their drinking water.

Table 3-6. Connecticut Wetland Soils

Wetland soils are defined in the Connecticut Inland Wetlands and Watercourses Act (sections 22a-36 through 22a-45) by soil drainage class and landscape position:
Poorly drained soils occur where the water table is at or just below the ground surface, usually from late fall to early spring. The land where poorly drained soils occur is nearly level or gently sloping. **Very poorly drained** soils generally occur on level land or in depressions. In these areas, the water table lies at or above the surface during most of the growing season. **Alluvial and Floodplain** soils occur along watercourses occupying nearly all level areas subject to periodic flooding. These soils are formed when material is deposited by flowing water. Such material can be composed of clay, silt, sand or gravel. Alluvial and floodplain soils range from excessively drained to very poorly drained. - CT DEEP, 2015

Typical wetlands in Connecticut include red maple swamps, marshes and bogs. Approximately 2.3 percent of Ekonk Brook is designated as wetlands. Of that, 1.9% (about 64 acres) is forested wetland, and is comprised primarily of red maple swamp.

Floodplains are low-lying areas adjacent to watercourses or ponds that are subject to flooding. Like wetlands, flood plains capture and hold flood waters, infiltrating them into the ground or releasing them slowly as flood waters recede. Floodplains are important to the management of flood waters and especially to the mitigation of potential down-stream flood damage.

The Federal Emergency Management Agency (FEMA) has designated Ekonk Brook and the adjacent stream corridor area from just south of State Route 14A north to the confluence with the Moosup River as flood zone A (Fig. 3-8). Flood zone A is designated as having a 1% annual chance of flooding. The 1% annual chance flood is also referred to as a100-year flood (FEMA, 2015).

Watershed managers are advised to review FEMA flood hazard data as it is updated and becomes available to determine flood risk within the Ekonk Brook watershed. Managers should also review the *2015 Northeastern Connecticut Council of Governments Regional Hazard Mitigation Plan* relative to potential flood risks. In most areas south of Sterling Hill Road and particularly to the south of State Route 14A, Ekonk Brook is relatively undeveloped and well connected to its natural floodplain, which may lessen the risk for flooding further upstream, particularly along the Moosup River, which flooded in March 2015 in response to uncharacteristically heavy early spring rains.

3.2.4. Dams

Dams are impoundments of free flowing waters. In colonial New England, many small streams were dammed to provide hydropower for small gristmills and saw mills needed to grind grain for flour and provide lumber for construction. In the 1800s, at the advent of the industrial era, larger dams were erected to provide hydropower for thread and cloth mills. Dams were also erected to create ponds for watering livestock and for fire suppression.

There are two dams located in the Ekonk Brook watershed, including an earthen dam at the north end of Lockes Meadow Pond in Pachaug State Forest, and a small earthen dam at a small pond located on private property in the eastern part of the watershed (Fig. 3-2). Neither dam is included in CT DEEP's *Listing of High, Significant, and Moderate Hazard Dam Owners and Dams in Connecticut* (updated on December 30, 2013).

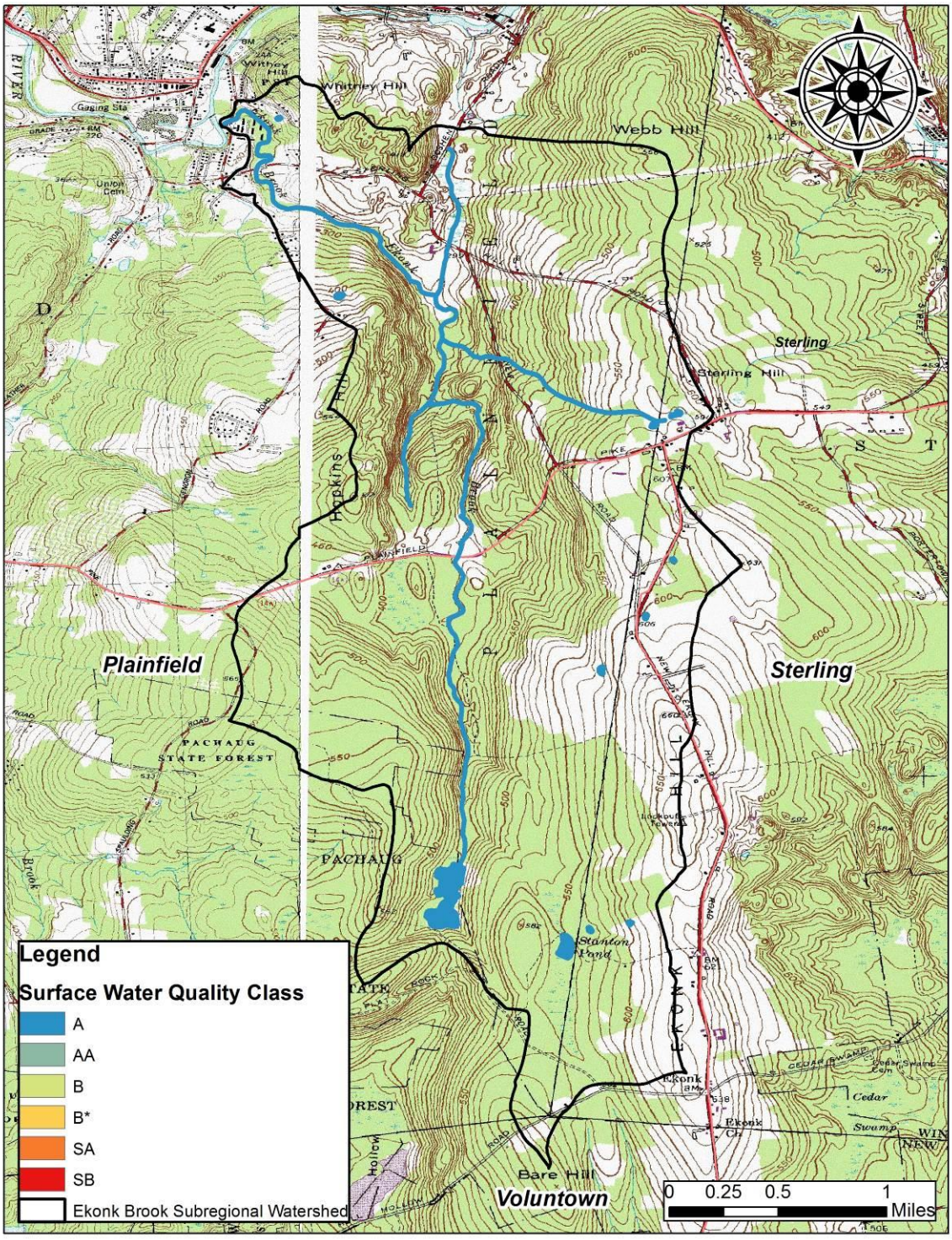


Figure 3-6. Surface water quality in the Ekonk Brook watershed (CT DEEP GIS, 2012).

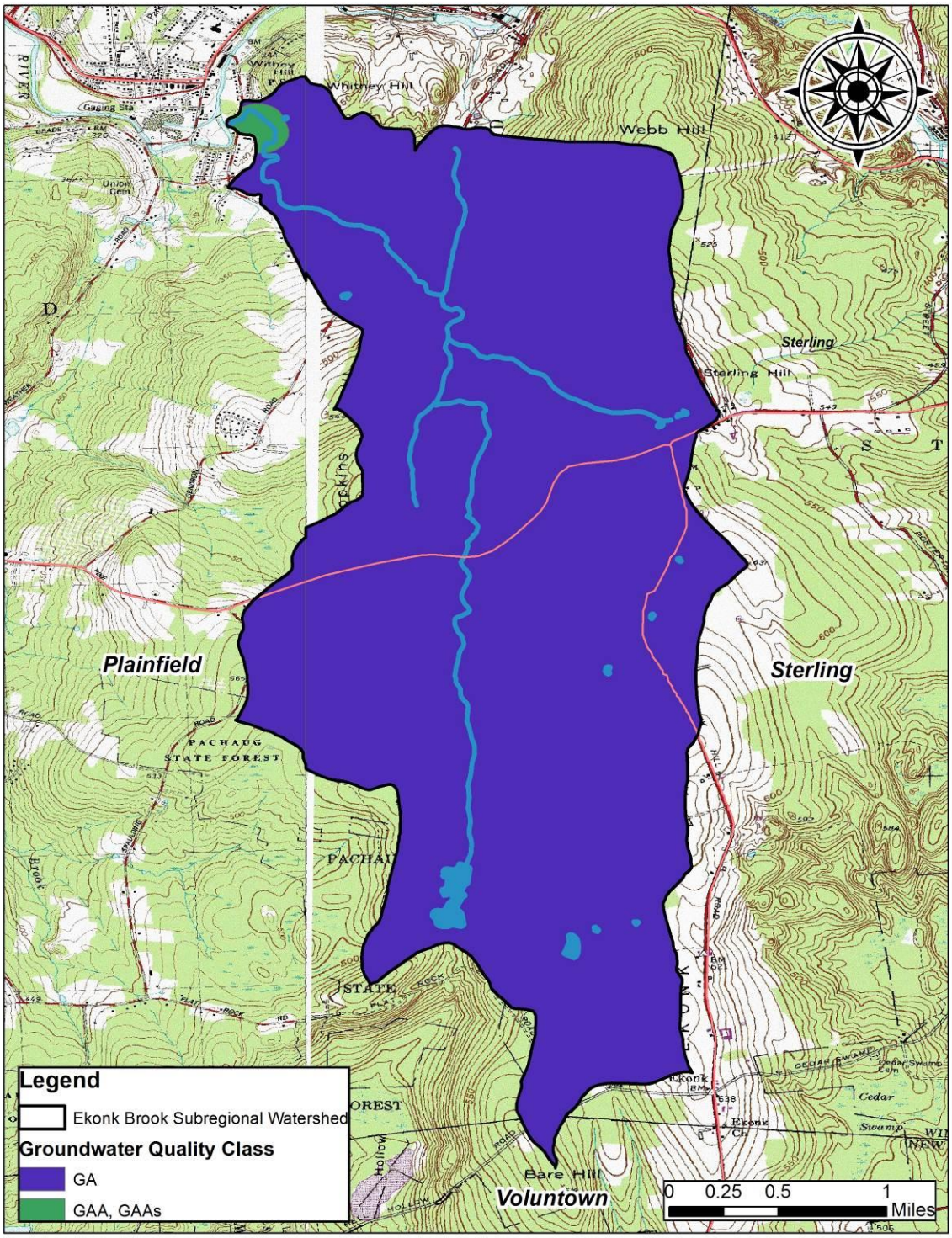


Figure 3-7. Groundwater quality classification (CT DEEP GIS, 2012).

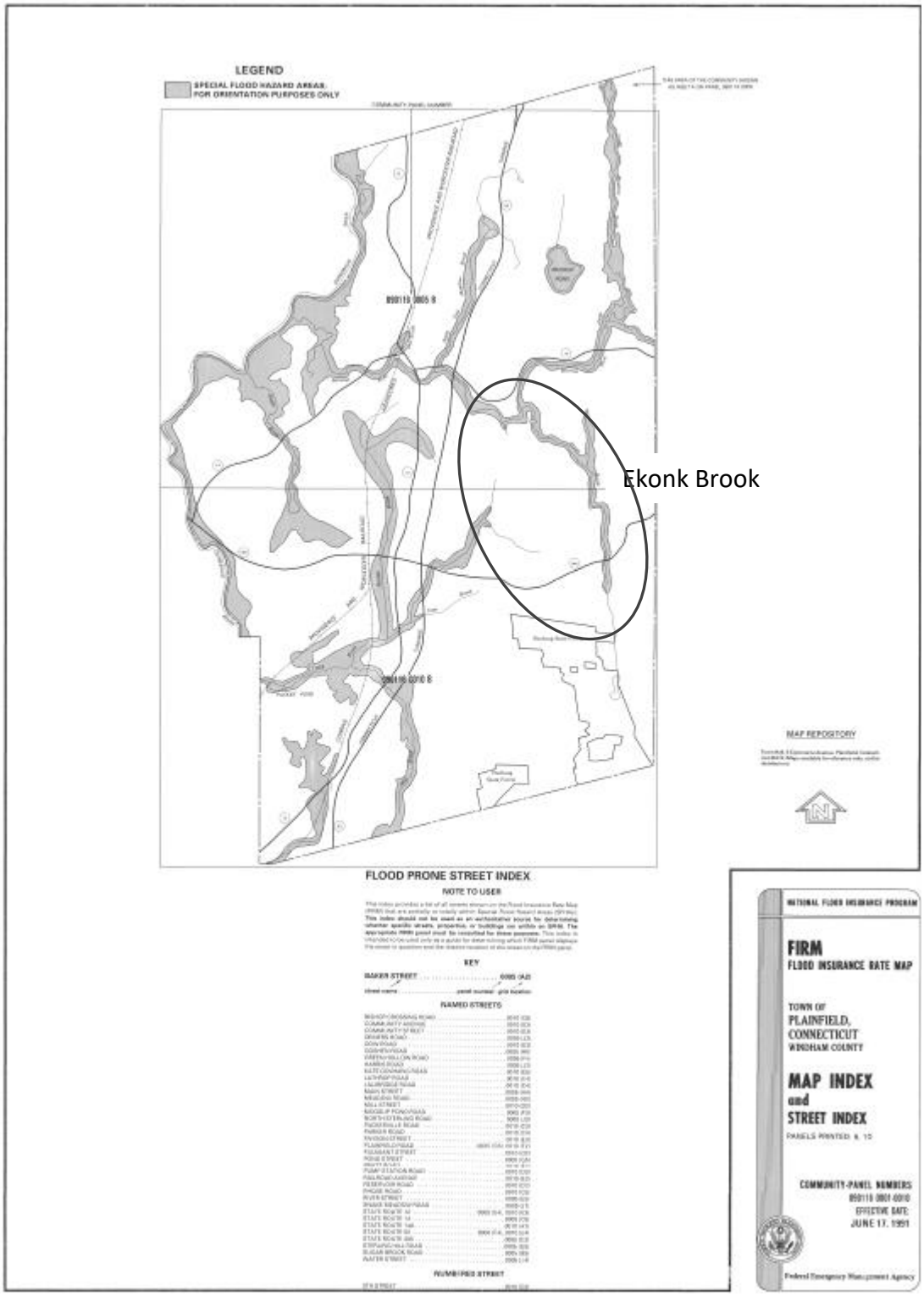


Figure 3-8. FIRM map of Plainfield depicting flood zone A along portions of Ekonk Brook (refer to individual Firm map panels for more detailed information regarding flood zones locations and descriptions).

3.3. Wildlife and Fisheries Resources

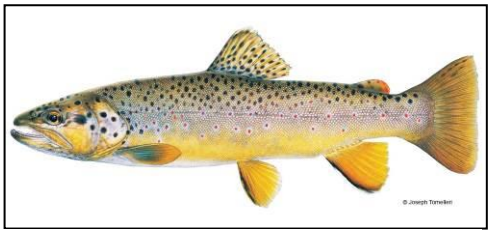
3.3.1. Wildlife/Waterfowl

Connecticut is located at the intersection of two ecological regions of the Eastern Broadleaf forest province, the lower New England section and the Northern Appalachian Piedmont section. As a result, Connecticut supports several animal species that are at the northern or southern limit of their natural ranges. The *2015 Connecticut Wildlife Action Plan* (CT DEEP) reports that "…the northeast-upland areas of Connecticut fall within the southern distribution limit for species like the northern saw-whet owl and yellow-rumped warbler." According to CT DEEP (2014), the state's "physiographic gradient and associated regional climatic differences provided a complex ecological framework that supports 84 species of mammals, 335 species of birds, 50 species of reptiles and amphibians, 169 species of fish and an estimated 20,000 species of invertebrates."

The Plainfield *Plan of Conservation and Development* (2008) notes that the greatest threat to wildlife in Plainfield is the encroachment of development which fragments forests and impinges on habitat necessary to support thriving wildlife populations. The 12-acre Lockes Meadow Pond, which is the largest waterbody in the watershed, contains both open water and open marsh habitat. It is the most suitable habitat in the watershed for waterfowl, and attracts both nesting birds and migratory waterfowl

3.3.2. Fisheries

Ekonk Brook is a recreational trout stream and is stocked annually by CT DEEP. DEEP typically stocks about 100 adult brown trout at the Ekonk Brook crossings at Sterling Hill Road and State Route 14A annually (*DEEP 2014 Fish Stocking Report*). Inland fishery surveys conducted by CT DEEP in 2014 indicated the presence of native fish species including tessellated darter (*Etheostoma olmstedi*) and white sucker (*Catostomus commersoni*).



http://www.vtfishandwildlife.com

The CT DEEP Inland Fisheries Division has been coordinating a dam/fish passage barrier removal program in the Moosup River, in partnership with the Town of Plainfield, American Rivers, Inc., and the USDA Natural Resources Conservation Service (NRCS). The purpose of the program is to improve river/stream passage and connectivity with previous disconnected up- and downstream areas, as well as with tributary streams such as Ekonk Brook, for migratory and resident fish and other aquatic organisms, as well as improve water quality.

3.3.3. Protected Species

In 1989, Connecticut passed the Endangered Species Act (Sec. 26-303 to 26-316 of the Connecticut General Statutes). The Endangered Species Act recognizes that certain plant and animal species and their habitats have become extinct or are threatened with extinction due to human activity (Table 3-7). The Act charges the State to "…conserve, protect, restore and enhance any endangered or threatened species and essential habitat."

Table 3-7. Listed Species Risk Level Definitions

Endangered Species: any native species documented by biological research and inventory to be in danger of extirpation throughout all or a significant portion of its range within the state and to have no more than five occurrences in the state, and any species determined to be an "endangered species" pursuant to the federal Endangered Species Act.
Threatened Species: any native species documented by biological research and inventory to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range within the state and to have no more than nine occurrences in the state, and any species determined to be a "threatened species" pursuant to the federal Endangered Species Act, except for such species determined to be endangered by the Commissioner in accordance with section 4 of this act.
Species of Special Concern: any native plant species or any native non-harvested wildlife species documented by scientific research and inventory to have a naturally restricted range or habitat in the state, to be at a low population level, to be in such high demand by man that its unregulated taking would be detrimental to the conservation of its population or has been extirpated from the state. -State of Connecticut Endangered Species Act, 1989

Each listed species is assigned a risk level and is listed in the Connecticut Natural Diversity Data Base (NDDB). The NDDB compiles data on listed species and natural communities and maintains maps that represent their approximate locations.

The Connecticut Department of Energy and Environmental Protection's Natural Diversity Database (NDDB) identifies multiple Natural Diversity Database sites along New Road, Goshen Road and the State Route 49 corridors (Fig. 3-9). Additional NDDB sites were identified in the west and south parts of the watershed. According to CT DEEP, these sites may include both terrestrial and aquatic plant and animal species.

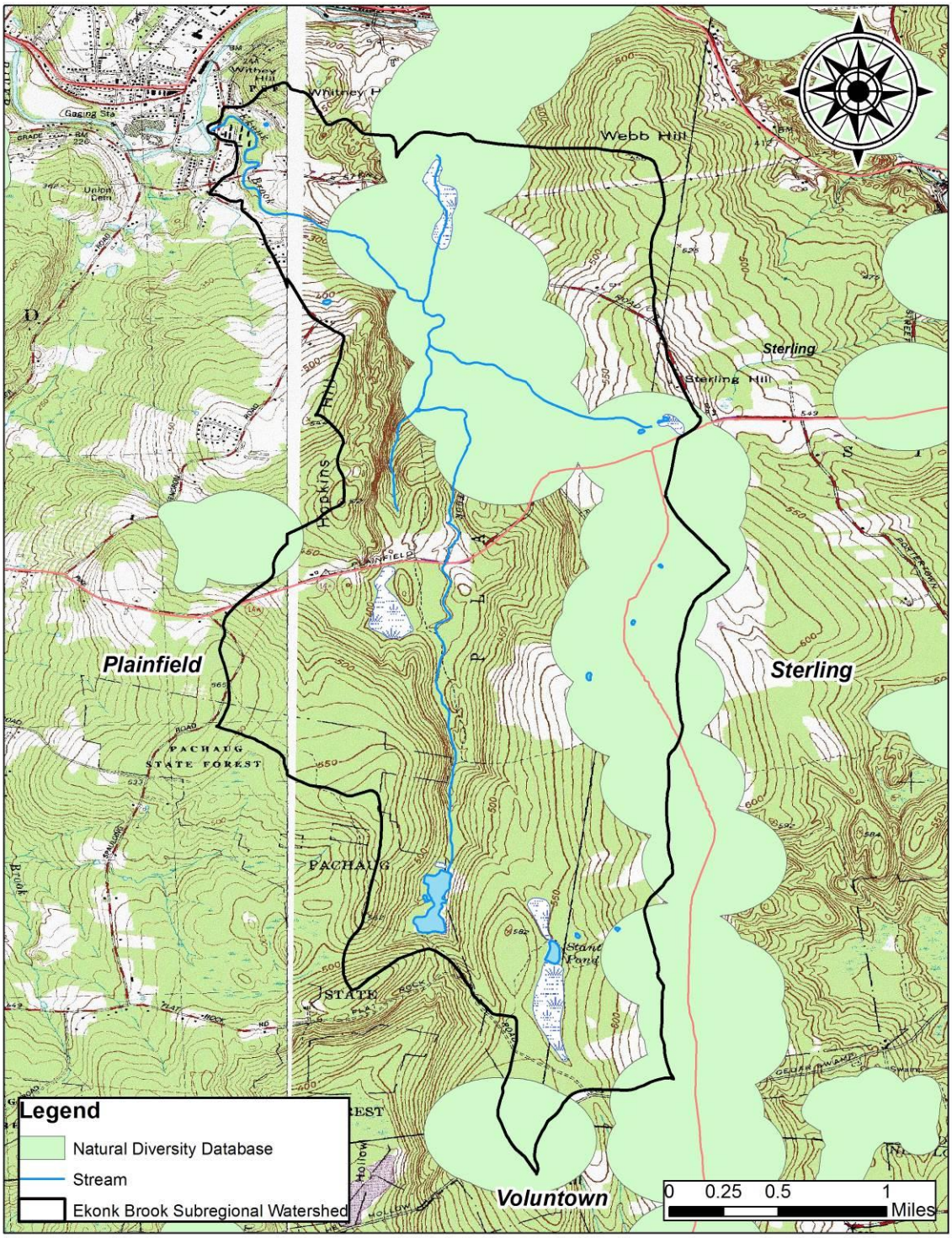


Figure 3-9. Natural diversity database (NDDB) sites in the Ekonk Brook watershed.

For more specific information on listed species and natural communities, inquiries should be directed to CT DEEP's Natural Diversity Database program. Watershed managers should take the presence of these species in mind when planning implementation activities. Local regulatory and advisory authorities should be aware of the presence of these species as well when reviewing land use permit applications to ensure that necessary actions are taken to protect these species, natural communities and habitats.

3.4. Sensitive Areas

Sensitive areas are those areas that contain plants, animals and physical or geographic features that could be threatened by poor land management or unrestricted development. These may include areas with listed species and natural communities, wetlands, floodways and floodplains, riparian corridors, and areas with steep slopes, erodible soils, or other physical or cultural constraints.

Sensitive areas within the Ekonk Brook watershed include:

- The mid-section of Ekonk Brook from State Route 14A to Northern Drive, and the entirety of Sterling Hill Brook and the unnamed stream flowing south from Goshen Road, where numerous Natural Diversity Database (NDDB) sites have been identified.
- Undeveloped floodplain and wetlands along Ekonk Brook extending south from Sterling Hill Road to Lockes Meadow Pond. The Natural Diversity Database identified flood plain forest as a critical habitat, as well as several plant and animal species associated with bogs. The lack of development and floodplain connection in this segment of Ekonk Brook not only provide habitat for numerous plant and animal species, but protect developed areas downstream from the effects of flooding.
- Erodible soils along the Ekonk Brook stream corridor and in the northern portion of the watershed, particularly those associated with steep slopes and agricultural activity.

3.5. Land Use and Land Cover

Land use and land cover define the character of a landscape. Whether a landscape is developed and how that development is distributed across the landscape can affect not only the aesthetic qualities of a place, but also the quality of the land, air and water.

The Ekonk Brook watershed is predominantly rural. Land cover in the watershed is dominated by undeveloped deciduous and coniferous forest (Fig. 3-10). Developed land (defined as residential, commercial and/or industrial development and associated paved surfaces), including rural residential, suburban and urban development as well as turf grass areas (lawns) comprises approximately 8.5% of the watershed (Table 3-8). About 20% of

the watershed is used for pasture, hay land and cropland. Approximately 88 acres, or 2.6% of the watershed, is comprised of wetlands and waterbodies.

Table 3-8. Land Use and Land Cover in the Ekonk Brook Watershed.

Land Cover Class	*Area (acres)*	*% Watershed*
Developed	183.7	5.4%
Turf & Grass	104.7	3.1%
Other Grasses	107.0	3.1%
Agricultural	578.5	17.0%
Deciduous Forest	2244.5	65.8%
Coniferous Forest	85.4	2.5%
Water	10.3	0.3%
Non-forested Wetland	14.0	0.4%
Forested Wetland	64.1	1.9%
Barren Land	4.1	0.1%
Utility Corridor	13.3	0.4%

A study conducted by CLEAR evaluated changes in land cover from 1985 to 2006 (CLEAR, 2008). An evaluation of land use in the Ekonk Brook watershed from 1985 to 2010 (Fig. 3-11) indicates that the amount of developed land (including turf and grass areas) has increased by 35%, land under cultivation has increased 9%, while the amount of forest land and wetlands have decreased 8% and 21%, respectively (Table 3-9).

Table 3-9. Change in land cover between 1985 and 2010 in the Ekonk Brook watershed (CLEAR, 2014).

Land Cover Class	*1985 Land Cover (acres)*	*2010 Land Cover (acres)*	*Land Cover Change (acres)*	*% Change*
Developed	164.1	183.7	19.5	12%
Turf & Grass	84.9	104.7	19.7	23%
Other Grasses	13.8	107.0	93.2	677%
Agricultural Field	531.7	578.5	46.8	9%
Deciduous Forest	2409.1	2244.5	-164.6	-7%
Coniferous Forest	86.1	85.4	-0.7	-1%
Water	13.3	10.3	-3.0	-22%
Non-forested Wetland	14.5	14.0	-0.5	-3%
Forested Wetland	78.3	64.1	-14.2	-18%
Barren Land	0.0	4.1	4.1	100%
Utility Corridor	15.2	13.3	-1.8	-12%

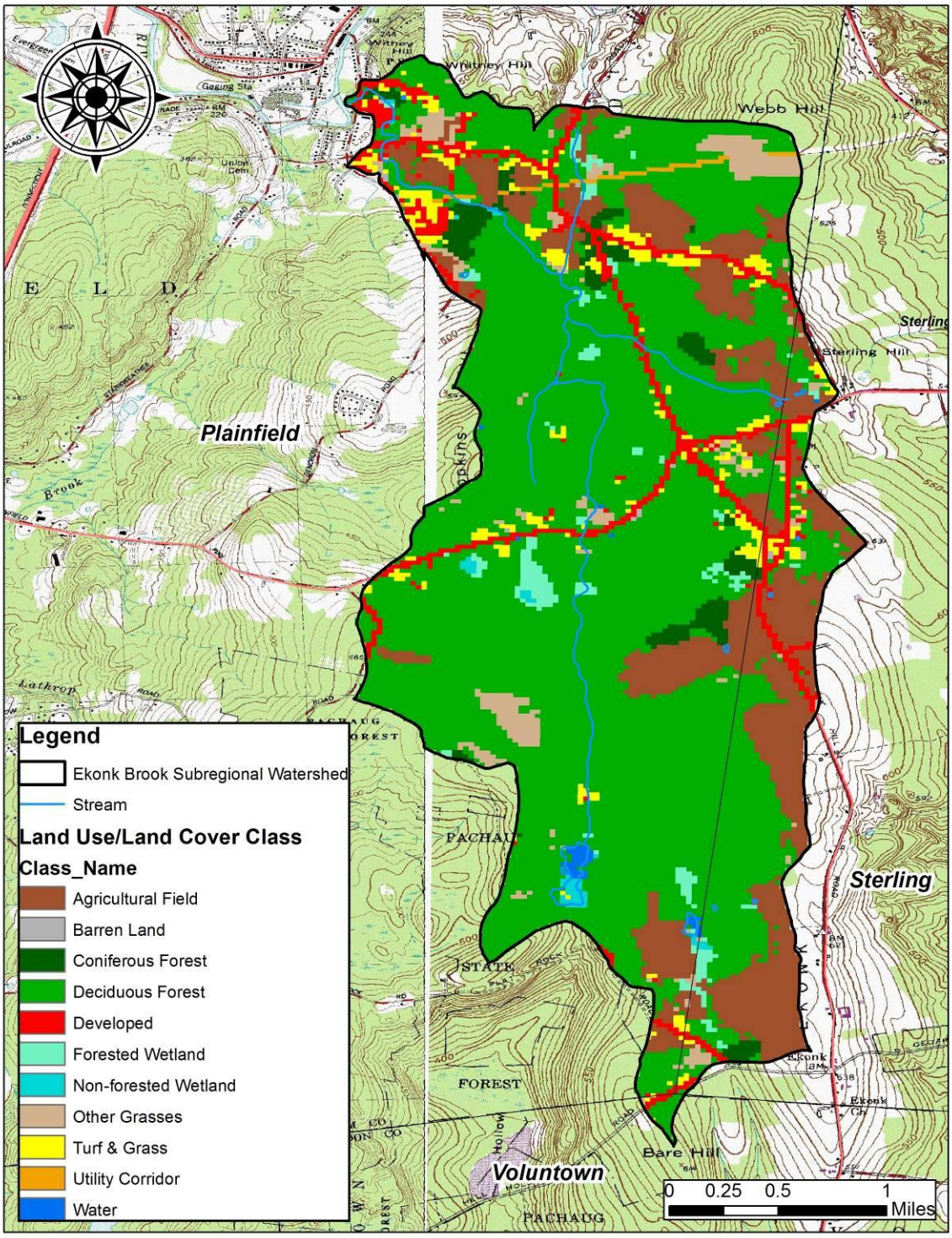


Figure 3-10. Land use and land cover in the Ekonk Brook watershed (CLEAR, 2010).

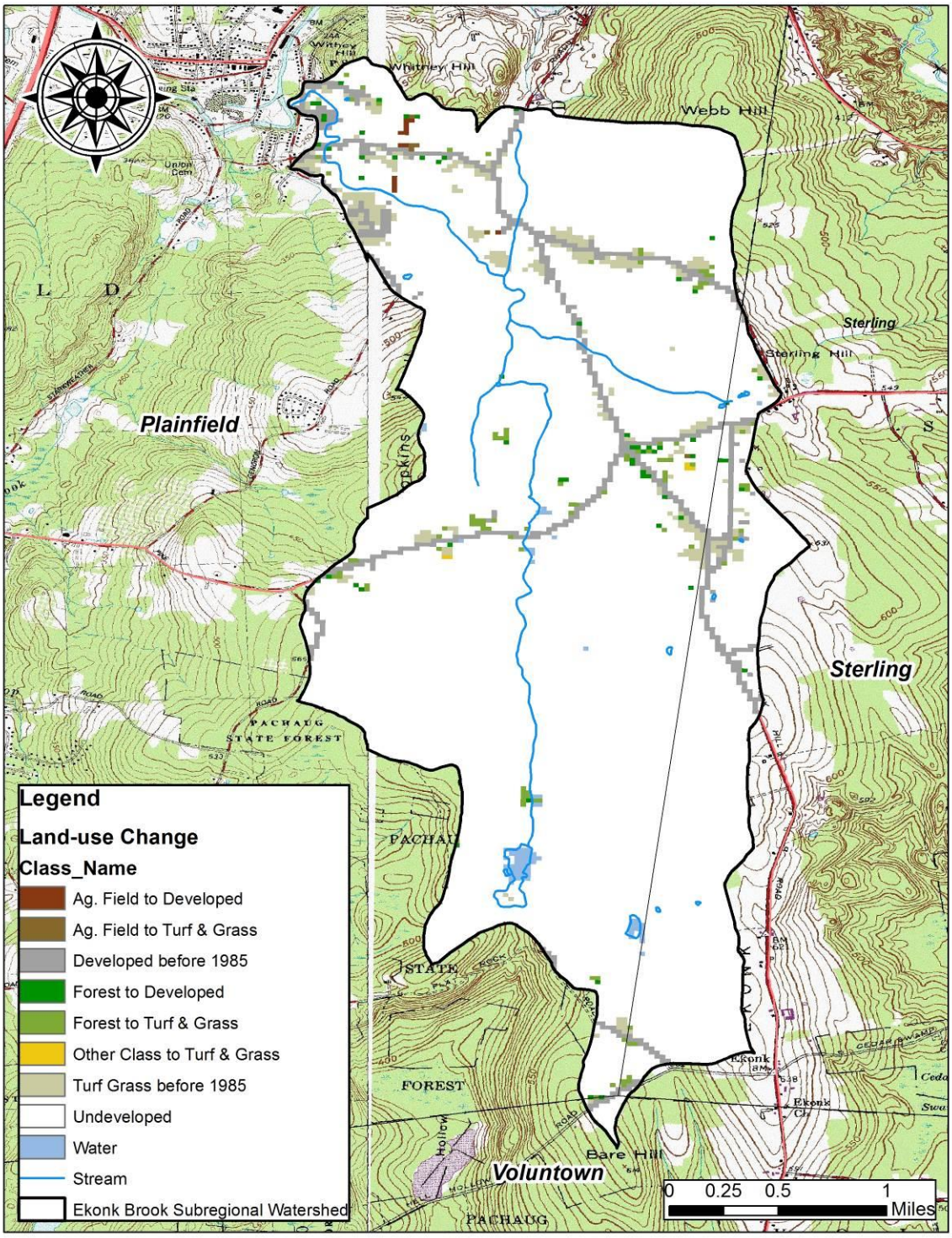


Figure 3-11. Change in land use from 1985 to 2010 in the Ekonk Brook watershed.

3.5.1. Open Space

Protecting and preserving open space is an important component of watershed planning. Large tracts of undeveloped land can and often do provide habitat and migration corridors for wildlife. Human benefits provided by open space include recreational opportunities for residents as well as aesthetic values. Open spaces provide ecosystem services including oxygen production, carbon sequestration and rain water purification and infiltration. Undeveloped areas are often included in the open space category, although undeveloped does not equal protected. Approximately 91% of the Ekonk Brook watershed is undeveloped, although this includes land that could be developed, including agricultural land and forest land. Protected open space in the Ekonk Brook watershed is comprised of approximately 504 acres of the Pachaug State Forest, including the Lockes Meadow Pond Wildlife Area (Fig. 3-12).

The *2008-2018 Plainfield Plan of Conservation and Development* recommends the establishment of a greenway along Ekonk Brook, recognizing that "…there are many large parcels of land along Ekonk Brook that could be developed in the future." The Plan states that "the Town should require open space be set aside in these future subdivisions. The open space should be along the brook, to create a linear greenway from Pachaug State Forest to the Moosup River." In addition to opportunities for open space set-asides through the municipal land permitting process, a network of private land conservation and protection organizations, including Wyndham Land Trust, Joshua's Tract Conservation & Historic Trust, Eastern CT Forest Landowners Association and others, exists to promote and support the preservation of open space.

3.5.2. Wetlands

Approximately 3% (88 acres) of land cover in the Ekonk Brook watershed is classified by CLEAR as wetlands. Of the 88 acres, 10 acres are identified as open water, including Lockes Meadow Pond and several small ponds; 64 acres are identified as forested wetlands; and 14 acres are identified as non-forested wetlands. Land use change between 1985 and 2010, as depicted in Table 3-9 indicates a 21% loss of wetlands in the Ekonk Brook watershed.

3.5.3. Forests

CLEAR land cover data (2010) indicates that approximately 68% of the Ekonk Brook watershed is forested. Forest cover is composed primarily of deciduous broadleaf trees (2,244.5 acres) with scattered stands of conifers (85.4 acres). Timber harvesting as a forest management practice was apparent throughout the watershed, including at Pachaug State Forest.

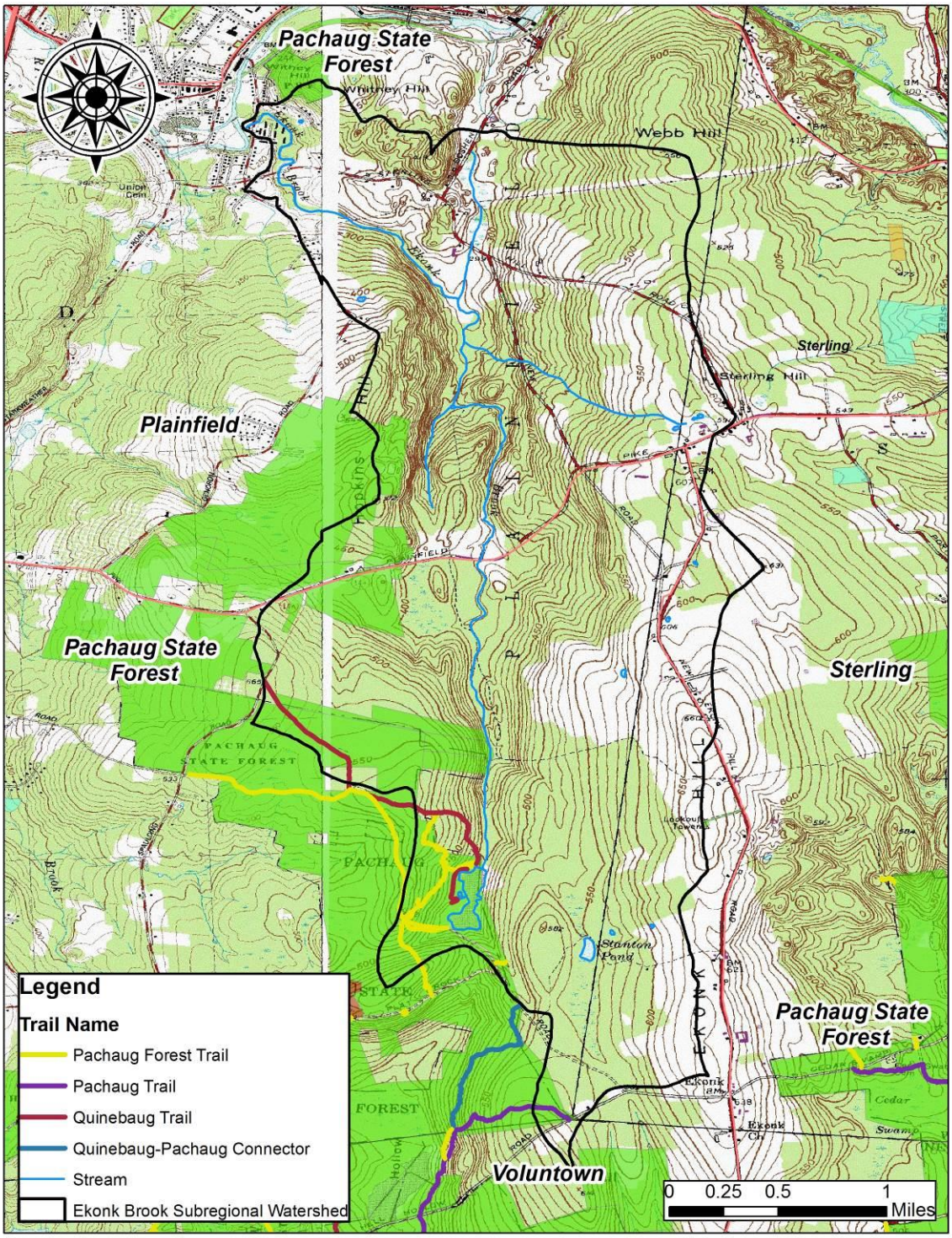


Figure 3-12. Open space and recreational opportunities in the Ekonk Brook watershed, including hiking trails in Pachaug State Forest.

A 2009 study conducted by the CLEAR evaluated forest fragmentation, the fracturing of large forest blocks into smaller and smaller pieces as a result of development, throughout Connecticut. The CLEAR study evaluated various categories of forest cover, including core forest, perforated forest, edge forest and patch forest to determine levels of fragmentation (Table 3-10). The fragmentation of forest land can be detrimental to many species of wildlife, especially those that require large tracts of undisturbed forestland to thrive. Fragmentation can also affect ecosystem services associated with forests, including clean water, the viability of forest products and recreation opportunities.

Table 3-10. Forest Fragmentation Category Descriptions.

Core Forest: Intact forest blocks 300 feet or more from the forest/non-forest boundary.
Perforated Forest: Small clearings within a forested landscape.
Edge Forest: The forested area within the 300-foot boundary between core forest and non-forested land.
Patch Forest: Small forested areas surrounded by non-forested areas that are isolated from core forests. - CLEAR, 2009

According to the CLEAR study, between 1985 and 2006, core forest has decreased state-wide by 3.6% and by 24.1% and 20.3% in Plainfield and Sterling, respectively (Table 3-11). An analysis of forest fragmentation in the Ekonk Brook watershed by ECCD, utilizing CLEAR methodology, indicates that core forest in the watershed has decreased by 18.5% (Fig. 3-13).

For more information about forest fragmentation, visit the CLEAR webpage at: http://clear.uconn.edu/projects/landscape/forestfrag/index.htm.

Table 3-11. Change in Forest Fragmentation in the Ekonk brook watershed from 1985 to 2006.

Forest Fragmentation Percent Change				
Forest Class	***Ekonk Brook Watershed***	***Plainfield***	***Sterling***	***State-wide***
Patch Forest	37.4%	17%	32.2%	0.5%
Edge Forest	5.3%	-2.1%	8.1%	-0.1%
Perforated Forest	30.8%	18.5%	56.5%	1.1%
Total Core Forest	-18.5%	-24.1%	-20.3%	-3.6%

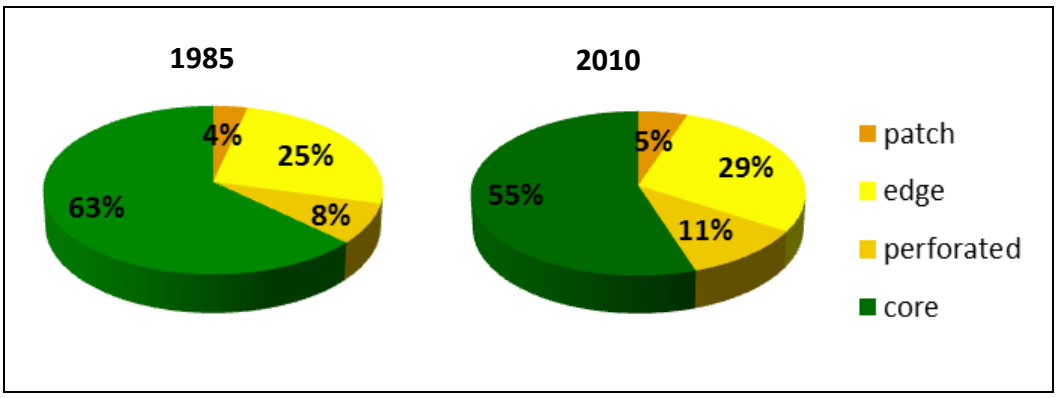


Figure 3-13. Forest fragmentation in the Ekonk Brook watershed from 1985 to 2010 (based on methodology and data from CLEAR, 2009).

3.5.4. Agriculture

Approximately 17% (578.5 acres) of the Ekonk Brook watershed is under agricultural use. An additional 107 acres (3%) are designated other grasses, which often encompasses vacant fields and pastureland. Agriculture is located primarily in the eastern portion of the watershed along Sterling Hill Road and Ekonk Hill Road (State Route 49) at the Plainfield /Sterling town line. Notable agriculture operations include Ekonk Hill Turkey Farm, Molodich Farm and Betsy's Stand. Agricultural products include fruits, berries, vegetables, bedding plants, baked goods, beef, dairy, pork, poultry, hay, sweet corn and silage corn.

3.5.5. Recreation

Publicly accessible outdoor or nature-based recreational opportunities in the Ekonk Brook watershed are available at the Pachaug State Forest. The state forest offers hiking and multi-use trails, including trails for off-road/ATV vehicles, horseback riding, winter use such as snowmobiling and cross-country skiing throughout the Pachaug State Forest. Sections of the Connecticut Blue Trails, including the Pachaug Trail and the Quinebaug Trail, are also located in the Pachaug State Forest (Fig. 3-12). Wildlife/bird watching opportunities are available at the Lockes Meadow Pond Wildlife Area. Ekonk Brook is stocked annually to support recreational fishing.

3.5.6. Developed Areas

Developed areas are defined as areas with impervious surfaces (buildings, roof tops, roads, parking lots and sidewalks) which prevent rainwater from infiltrating into the ground. Rainwater instead flows along the ground surface from these areas, mobilizing and conveying various pollutants, into storm drain systems and is then discharged into nearby waterbodies. Developed land, including residential, commercial and/or industrial development, paved surfaces, and associated lawns areas, comprises approximately 8.5% of the Ekonk Brook watershed. The majority of the watershed is lightly developed, and is characterized by undeveloped back land with rural residential

development along road frontages. Development increases in density in the northern part of the watershed in the vicinity of the village of Moosup. Residential development transitions from rural to suburban residential in the vicinity of Gendron Road and Northern Drive and to urban residential along River Street.

3.5.7. Transportation

There are approximately 9.9 miles of roadway in the Ekonk Brook watershed. There are 6.6 miles of local surface roads owned and maintained by the towns of Sterling or Plainfield. There are 3.3 miles of state highway, including State Routes 49 and 14A, which are maintained by the Connecticut Department of Transportation. There are no rail lines in the Ekonk Brook watershed.

3.6. Cultural and Demographic Characteristics

3.6.1. Cultural Resources

Agriculture in the Ekonk Brook watershed has been prevalent since colonial times. The eastern part of the watershed, including Ekonk Hill and Sterling Hill, still has many operating farms. Rural areas of the watershed "…maintain a historic agricultural character, with farm houses and buildings, stone walls and cultivated fields among hills and forests (Plainfield Plan of Conservation and Development, 2008)."

The northern section of the watershed, at the outlet to the Moosup River, was developed as a mill district in the early 1800s. This section of Moosup is locally known as Gladdingville after Joseph S. Gladding, who built a mill there in 1817 for the manufacture of cotton cloth (Connecticut Geneology, 2009). The Gladding Mill, more recently known as the Cranska Thread Mill, is still in operation, and many of the mill houses built to house workers are still in existence.

Of cultural significance is the Sterling Hill Historic District, located on State Route 14A (Fig. 3-14), the western portion of which is located in the Ekonk Brook watershed. According to the Connecticut Trust for Historic Preservation, the Sterling Hill Historic District "…is a group of 14 houses with related outbuildings and one church perched upon a broad ridge at the western edge of the Town of Sterling, bordering the town line of Plainfield. The Historic District is significant as a representative example of a particular 18th- and early 19th-century Connecticut settlement type, the upland-ridge village crossroads (CT Trust for Historic Preservation, 2011)."

3.6.2. Population/Economics

The towns of Plainfield and Sterling are located in Windham County, while Voluntown is located in New London County. All three towns are part of the Northeast Connecticut Planning Area and the Northeast Economic Development Region.

Plainfield was incorporated in 1699. It encompasses a land area of 43 square miles. The population in 2012 was 15,358, with a population density of 363 people per square mile. According to 2012 census data, ninety-six percent (96%) of the population identifies as white, <1% as black, 3.7% as Hispanic and <1% as multi-race or other ethnicity. Of residents 25 years or older, 45% have a high school degree, 7% have an Associate's degree, and 12% have a Bachelor's degree or higher. Labor statistics indicate that the unemployment rate in 2013 was 10.1% which was higher than county and state averages. Local industries include construction, manufacturing, retail trade, accommodation/food services, health care/social assistance and government, including local/municipal government. Major employers include Lowe's Distribution Center, C&M Corporation, Staples Distribution center, Big Y World Class Market and Brookwood Laminating Inc. Median household income in Plainfield is greater than the county average and approximately 10% less than the state average (Connecticut Economic Resource Center, 2014).

Sterling was incorporated in 1794. It encompasses a land area of 27 square miles. The population in 2012 was 3,786, with a population density of 139 people per square mile. According to 2012 census data, ninety-five percent (95%) of the population identifies as white, <1% as black, 2% as Hispanic and 2% as multi-race or other ethnicity. Of residents 25 years or older, 44% have a high school degree, 7% have an Associate's degree, and 14% have a Bachelor's degree or higher. Labor statistics indicate that the unemployment rate in 2013 was 8.3%, which was slightly lower than the county average and slightly higher than the state average. Local industries include construction, manufacturing, wholesale trade, retail trade, accommodation/food services and government, including local/municipal government. Major employers include Sterling Community School, Sterling Foster Pharmaceutical, and ReEnergy Sterling. Median household income in Sterling is greater than the county average, and slightly less (2.5%) than the state average (Connecticut Economic Resource Center, 2014).

Voluntown was incorporated in 1721. It encompasses a land area of 39 square miles. The population in 2012 was 2,599, with a population density of 67 people per square mile. According to 2012 census data, ninety-five percent (95%) of the population identifies as white, 1.7% as Hispanic and 3.3% as multi-race or other ethnicity. Of residents 25 years or older, 35% have a high school degree, 9% have an Associate's degree, and 20% have a Bachelor's degree or higher. Labor statistics indicate that the unemployment rate in 2013 was 8.2% which was slightly lower than the county average and slightly higher than the state average. Local industries include construction, retail trade, accommodation/food services, and government, including state and local/municipal government. Major employers include the Voluntown Elementary School, Dunkin' Donuts, Bronson True Value, the Town of Voluntown, and Pachaug Animal Hospital. Median household income in Voluntown is greater than the county and state averages (8% and 6%, respectively, Connecticut Economic Resource Center, 2013).

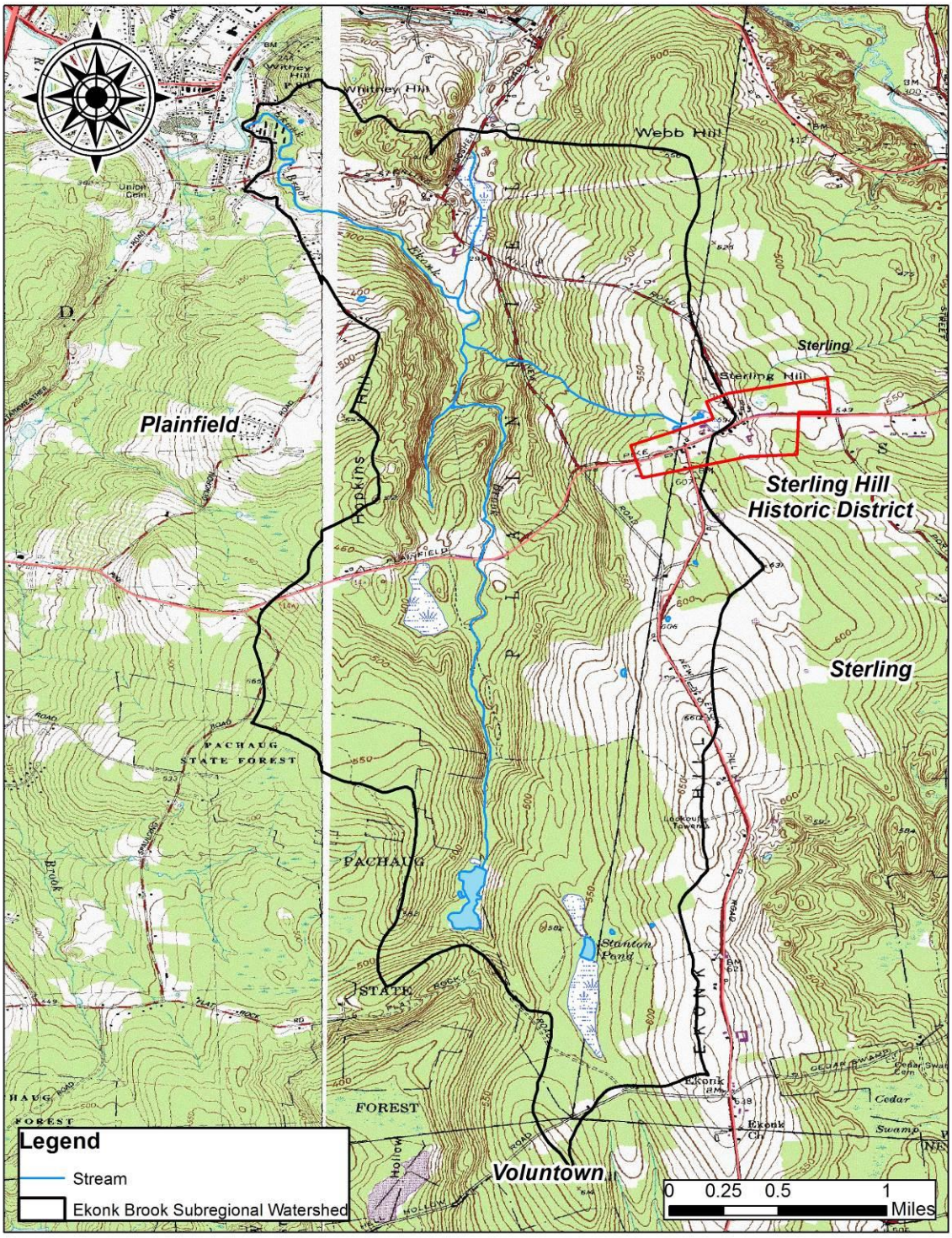


Figure 3-14. Location of the Sterling Hill Historic District.

3.7. Land Management Policies

Land management policies determine how land is used, developed and protected. Documents such as land use plans, policies and regulations provide a framework for land use managers to guide development while protecting important natural and cultural resources. Land use planning determines the "character of place" by identifying what aspects of a landscape are important or significant and providing guidance to protect, preserve and enhance those qualities.

Land management in Connecticut occurs on multiple administrative levels, from state to regional to local levels. Land management policies, especially in the form of municipal land use regulations, can play a significant role in the protection of water quality and other natural resources. When land use planning policies and goals are designed to be consistent on local, regional and state levels, land use planning is at its most effective. As a consequence, local land use planners should review regional and state-level guidance documents and work with regional and state agencies to ensure that planning goals align.

This section reviews and summarizes existing planning documents that affect and influence land use and development and water quality protection in the Ekonk Brook watershed.

3.7.1. State-Level Land Planning Policies

3.7.1.1. State of Connecticut

The State of Connecticut conducts state-wide land use planning through the Office of Policy and Management (OPM). The State Plan of Conservation and Development serves as the official state policy in matters pertaining to land and water resources conservation and development, and directs and informs decision making by the executive branch of state government. The *2013-2018 Conservation & Development Policies: The Plan for Connecticut*, prepared by the Office of Policy and Management in accordance with Connecticut General Statutes Section 16a-29, identifies six growth management principles to direct growth and development throughout the State of Connecticut. Growth Management Principle #4 - Conserve and Restore the Natural Environment, Cultural and Historical Resources, and Traditional Rural Lands, which promotes the protection of natural and cultural resources, identifies the presence of preserved farmland, large tracts of wetland soils (> 25 acres), core forest areas (>250 acres) and critical habitat (forested flood plains) in the Ekonk Brook watershed.

3.7.1.2. Connecticut Department of Transportation

The Connecticut Department of Transportation (CTDOT) has developed a stormwater management plan (SWMP) "…for the purpose of establishing, implementing and enforcing a stormwater management program to reduce the discharge of pollutants from the Department's highways, roadways, railways and facilities to the maximum extent practicable, to protect water quality, and to satisfy

the appropriate requirements of the Clean Water Act (2015)." At the time of the preparation of this document, a plan dated February 2004 was in place; however, a draft plan dated February 2015 was under review.

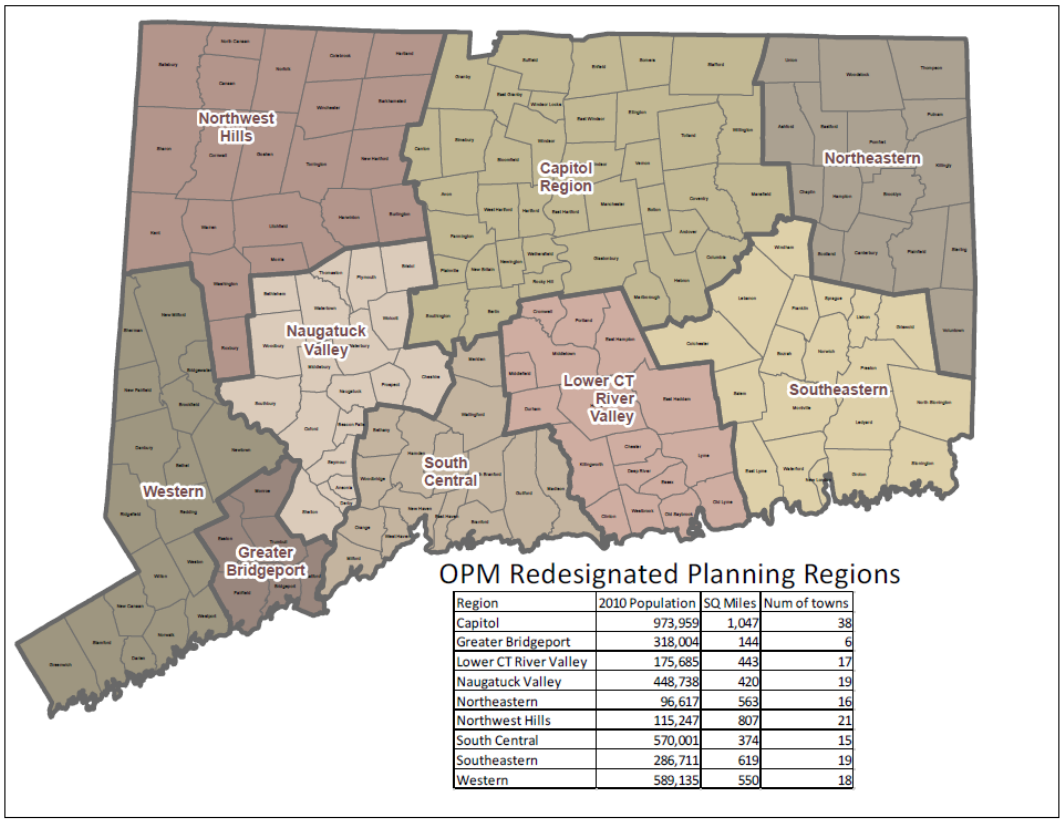
The draft 2015 SWMP will address "…the requirements of the NPDES [National Pollutant Discharge Elimination System] Phase II program as implemented and administered by the CTDEEP… through the use of the General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4)."

Key elements of the SWMP include:

- Stormwater runoff erosion and sediment (E&S) controls
- Post-construction stormwater management
- Stormwater outfall mapping
- Illicit discharge detection and elimination
- Water quality sampling
- Good housekeeping practices for the prevention of pollution

3.7.1.3. Regional Land Use Planning

Regional planning occurs through Connecticut's nine regional planning areas, each overseen by a regional planning agency (Fig. 3-15), as well as other regional organizations, such as The Last Green Valley, Inc. Plainfield, Sterling and Voluntown are members of the Northeast Connecticut Council of Governments, located in Killingly. Connecticut's planning regions, through the Councils of Government "… provide a geographic framework within which municipalities can jointly address common interests, and coordinate such interests with state plans and programs (CT OPM 2015)." Several key planning documents for northeast Connecticut were not available at the time of the preparation of this plan due to a recent realignment of planning regions in eastern Connecticut, including the *Northeast Connecticut Comprehensive Plan* and the *Comprehensive Economic Development Strategy*. Land managers are urged to review regional planning documents when they become available.



Region	2010 Population	SQ Miles	Num of towns
Capitol	973,959	1,047	38
Greater Bridgeport	318,004	144	6
Lower CT River Valley	175,685	443	17
Naugatuck Valley	448,738	420	19
Northeastern	96,617	563	16
Northwest Hills	115,247	807	21
South Central	570,001	374	15
Southeastern	286,711	619	19
Western	589,135	550	18

Figure 3-15. Connecticut's Planning Regions

The Last Green Valley, Inc. (TLGV) is a non-profit organization that manages the Quinebaug and Shetucket Rivers Valley National Heritage Corridor (designated by Congress in 1994). The National Heritage Corridor is comprised of 35 towns in the Quinebaug and Shetucket River watersheds, including nine towns in Massachusetts. The TLGV's planning document *Vision 2020 – The Next Ten Years* provides goals and planning strategies including:

- stewardship
- economic development and community revitalization
- cultural resources
- land use
- agriculture
- air quality
- water quality
- wildlife
- recreation

3.7.2. Municipal Land Use Policies

Planning on the local level typically has the most direct impact on how development and resource protection are managed at the community level. Local planning occurs via the preparation of municipal planning documents and is administered through land use boards or commissions. Several organizations in Connecticut offer support, technical tools, assistance and training to municipal land use commissioners and staff. These include the Center for Land Use Education and Research (CLEAR) and Connecticut Nonpoint Education for Municipal Officials (NEMO) at the University of Connecticut, the Connecticut Conservation Districts, the DEEP Inland Wetlands Management Section, the Connecticut Association of Zoning Enforcement Officials and the Connecticut Chapter of the American Planning Association.

Municipalities address land management policies through variety of documents, including Plans of Conservation and Development, which towns are required by Section 8-23 of the Connecticut General Statutes to update every ten years. Other planning documents include local ordinances and municipal land use regulations, such as planning, zoning, subdivision and inland wetlands and watercourses regulations, stormwater management plans, and watershed management plans. These regulations may be updated or amended from time to time as necessary to ensure they provide the framework necessary for the protection of water and other natural and cultural resources.

Following is a summary of land management policies in effect at the time of the preparation of this document that address water quality concerns. Land use regulations and policies from the Town of Voluntown were not examined as less than 1% (10.8 acres) of the land area of Voluntown is located in the Ekonk Brook watershed. Readers are advised that they should contact the municipal staff in the appropriate watershed town to obtain the most current land management regulations and policies.

3.7.2.1. Plans of Conservation and Development

A Plan of Conservation and Development is a blueprint for how a municipality wants to develop over the following 10 – 20 years and is a guide to local decision making in areas such as natural resources preservation, economic development, housing, land use and public services. The Plan documents a town's cultural and natural resources, provides guidance regarding the continued development and progress of a town, and addresses current conditions and the future needs of the citizens and the community.

Section 8-23 of the Connecticut General Statutes states that "…at least once every ten years, a town shall prepare or amend and shall adopt a plan of conservation and development for the municipality. Following adoption, a town shall regularly review and maintain such plan. A town may adopt such geographical, functional or other amendments to the plan or parts of the plan, in accordance with the provisions of this section, as it deems necessary."

Following is an overview of elements in the Plans of Conservation and Development in Plainfield and Sterling that pertain to natural resource and water quality protection and preservation.

Town of Plainfield:

The Plainfield *2008-2018 Plan of Conservation and Development* was adopted on August 12, 2008. The Plan addresses issues of water quality and natural resource protection, and makes recommendations to guide and inform future development in Plainfield while providing protection to natural and manmade resources identified as valuable. The Plan specifically cites the preservation of open space and natural resources, including the establishment of a greenway along Ekonk Brook.

Key recommendations in the Plan regarding the protection of water resources and open spaces include:

- Preservation of "… major portions of the Town, in their natural or nearly natural state, thereby preserving the Town's scenic resources, wildlife habitat and natural resources."
- Water quality protection: "The Town should work to maintain current regulations regarding water resource protection. The Town should work with the Connecticut Department of Environmental Protection (CT DEP) and private water companies to establish clear and concise expectations. The town should require non-point source Best Management Practices (BMPs) implementation on storm water systems for all new developments."

Town of Sterling:

The Sterling *2009 Plan of Conservation and Development* addresses issues of water quality and natural resource protection, and makes recommendations to guide and inform future development in Sterling while providing protection to natural and manmade resources identified as valuable. The Plan recognizes the need to conserve natural and historic resources in order to preserve the rural character of Sterling.

Key recommendations in the Plan regarding the protection of natural and cultural resources include:

- Creation of a non-regulatory Conservation Commission to address conservation needs
- Establishment of open space policies and program
- Creation of an inventory of permanently preserved open space
- Land use regulation review and revision
- Permanent protection of wetlands and steep slopes
- Expansion of inland wetlands upland review area to 150 feet
- Review and revision of monitoring and inspection procedures
- Establishment of a greenbelt/trail system
- Enhancement of natural and scenic resources that provide context to the character of the community

3.7.2.2. Inland Wetlands and Watercourses Regulations

In 1972, the Connecticut legislature passed the *Connecticut Inland Wetlands and Watercourses Act* to protect the environmental quality of the state's wetlands and watercourses. Section 22a-42 of the Act authorizes the municipal regulation of activities affecting the wetlands and watercourses within the territorial limits of the various municipalities or districts.

Town of Plainfield:

The Inland Wetlands and Watercourses Commission of the Town of Plainfield was established in accordance with an ordinance adopted February 14, 1974. The Plainfield Inland Wetland and Watercourses Commission (IWWC) is charged with enforcing the provisions of the *Inland Wetlands and Watercourses Act*, Sections 22a-36 through 22a-45, inclusive, of the Connecticut General Statutes, as amended.

The Plainfield Inland Wetlands Commission is authorized to regulate any "clearing, grubbing, grading, paving, excavating, filling, constructing, depositing or removing of material and discharging of storm water on the land within 100 feet measured horizontally from the boundary of any wetland or watercourse."

Town of Sterling:

The Inland Wetlands and Watercourses Commission of the Town of Sterling, was established in accordance with an ordinance adopted February 3, 1988. The Sterling Inland Wetlands and Watercourses Commission is charged with enforcing the provisions of the *Inland Wetlands and Watercourses Act*, Sections 22a-36 through 22a-45, inclusive, of the Connecticut General Statutes, as amended.

The Sterling Inland Wetlands Commission is authorized to regulate "… any operation within or use of wetland or watercourse involving removal or deposition of material, or any obstruction, construction, alteration or pollution, of such wetlands or watercourses, but shall not include the specified activities in section 4 of these

regulations. Furthermore, any clearing, grubbing, filling grading, paving, excavating, constructing, depositing or removing of material and discharging of storm water on the land within the following upland review areas is a regulated activity:

(1) Within 200 feet measured horizontally from the ordinary high water mark of the Moosup River.

(2) Within 100 feet measured horizontally from the boundary of any other wetland or watercourse."

3.7.2.3. Planning and Zoning Regulations

Planning and Zoning Regulations define how a community will be developed. These regulations provide specific criteria and standards that determine the type of land use, form, design and compatibility of proposed development within designated building zones. Following is an overview of zoning regulations in Plainfield and Sterling that address natural resource and water quality concerns.

Town of Plainfield:

The *Zoning Regulations of the Town of Plainfield* were adopted by the Town, under authority of Chapter 124 of the General Statutes of the State of Connecticut, on September 25, 1972, and were amended through October 1, 2014.

- Section 3 – Aquifer Protection Overlay District: establishes an overlay district to "…protect and preserve groundwater quality within stratified drift aquifers which are existing or potential public drinking water supplies."
- Section 4 – Wetlands: prohibits activity within 100 feet of a wetland or watercourse unless permitted by the Plainfield Inland Wetlands and Watercourses Commission.
- Section 5 – Floodplain Management: requires inclusion of 100-year flood elevation data in application material and provides standards for construction in the 100-year flood zone.
- Section 6 – Erosion and Sediment Control: provides guidelines for erosion and sediment control, including the preparation of Erosion and Sediment Control Plans, standards, and inspection.
- Section 21 – Conservation Subdivisions: authorizes the development of conservation subdivisions in order to "…facilitate the preservation of open space, natural resources, recreational uses, and community character."

Town of Sterling:

The *Zoning Regulations of the Town of Sterling* were adopted, under authority of Chapter 124 of the General Statutes of the State of Connecticut, on September 10, 2009, and were last revised March 24, 2015.

- Section 4.02 Minimum Buildable Area – excludes inland wetlands and watercourses, floodplain soils, areas within the 100-year flood boundary, and slopes exceeding 20% from the definition of buildable areas.
- Section 4.05 Building and Impervious Surface Coverage – defines the maximum allowable amount of impervious cover on residential and non-residential building lots.

3.7.2.4. Subdivision Regulations

Subdivision regulations provide guidance and standards for the design of subdivisions and the construction of streets and other improvements in order to provide for the orderly growth in accordance with other planning documents such as planning and zoning regulations and Plans of Conservation and Development. Following is an overview of subdivisions regulations in Plainfield and Sterling that address natural resource and water quality concerns.

Town of Plainfield:

The Town of Plainfield Planning and Zoning Commission *Subdivision Regulations* were adopted on September 29, 1971 and were amended through April 1, 2013 in accordance with Section 8 - 25 of the Connecticut General statutes.

- Section 1 - Purpose: states that "Proper provision shall be made for the conservation of natural, historical and cultural resources and the preservation of open space, stream belts, scenic points, large trees, agricultural lands and recreation areas as identified in the Plan of Development and required by the Planning and Zoning Commission (1f); proper provision shall be made to control soil erosion and sedimentation and to prevent the pollution of wetlands, watercourses and water bodies (1g); and provision shall be made to encourage and permit energy efficient patterns of development and land use in accordance with Section 8-25 (b) of the Connecticut General Statutes (1h)."
- Section 4 - General Provisions requires that:
  - "Land subject to flooding shall not be put to any use which will aggravate flood hazard conditions and shall comply with the Flood Plain Management requirements outlined in the Zoning Regulations (4.5)";
  - "Due regard shall be given to the preservation and enhancement of natural features, scenic points, large trees, natural cover, contours of the land and other community assets (4.7)";
  - "No subdivision application which involves an activity or affects areas regulated pursuant to the Town's Inland Wetlands and Watercourses Regulations shall be approved by the Commission unless and until it has

received approval from the Inland Wetlands and Watercourses Commission (4.9)."

- Section 7 - Erosion & Sediment Control Plans: requires the development of an erosion and sediment control plan in conformance with Connecticut Guidelines for Soil Erosion and Sediment Control (1985), and provides for inspection by the Commission or its authorized agent.
- Section 8 - Special Flood Hazard Areas/Flood Ways: requires that "The lots and improvements shall be located and constructed to minimize flood damage within the special flood hazard area and shall be capable of use without danger from flooding or flood related damages."
- Section 9 - Open Space Requirements: specifies that the Commission may require "the preservation of up to 10 percent of the land included within all subdivisions or resubdvisions for open space, parks and playgrounds when and in places it deems proper, unless otherwise exempted according to Section 8-25 (a) of the Connecticut General Statutes," or may accept the submittal of a fee in lieu of open space.
- Section 16 - Conservation Subdivisions: provides guidance regarding the design and development of conservation subdivisions.

Town of Sterling:

The Town of Sterling Planning Commission *Subdivision Regulations* were adopted on April 14, 1988 and were most recently amended through March 23, 2010 in accordance with Section 8 - 25 of the Connecticut General statutes.

- Section 2- General Provisions: requires that "Land subject to flooding shall not be put to any use which will aggravate flood hazard conditions and shall comply with Town Flood Management Ordinance (2.4);" and "Due regard shall be given to the preservation and enhancement of natural features, scenic points, large trees and natural cover and contours of the land and other community assets (2.6)."
- Section 5 - Subdivision Plan Requirements: requires the identification of features including:
  - "All inland wetlands and watercourses and areas regulated by the Sterling Inland Wetland Commission (5.3.6)",
  - "Areas within 100 year flood hazard areas as delineated by the Federal Emergency Management Agency (FEMA) and as shown on the most recently amended maps prepared by FEMA (5.3.8)",
  - "Prime and important farmland soils as defined by the Soil Conservation Service (5.6.3)",
  - Ridgetops (5.6.5), and
  - "Areas recommended for preservation as open space in the Sterling Open Space Plan and Map which is part of the Plan of Development (5.6.10)."

- Section 6 - Erosion and Sediment Control Plans: requires the development of an erosion and sediment control plan in conformance with Connecticut Guidelines for Soil Erosion and Sediment Control (1985), and provides for inspection by the Commission or its authorized agent.
- Section 7 - Special Flood Hazard Areas/Floodways: requires that development be "…reasonably safe from flood damage and shall conform to the Sterling Flood Plain Management Ordinance."
- Section 8 - Public Open Space: provides for the designation of protected open space or submittal of a fee in lieu of open space.

3.7.3. Future Land Use Considerations

Very little of the Ekonk Brook watershed is developed. Barring conditions that would impact or prohibit development, such as the locations of wetlands and watercourses or steep slopes, substantial areas of land are available for development. Land use planners should consider carefully how land is developed to provide maximum protection to all resources in the watershed.

Town of Plainfield:

Future land use in Plainfield is defined in the *2008-2018 Plan of Conservation and Development*. Desired future development is focused on the main transportation corridors, including State Route 14A, which is the main east-west corridor through the Ekonk Brook watershed. However, "concerns about sight lines, and road width should constrain future commercial and industrial development from the Sterling Town Line to Gendron Road (Plainfield POCD)."

Town of Sterling:

The *2009 Sterling Plan of Conservation and Development* identifies the need for the development of strategies that "…allow the community to permit high quality residential development at sustainable rates of growth" and that consider the capability of the land to support development, meet prescribed growth goals, and balance the impact of residential and non-residential uses.

4. Watershed Conditions

4.1. Water Quality Standards

The 1972 Federal Clean Water Act requires all states to designate uses for all waterbodies within their jurisdictional boundaries, and to test waters to determine if they are meeting their designated uses. Ekonk Brook's designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Ekonk Brook has not been meeting its designated use for recreation due to periodic high levels of *Escherichia coli* from unknown sources.

The State of Connecticut Department of Energy and Environmental Protection Water Quality Standards (effective October 10, 2013) established water quality criteria for indicator bacteria (*E. coli*) for freshwater as defined in Table 4-1. For the purposes of this investigation, ECCD utilized the single sample criteria for *Freshwater – All other recreational uses* of 576 cfu/100ml and the maximum sample set geometric mean of less than 126 cfu/100 ml to evaluate water quality data collected from Ekonk Brook and tributaries.

Table 4-1. **State of Connecticut water quality criteria for indicator bacteria in fresh water.**

DESIGNATED USE	CLASS	INDICATOR	CRITERIA
Freshwater			
Drinking Water Supply (1) Existing / Proposed	AA	Total coliform	Monthly Moving Average less than 100/100ml Single Sample Maximum 500/100ml
Potential	A	----	--------
Recreation (2)(3) Designated Swimming (4)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 235/100ml
Non-designated Swimming (5)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 410/100ml
All Other Recreational Uses	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 576/100ml

Table Notes:
(1) Criteria applies only at the drinking water supply intake structure.
(2) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23.
(3) See Standard # 25.
(4) Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protection and the Department of Public Health, May 1989, revised April 2003 and updated December 2008.
(5) Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.

4.1.1. Anti-degradation Policies

The Clean Water Act requires that states adopt anti-degradation policies to protect water quality. An anti-degradation policy is a "framework and methodology for deciding if, when, and how water quality that exceeds the CWA 101(a) goal can be degraded by regulated activities and when that water quality must be maintained (USEPA, 2015)."

The Act further specifies that states must identify implementation methods that:

- protect existing uses,
- authorize the lowering of water quality in high quality waters, where necessary for social or economic importance, and
- provide mechanism to provide additional protection for water of exceptional ecological or recreational significance.

Connecticut's Anti-degradation Standards and Anti-degradation Implementation Policies (Section 22a-426-8 of the Connecticut General Statutes) are fully defined in the 2013 *Connecticut Water Quality Standards*.

4.2. Available Monitoring/Resource Data

4.2.1. Water Quality Data

In 2014, ECCD and volunteers from The Last Green Valley (TLGV) Volunteer Water Quality Monitoring Program collected water samples from eleven sites on Ekonk Brook and its tributaries (Fig. 4-1). The water samples were analyzed by the State of Connecticut Department of Public Health Laboratory for fecal bacteria content. The sites were sampled twice weekly for four weeks in August and September, utilizing Quality Assurance Project Plan (QAPP) protocols in accordance with an approved monitoring plan. Due to a lack of precipitation during the sampling period, ECCD also collected one additional wet weather sample in October 2014.

Bacteria levels at seven of the eleven sites sampled by ECCD in 2014 failed to meet Connecticut water quality standards (Table 4-2). These sites included EB-01 at the Moosup Garden Apartments, EB-02.5 near Northern Drive, UN-01-01 near 249 Sterling Hill Road, UN-01-02 near Goshen Road, UN-02-01 at Route 14A, UN-03-01 at Route 14A, and SPB-01 in Pachaug State Forest. It is important to note that EB-02.5 and UN-01-02 were added to bracket potential bacteria sources. These two sites contributed only two samples each and do not constitute a reliable sample set. The four sites that met Connecticut water quality standards included EB-02 at 79 Sterling Hill Road, SHB-01 near 116 New Road, EB-03 at Route 14A and EB-04 at Lockes Meadow Pond. A statistical distribution of bacteria levels by site is presented in Fig. 4-2.

In order to determine the role of wet weather on stream bacteria levels, the bacteria results and rainfall amounts were plotted for the months of August and September (Fig.

4-2). It was noted that bacteria levels spiked during and immediately after periods of rainfall, and that during dry periods, bacteria levels were generally low at most of the sampling sites, indicating that the majority of pollutant loading to Ekonk Brook and its tributaries may be contributed by stormwater flow. However, bacteria levels at two sites, EB-01 and UN-01-01, remained relatively high even during dry periods, indicating that a steady source contributing to baseflow may be responsible for bacteria levels observed at those locations.

In June 2015, ECCD collected water samples from three stormwater outfalls at Moosup Garden Apartments, which were delivered to the DPH laboratory for fecal bacteria analysis. The outfall locations are depicted in Fig. 4-4 and the results are presented in Table 4-3.

4.2.2. Review of Data by Others

ECCD reviewed water quality data collected by CT DEEP between 2007 and 2009 as part of its probabilistic water quality monitoring program. This data was used by DEEP to develop a bacteria total maximum daily load (TMDL) for Ekonk Brook. A TMDL is a determination of the maximum amount of a pollutant (in this instance, *E. coli* bacteria) that a waterbody can receive and still meet water quality standards. Based on the TMDL prepared by DEEP for Ekonk Brook, a pollutant load reduction of 17% is required in order for Ekonk Brook to meet Connecticut water quality standards. A TMDL analysis also provides guidance for the development of a plan to reduce pollutants in the impaired waterbody in order to meet the water quality improvement goal. The Ekonk Brook TMDL recommends the following actions to meet the recommended TMDL:

- development of a watershed based plan
- use of Low Impact Development (LID) techniques and strategies
- development of a comprehensive water quality monitoring plan to detect pollutant sources and track water quality improvements

The Ekonk Brook TMDL is included in Appendix A.

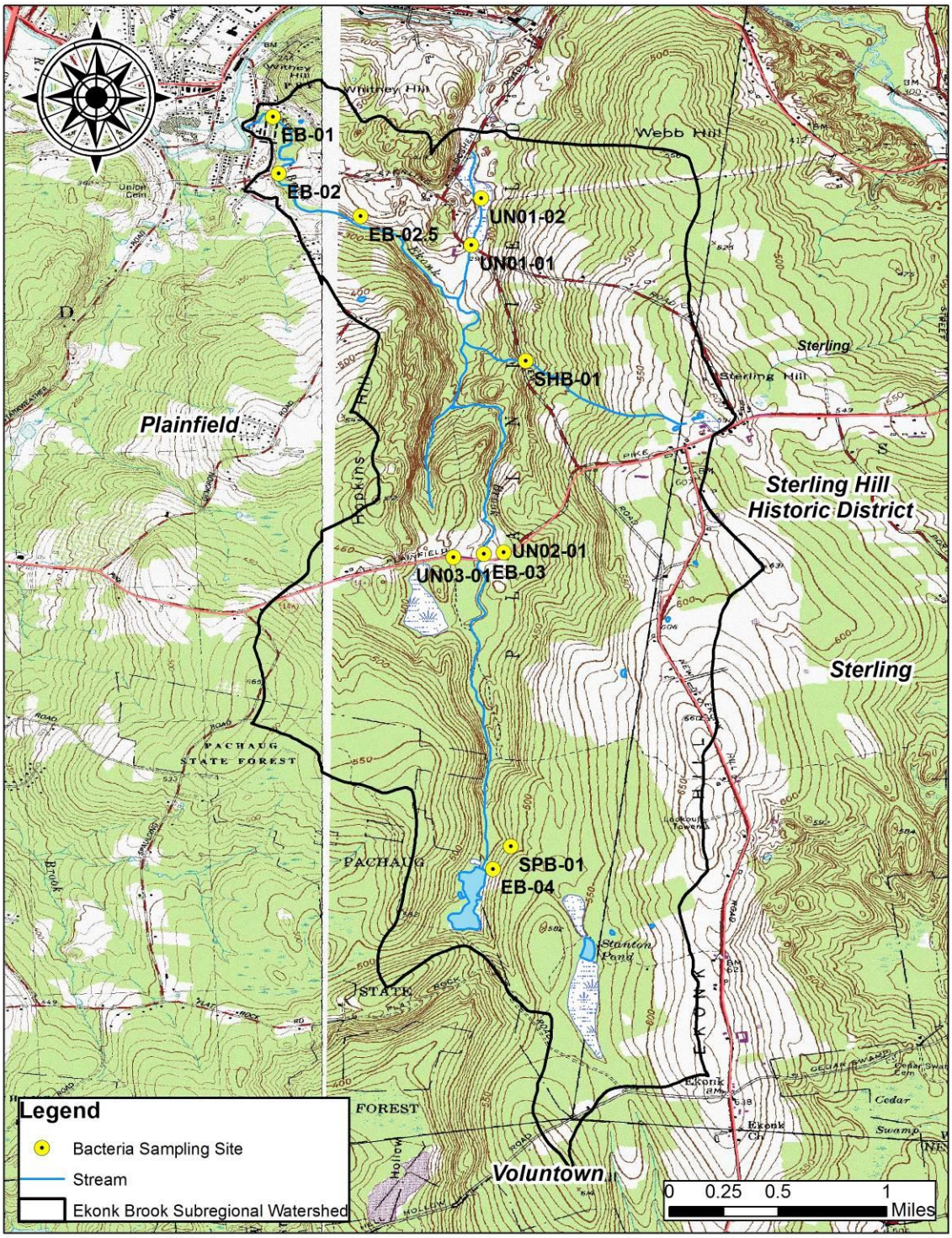


Figure 4-1. Bacteria sampling sites along Ekonk Brook and perennial tributaries.

Table 4-2. Ekonk Brook Bacteria Data Summary.

Sampling Site	Site Description	8/12/14	8/14/14	8/19/14	8/21/14	8/26/14	8/28/14	9/02/14	9/04/14	10/2/14	Geo-mean
EB-01	Ekonk Brook – CT DEEP site #789 Moosup Garden Apts.	41	**6500**	**2000**	**640**	**990**	380	400	430	**4400**	**772**
EB-02	Ekonk Brook @ 79 Sterling Hill Rd	120 (156)	**7300**	280 (200)	120 (63)	63	20	**710**	20 (74)	10	117
EB-02.5*	Ekonk Brook near Northern Drive	--	--	--	160	DNS	DNS	180	DNS	DNS	**170**
EB-03	Ekonk Brook US of Route 14A	20	**5800** (300)	75	52	31	20	110 (120)	10	DNS	80
EB-04	Lockes Meadow Pond near outlet	30	200	30	20	10	10 (10)	10	41	41	24
UN-01-01	Unnamed stream #1 at Sterling Hill Road	--	**3300**	**990**	440	250 (230)	DNS	**990**	DNS	DNS	**659**
UN-01-02**	Unnamed stream #1 near Goshen Road	--	--	--	--	370	DNS	510	DNS	DNS	**434**
SHB-01	Sterling Hill Brook DS Sterling Hill Road	20	**1500**	63	20	10	87	31	63	20 (10)	41
UN-02-01	Unnamed stream #2 at Route 14A	--	**1100**	**610**	86	41	52	DNS	DNS	DNS	**165**
UN-03-01	Unnamed stream #3 at Route 14A	--	**4400**	140	86	20	**820**	63	41	DNS	**156**
SPB-01	Stanton Pond Brook in Pachaug State Forest	--	**1600**	41	130	DNS	DNS	DNS	DNS	DNS	**204**
Wet/Dry		Dry	Wet	Dry	Dry	Dry	Dry	Dry	Dry	Wet	

* Site added 8/21/14 to bracket bacteria levels documented at UN-01-01 ** Site added 8/26/14 to bracket bacteria levels documented at UN-01-01
DNS – Did not sample - Water levels were too low to sample or stream was dry. Value in parentheses (156) indicates duplicate sample value.

Bold denotes that the sample exceeded established indicator bacteria single sample and/or geometric mean criteria for that site.

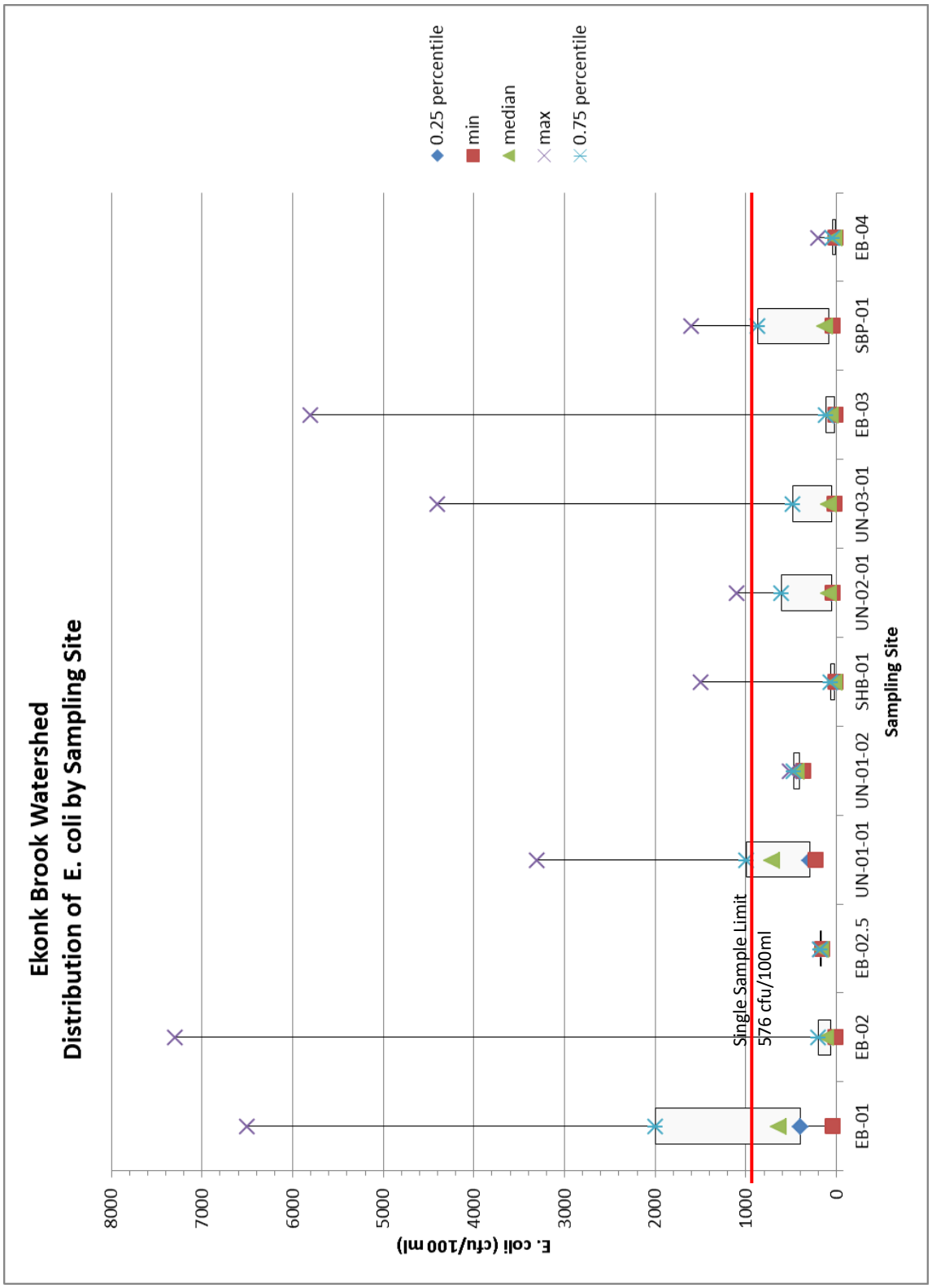


Figure 4-2. Statistical distribution of bacteria levels by sampling site.

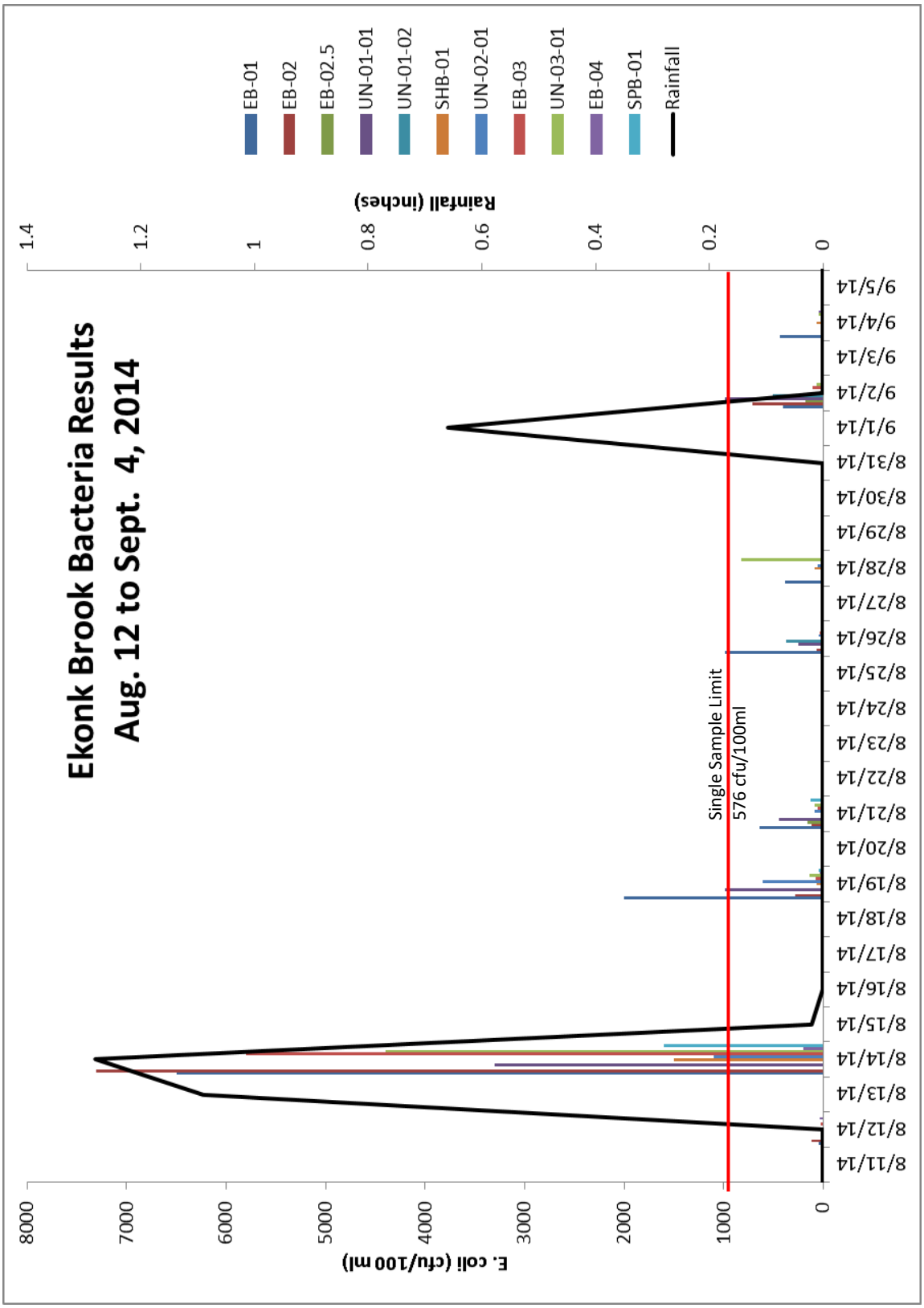


Figure 4-3. Comparison of bacteria levels by sampling site to rainfall.

Table 4-3. Results of 6/15/15 stormwater outfall sampling

Sampling Site	EB-0.5	SWO-01	SWO-02	SWO-03	EB-1.5
Site Description	Ekonk Brook DS SWO-01	Outfall 01	Outfall 02	Outfall 03	Ekonk Brook US SWO-03
E. coli (cfu/100ml)	2600	2600	1300	2100	2850

Figure 4-4. Location of stormwater outfalls at Moosup Garden Apartments.

5. Pollutant Source Assessment

The Eastern Connecticut Conservation District (ECCD) conducted a water quality investigation in Plainfield and Sterling, Connecticut in 2014 to identify potential sources of fecal coliform bacteria that have contributed to the degradation of water quality in Ekonk Brook (Table 5-1). Ekonk Brook has been listed in recent State of Connecticut Integrated Water Quality Reports as impaired for recreation due to periodic elevated levels of the indicator fecal bacteria *Escherichia coli (E. coli)*. *E. coli* is a common bacterium that is found in the intestinal tract of warm-blooded animals. While most forms of *E. coli* are not harmful to humans, they can indicate the presence of other pathogens, including fecal bacteria and viruses, that can be harmful if ingested. As part of the investigation, ECCD and volunteers from The Last Green Valley Water Quality Monitoring program collected water samples for fecal bacteria analysis from multiple sites along Ekonk Brook and its perennial tributaries. Water samples were processed by the Connecticut Department of Public Health Micro-biology Laboratory. ECCD conducted a field assessment of the watershed to identify potential bacteria sources, and reviewed water quality data collected by DEEP from 2007-2009 that was used by DEEP to develop a bacteria Total Maximum Daily Load (TMDL) for the Ekonk Brook (CT DEEP, 2011). ECCD also conducted a desktop pollutant load analysis to determine the annual loading of common nonpoint source (NPS) pollutants such as sediment, nutrients, petroleum hydrocarbons and metals.

Table 5-1. Possible sources of fecal bacteria and other NPS contaminants to Ekonk Brook and its tributaries.

Possible Source	Location	Pollutant(s)	Receiving Waterbody
Stormwater Runoff/ Outfalls	River Street & Gorman Road area, State Route 14A	Sediment, bacteria, nutrients, automotive chemicals, metals	Ekonk Brook, unnamed stream #2, unnamed stream #3
Sanitary Sewers/ Septic Systems	River Street & Gorman Road /Goshen Road & Sterling Hill Road areas	Bacteria, nutrients, pharmaceuticals, household chemicals	Ekonk Brook, unnamed stream #1
Agriculture/ Livestock/ Poultry	Sterling Hill Road & Ekonk Hill Road areas	Bacteria, nutrients, chemical fertilizers, herbicides/pesticides, vehicular chemicals	Stanton Pond Brook, Ekonk Brook, unnamed stream #1
Pets	Watershed-wide	Bacteria, nutrients	Ekonk Brook, unnamed stream #1
Wildlife/Waterfowl	Lockes Meadow Pond	Bacteria, nutrients	Ekonk Brook

5.1. Nonpoint Sources

Nonpoint source pollution (NPS) is pollution that is not derived from a single discernible source or point, such as a pipe. NPS results from a diffuse and diverse array of pollutants derived from our everyday activities that are found on the ground surface. These pollutants are mobilized and transported via rain or snowmelt into streams, rivers, lakes, ponds, estuaries and, ultimately, the ocean, and include:

- Excess or poorly managed fertilizers, herbicides and insecticides from agricultural lands and residential areas
- Oil, grease and toxic chemicals from urban runoff and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks
- Salt from roadway de-icing materials, irrigation practices and acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes and faulty septic systems
- Atmospheric deposition and hydro-modification (US EPA, 2014).

5.1.1. Stormwater Runoff/Outfalls

Stormwater runoff occurs when rain and snow-melt cannot soak into the ground where it falls due to the presence of hard surfaces (also called impervious cover or IC) usually associated with development. Impervious cover includes rooftops and paved areas such as roads, sidewalks, driveways and parking lots. Rainwater that falls onto impervious cover is typically directed into stormdrain systems, which funnel rainwater away from hard surfaces, especially roadways, in order to maintain safe conditions for vehicular traffic. Stormdrain systems typically discharge stormwater into low-lying "safe" receiving areas, such as ditches, streams, wetlands and ponds. Traditionally, stormdrain systems have not been designed to treat the many pollutants that rainwater mobilizes and transports as it is conveyed into the receiving waterbodies. As a result, stormwater can contain a variety of pollutants including bacteria, sediment, nutrients from pets, livestock and lawn care products, trash and debris, and oils, greases and other chemicals from vehicles that can be detrimental to water quality and exceed established water quality standards. Traditional stormdrain systems may also be a significant source of fecal bacterial loading, either via the transmission of contaminated surface stormwater runoff to the receiving waterbody, or by loading of bacteria originating in the stormdrain. Recent studies have indicated that *E. Coli* and other fecal coliform bacteria, once introduced into the environment, can survive and proliferate in the biofilm (scum) layer that forms in stormdrain pipes (Skinner *et al*, 2010).

The enumeration of impervious cover in a watershed can be used to evaluate the effects of stormwater runoff on stream quality. Numerous studies, including those conducted by Schueler (1994), have demonstrated that the amount of impervious cover in a watershed directly impacts stream quality (Fig. 5-1). In 2007, Roy Schiff and Gaboury Benoit published data from a study of the West River in New Haven, CT. Their study

showed that water quality declined when the total impervious area within a stream's contributory watershed exceeded 5%. A 2008 study conducted by CT DEEP indicated that water quality declined when impervious cover in a watershed exceeded 6% (Bellucci, Beauchene and Becker, 2008). The Connecticut Watershed Response Plan for Impervious Cover (DEEP, 2015), which was developed to provide guidance for "managing stormwater and impervious cover to support water quality improvements" suggests a target imperious cover limit of 12%. Twelve percent impervious cover represents "the level of impervious cover in the contributing watershed, below which a stream is likely to support a macroinvertebrate community that meets aquatic life use goals in Connecticut Water Quality Standards."

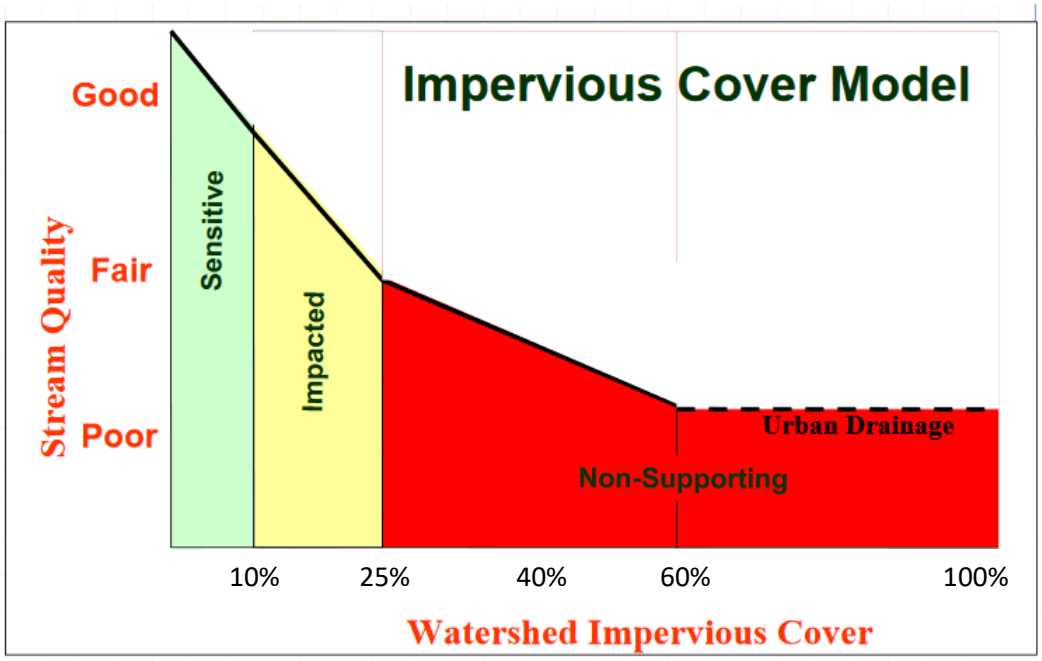


Figure 5-1. The relationship between stream quality and impervious cover in a watershed (Schueler, 1994).

Approximately 8.5% of the Ekonk Brook watershed is developed, and the generally good water quality throughout most of the watershed is indicative of this low level of development. However, as residential development increases in the northern portion of the watershed, a corresponding decrease in water quality is noted. The upper Ekonk Brook sub-watershed, which extends from the confluence of Ekonk Brook with unnamed stream 1 to the confluence with the Moosup River, is characterized by a transition from rural to suburban and even urban residential development as it extends into Moosup. Approximately 25% of the upper Ekonk Brook subwatershed is developed, indicating that stream quality is impacted and is on the borderline of being non-supportive for aquatic habitat.

5.1.2. Sanitary Sewers/Septic Systems

Fecal bacteria loading can occur as a result of undetected leaks in municipal sewer systems or malfunctioning or under-functioning septic systems. The municipal sewer system in Plainfield is operated by the Plainfield Water Pollution Control Authority (WPCA). Municipal sewers in the Ekonk Brook watershed are located in the very northwestern portion of the watershed (Fig. 5-2) and provide service to Northern Drive, Gendron Road, River Street and Gorman Road (including the Moosup Garden Apartment complex). Raw sewage from these areas is conveyed via sewer main to the Central Village treatment plant (located outside the Ekonk Brook watershed) where it is treated and discharged to the Moosup River. Sewer lines are owned and maintained by the WPCA. Older lines, including those in vicinity of River Street, tend to be comprised of clay pipe. Those sections of clay sewer lines with known trouble spots are inspected twice a year. Newer sewer lines, including those at Northern Drive, are comprised of concrete pipe. The WPCA does not typically inspect concrete sewer mains unless there is a suspected problem. In 2013, approximately 300 feet of clay pipe sewer line on Gorman Road was replaced by the town in response to a blockage that caused the sewer line serving Moosup Garden Apartments line to fail. Additional information regarding sewer line maintenance and repairs can be obtained from the Plainfield WPCA.

Most of the Ekonk Brook watershed is served by individual on-site subsurface sewage (septic) systems. Individual septic systems are regulated by the Northeast District Department of Health (NDDH) located in Brooklyn, CT. The Health District is responsible for the review of septic system siting and design, including soil evaluations to ensure septic effluent will infiltrate the soil at a specified range of rates and provide adequate bacteria renovation.

Septic system failures can result in sewage breakouts, where untreated effluent containing both nutrients and fecal bacteria is discharged to the ground surface, where it can contaminate not only nearby waterbodies, but nearby drinking water wells. Septic system failures can also result in the leaching of untreated effluent into groundwater, which can then be conveyed to nearby wells and waterbodies. Septic system functionality can be affected by improper installation and limitations including soil suitability, depth to groundwater, and depth to bedrock. Figure 5-3 depicts the septic suitability of soils in the Ekonk Brook watershed. In general, the watershed appears to be dominated by soils that have low septic potential, necessitating the need for engineered septic systems to ensure effluent is treated properly. Property owners are encouraged to maintain their systems through best management practices, including regular tank pumping, system inspections and proper disposal of chemicals and other materials that might otherwise impact or impair the proper function of the septic system. At the present time, there is no regulatory mechanism in place to require or enforce septic system maintenance and inspections.

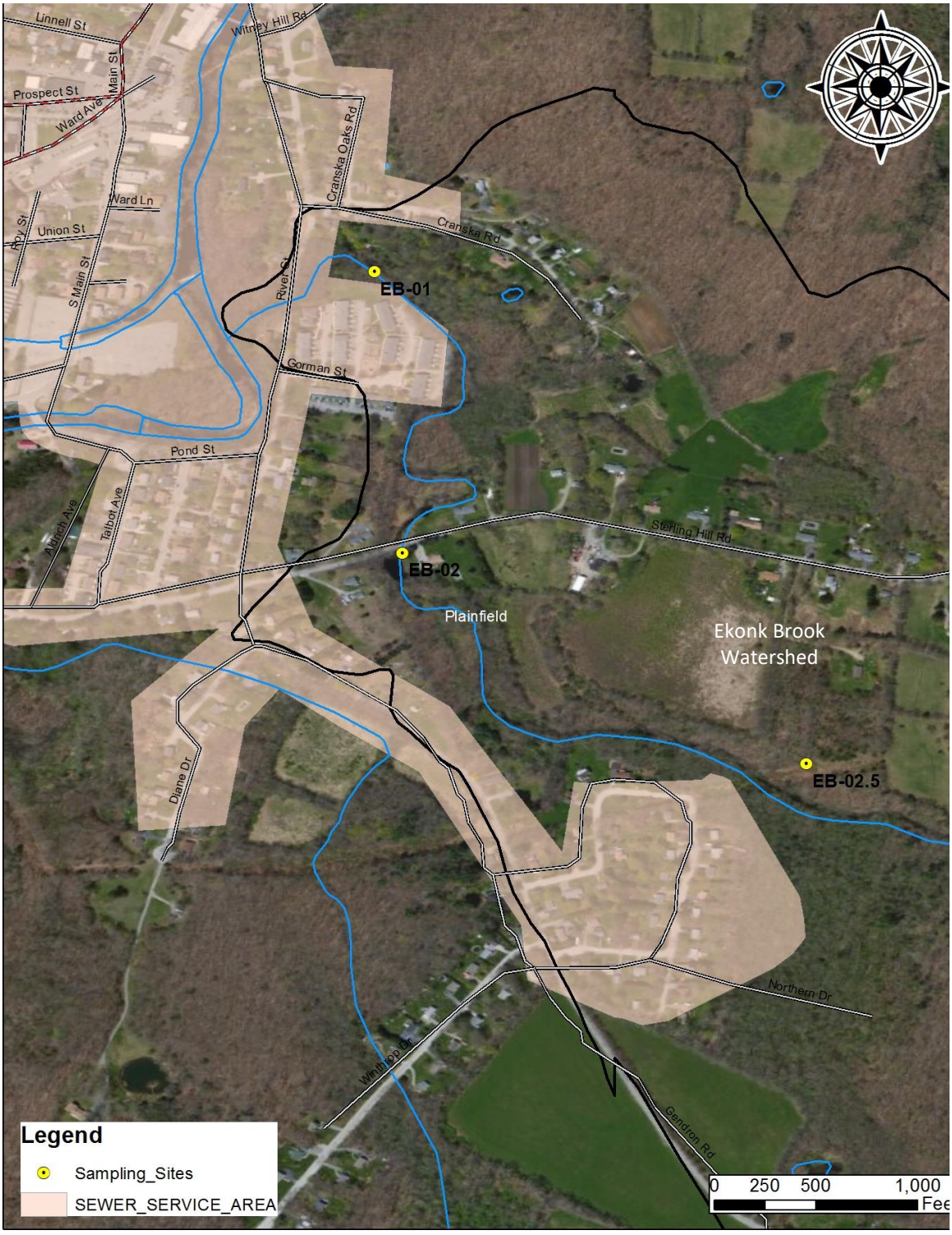


Figure 5-2. Municipal sewer service area in the Ekonk Brook watershed in Plainfield, CT. The limits of the Ekonk Brook watershed are depicted by the black line.

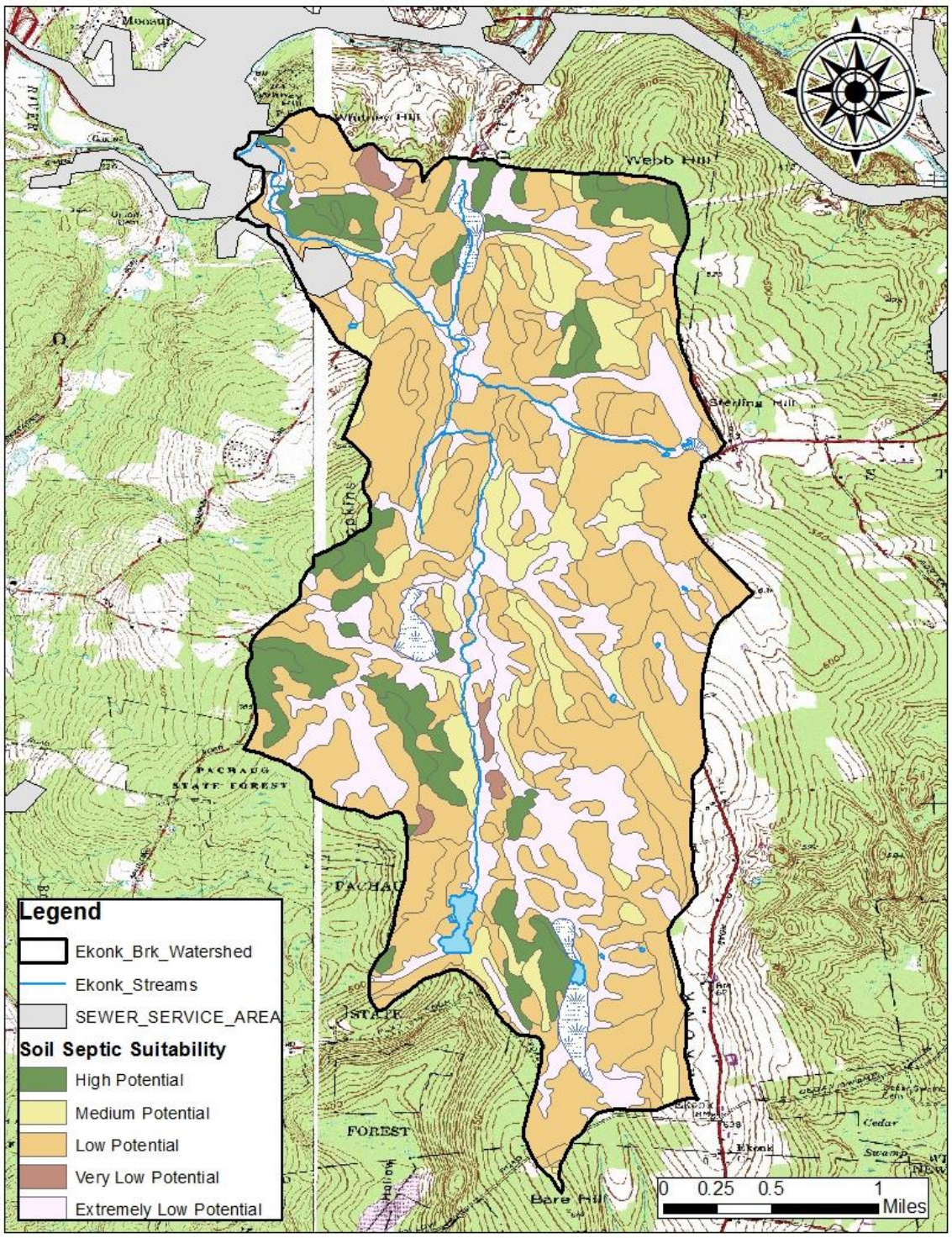


Figure 5-3. Suitability of soils in the Ekonk Brook watershed for the installation of septic systems (USDA-NRCS Web Soil Survey, 2010).

Bacteria levels documented at sampling site UN-01-02 from unnamed stream 1, which originates in a wetland system on the east side of Goshen Road, exceeded allowable limits. No livestock were noted on the portion of Goshen Road within the Ekonk Brook watershed. However, older residences, coupled with a seasonally high water table as evidenced by the nearby wetland, indicate that older, underperforming septic systems could be contributing to bacteria loading.

5.1.3. Agriculture/Cropland

While forest is the dominant land cover in the Ekonk Brook watershed, agriculture is the predominant land use activity. Approximately 685 acres of land in the watershed (20%) are under active agricultural use. Agricultural operations are located primarily along Sterling Hill Road in Plainfield and Ekonk Hill Road in Sterling, although corn and hay fields were noted throughout the watershed. Agricultural land use can contribute to both point and nonpoint source pollution. Common agriculture-related pollutants include sediment, nutrients from fertilizer and manure (particularly phosphorus and nitrogen), herbicides and pesticides, and pathogens from animal waste. Pollutant loading varies depending on the type of farming activity, and can be minimized through the selection of appropriate farm management practices and application methods.

Much of the agricultural land in the Ekonk Brook watershed is under cultivation for silage corn and/or hay for livestock (primarily dairy cows) that are located outside of the watershed. These fields are fertilized variously with liquid manure, chicken manure or chemical fertilizers, depending on the preferences of the field managers and availability of manure. Of particular note was a corn field adjacent to unnamed stream 1 on Sterling Hill Road, upstream of sampling site UN01-01. Bacteria levels in the stream at this location exceeded allowable limits. A 100-foot wide vegetated buffer strip separates the stream from the edge of the cultivated field and it was reported that chemical fertilizer (which does not contain fecal bacteria) rather than manure is used on this field.

5.1.4. Livestock/Poultry

Livestock can contribute to NPS in several ways. Nutrient and pathogen loading can occur from poor or improper manure management practices. Sediment loading can occur via overgrazing and runoff from bare soils in confined paddock areas. Nutrient, pathogen and sediment loading can also occur in areas where livestock are kept near to or allowed access to waterways. As noted in Section 5.1.3, dairy herds are located outside of the Ekonk Brook watershed. A large poultry flock (approximately 4000 birds) is located within the Ekonk Brook watershed. The poultry farm maintains an annual animal crop. The majority of animals on the farm are brought in in July, and are harvested in November. There are also approximately 24 beef cattle associated with the farm and "pet" livestock that are not harvested for meat. The farm also has laying hens, ducks, and geese, however the largest biomass is the turkey and broiler chicken flocks (Ray Covino, CT NRCS, personal communication, 2016). The poultry producer participates in USDA Natural Resource Conservation (NRCS) programs and maintains

composting facilities to manage animal waste and all waste is exported off-site. There were no known water quality issues noted in association with that facility.

5.1.5. Pets

In developed areas, pet feces, particularly dog feces, can be a significant source of bacteria. A study conducted by the University of Nevada Cooperative Extension (Walker and Garfield, 2008) determined that one gram of fresh dog feces contained an average of 50 million colony forming units (CFU) of E. coli bacteria. The improper or lack of disposal of pet waste can contribute to the total amounts of bacteria in stormwater runoff. The Ekonk Brook Total Maximum Daily Load (DEEP, 2011) cites improper disposal of pet waste as a potential source of bacteria in nonpoint source (NPS) pollution. In 2016, approximately 1050 dogs were licensed in Plainfield (equivalent to 24 dogs per square mile), and approximately 300 dogs were licensed in Sterling (equivalent to approximately 11 dogs per square mile).

A small colony of feral cats was observed at Moosup Garden Apartments, living in the wooded area alongside Ekonk Brook. The exact number of the cats in the colony is unknown, though it was estimated by apartment residents to be approximately 15 – 20 animals. It was also reported by residents that at least some of the cats had been spayed or neutered to prevent reproduction.

5.1.6. Wildlife/Waterfowl

In relatively undeveloped watersheds like the Ekonk Brook watershed, wildlife can contribute to the total bacteria load. Approximately 71% of the Ekonk Brook watershed is undeveloped. The Ekonk Brook Total Maximum Daily Load (DEEP, 2011) cites waste from wildlife as a potential nonpoint source of bacteria in the watershed; however, it is difficult to determine the exact contribution of the many types of wildlife found in eastern Connecticut to the total bacteria load. Common mammals, including whitetail deer, contribute to "background" or natural levels of bacteria found in the watershed.

No estimates of the presence of Canada geese or other migratory waterfowl were made during the Ekonk Brook bacteria trackdown. Non-migratory Canada geese were not reported to be a problem in the watershed. Lockes Meadow Pond, located at the headwaters of Ekonk Brook in the Pachaug State Forest, is a prime habitat for migratory waterfowl. Large flocks of waterfowl can contribute significantly to bacteria loading, and migratory waterfowl can produce seasonal plugs of fecal bacteria, temporarily inflating bacteria levels in watercourses. According to a study conducted by Alderisio and DeLuca (1999), waterfowl can contribute an average of 4,500 to 24,200,000 colony-forming units of fecal coliform bacteria (probably mostly Escherichia coli) per gram of feces "depending on the season and year of observation." However, bacteria levels documented at the outlet of Lockes Meadow Pond (EB-01) demonstrated that fecal bacteria levels were well within allowable levels for surface waters, indicating waterfowl were not a significant source of bacteria loading in Lockes Meadow Pond.

5.2. Point Sources

Point source pollution is pollution that is discharged from a single, identifiable point, such as a sewage outfall or combined sewer overflow pipe, factory, or confined animal feedlot (National Water Quality Monitoring Council, 2007). Point sources may be regulated by state or federal authorities via the National Pollutant Discharge Elimination System (NPDES) permit program.

Potential point sources can include National Pollutant Discharge Elimination System (NPDES) permits, Phase I and ll Municipal Stormwater (MS-4) permits, Construction Stormwater General permits, and confined animal feeding operation (CAFO) permits. Commercial enterprises, particularly shopping malls, may be subject to the Commercial Stormwater General permit, which applies to discharges from any stormwater system that collects and conveys stormwater and is directly related to retail, commercial, and/or office services whose facilities occupy *five acres or more* of contiguous impervious surface.

5.2.1. NPDES Permits

The National Pollutant Discharge Elimination System (NPDES) is authorized by Section 402 of the Clean Water Act through the 1987 Water Quality Act. The NPDES program regulates direct discharges into navigable waters of the US, including point source discharges and nonpoint sources. NPDES permits may be issued directly by the US EPA or by states authorized by EPA. Connecticut is authorized to issue NPDES permits. Permits establish pollutant monitoring and reporting requirements, and may include pollutant discharge limits based on specific water quality criteria or standards (US EPA, 2015).

Stormwater discharges regulated by NPDES permits include:

- discharges permitted prior to February 4, 1987
- discharges associated with industrial activity
- discharges from large Municipal Separate Storm Sewer Systems (MS4s) (systems serving a population of 250,000 or more)
- discharges from medium MS4s (systems serving a population of 100,000 or more, but less than 250,000)
- discharges judged by the permitting authority to be significant sources of pollutants or which contribute to a violation of a water quality standard (*US EPA, 2014*).

5.2.1.1. Phase 1 and 2 Stormwater Permits

Stormwater permits issued under Phase 1 of the NPDES program include the categories of stormwater discharges listed above. Also included in Phase 1 are municipal separate storm sewer systems (MS4) program permits for medium and large MS4s; construction sites which disturb five or more acres; and for numerous types of industrial facilities. Stormwater permits issued under Phase 2 of the

stormwater program include discharges not covered by Phase I, including small MS4s; construction sites of one to five acres; and industrial facilities owned or operated by small MS4s which were previously exempted under the Intermodal Surface Transportation Efficiency Act (US EPA, 2014).

Stormwater permits issued by the State of Connecticut under the NPDES program include:

- **General Permit for the Discharge of Stormwater Associated with Industrial Activity** ("Industrial General Permit"), which regulates industrial facilities with point source stormwater discharges that are engaged in specific activities according to their Standard Industrial Classification (SIC) code.
- **General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities** ("Construction General Permit"), which requires developers and builders to implement a Stormwater Pollution Control Plan to prevent the movement of sediments off construction sites into nearby water bodies and to address the impacts of stormwater discharges from a project after construction is complete.
- **General Permit for the Discharge of Stormwater Associated with Commercial Activity** ("Commercial General Permit"), found only in Connecticut, which requires operators of large paved commercial sites such as malls, movie theaters, and supermarkets to undertake actions such as parking lot sweeping and catch basin cleaning to keep stormwater clean before it reaches water bodies.
- **General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems** ("MS4 General Permit"), which requires each municipality to take steps to keep the stormwater entering its storm sewer systems clean before entering water bodies (CT DEEP, 2014).

The purpose of the MS4 stormwater general permit is to protect surface waters from stormwater runoff from storm drain systems originating in urbanized areas. The MS4 permit has specific requirements, including the development of a Stormwater Management Plan (SWMP) and the monitoring of specified stormwater outfalls. The SWMP identifies six *Minimum Control Measures* that the permittee must implement, including:

- Public education and outreach
- Public participation
- Illicit discharge detection and elimination (IDDE)
- Construction stormwater management
- Post-construction stormwater management
- Pollution prevention and good housekeeping

The Towns of Plainfield and Sterling were previously waived from MS4 permitting under then-current rules because the population in the Urbanized Area was less

than 1000. However, due to changes to the MS4 General Permit by CT DEEP, Plainfield will be required to comply with the MS4 program when the 2016 General Permit becomes effective on July 1, 2017. CT DEEP has provided resources for municipalities, including town-based impervious cover (IC) and impaired waters mapping, at the DEEP MS4 Stormwater webpage. For more information, see the DEEP Stormwater webpage at www.ct.gov/deep/stormwater, and navigate to *General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems ("MS4 General Permit").*

A review of existing CT DEEP and US EPA data indicated that there are no facilities in Ekonk Brook that are registered in the Industrial, Commercial or Construction SWGP programs. Additionally, there are no underground injection permits in the Ekonk Brook watershed.

5.2.1.2. CAFO Permits

Concentrated Animal Feeding Operations (CAFOs) are agricultural operations where:

> Animals are kept and raised in confined areas for a total of 45 days or more in any 12-month period, and crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility. CAFOs generally congregate animals, feed, manure, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain), and non-agricultural application of manure to crop land. CAFOs are point sources, as defined by the CWA Section 502(14) and are regulated through the NPDES program (US EPA, 2014).

Currently, in Connecticut, permits are not being issued for CAFOs, although DEEP does review Comprehensive Nutrient Management Plans (CNMPs) that are voluntarily submitted by producers enrolled in USDA-NRCS programs. DEEP is in the process of preparing a general permit under which CAFOs will be permitted in the future. NRCS reported that only one CNMP has been prepared for an agricultural producer in the Ekonk Brook watershed at the time of the preparation of this document. There are no CAFOs located in the Ekonk Brook watershed.

5.3. Hazardous Waste

EPA defines hazardous waste as “waste that is dangerous or potentially harmful to our health or the environment. Hazardous wastes can be liquids, solids, gases, or sludges. They can be discarded commercial products, like cleaning fluids or pesticides, or the by-products of manufacturing processes” (US EPA, 2014). Authority for the State of Connecticut to regulate hazardous waste is prescribed through Connecticut General Statutes Section 22a-449.

5.3.1. CERCLA Sites

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as the Superfund, was enacted by Congress on December 11, 1980. A CERCLA or Superfund site is an uncontrolled or abandoned place where hazardous waste is located (US EPA, 2014). There are no CERCLA sites in the Ekonk Brook watershed.

5.3.2. RCRA Sites

The Resource Conservation and Recovery Act (RCRA) was enacted by Congress in 1976. RCRA's primary goals are "to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner. RCRA regulates the management of solid waste (e.g., garbage), hazardous waste, and underground storage tanks holding petroleum products or certain chemicals" (US EPA, 2014). There are no RCRA sites in the Ekonk Brook watershed.

5.3.3. Brownfields

A brownfield is defined by Connecticut General Statutes §32-9kk(a)(1) as "any abandoned or underutilized site where redevelopment, reuse or expansion has not occurred due to the presence or potential presence of pollution in the buildings, soil or groundwater that requires investigation or remediation before or in conjunction with the restoration, redevelopment, reuse and expansion of the property." The Connecticut Brownfields Redevelopment Authority (CBRA) maintains a town- by- town brownfields inventory that can be found on the CT DEEP brownfields portal (www.ct.gov/deep/cwp/view.asp?A=2715&Q=324930), along with additional information regarding brownfields redevelopment. No brownfields have been identified in the Ekonk Brook watershed.

5.3.4. Underground Storage Tanks (USTs)

The US EPA defines an underground storage tank (UST) as "a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground" and that stores petroleum or certain hazardous substances (US EPA, 2014). This typically refers to underground tanks at gas and service stations and residential heating oil tanks. The State of Connecticut regulates USTs through the Department of Energy and Environmental Protection Storage Tank Enforcement Unit. There is one registered UST site in the Ekonk Brook watershed (Fig. 5-4).

5.4. Other Potential Pollutant Sources

5.4.1. Winter Road De-icing

CT DOT maintains state highways in the Ekonk Brook watershed, including Route 14A which runs east-west across the midsection of the watershed, and Route 49, which runs

north-south along Ekonk Hill in Sterling. In 2006, CT DOT switched to a winter de-icing program utilizing salt and liquid chemicals, and discontinued the use of road sand. Chlorides are prime constituents of de-icing compounds. Chlorides can negatively impact water quality as well as stormwater infrastructure. The development of best management practices to address chloride has been very challenging.

The Towns of Sterling and Plainfield manages all municipal roads within their respective jurisdictions. Both municipalities utilize a salt-sand mix for winter road management.

5.4.2. Land Clearing/Development

Other potential sources of pollution include activities such as residential and/or commercial development, earth removal and logging operations. These operations can result in the clearing of large tracts of land and erosion and transport of soil. Land development and land clearing activities occur under the auspices of the municipal land-use commissions, including the Planning and Zoning and Inland Wetlands and Watercourses Commissions. Commissions are responsible for reviewing land development permit applications, ensuring the proposed activities comply with land-use regulations and issuing permit conditions as necessary. Land-use staff are responsible for ensuring permitted activities are being conducted in compliance with the municipal regulations and the terms of the permits.

Typical permit conditions include proper use of on-site erosion and sediment control, and adoption of a stormwater management plan. Forestry activities should follow industry-established guidelines such as those outlined in the *BMPs for Water Quality While Harvesting Forest Products* guidebook. Inland Wetlands and Watercourse Commissions and/or the Inland Wetlands Official should require a *Forest Practices Notification Form* (or similar form) when stream or wetland crossings are proposed as part of a timber harvest.

There were no residential and/or commercial developments or earth removal operations in the Ekonk Brook watershed at the time of the preparation of this Plan. There was a small logging operation being conducted on the west side of Sterling Hill Road, near Sterling Hill Brook in 2014.

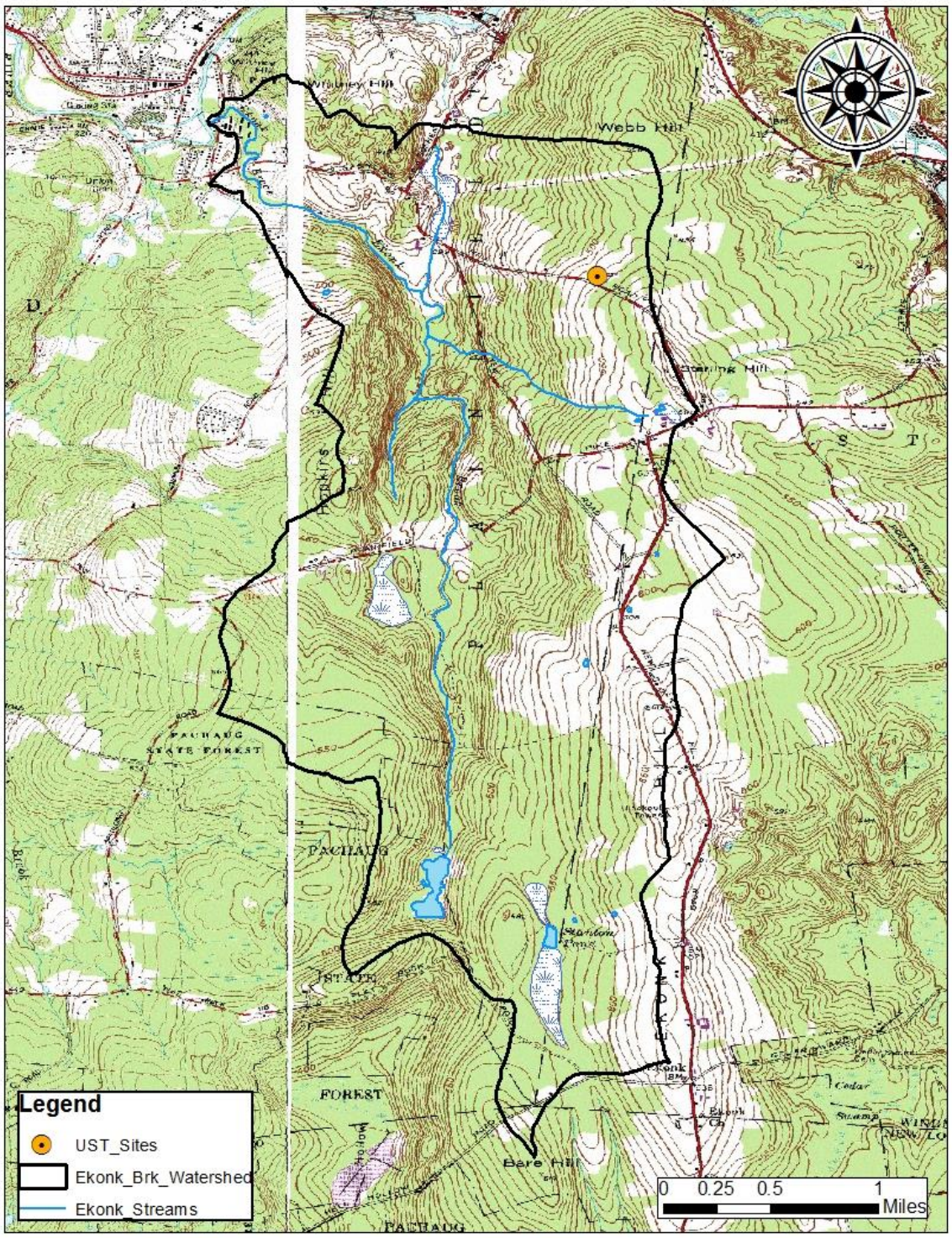


Figure 5-4. Location of registered underground storage tanks (UST) in the Ekonk Brook watershed.

6. Pollutant Load Assessment

6.1. Estimation of Pollutant Loads

The estimation of pollutant loads is a critical element in the overall watershed planning process. An estimation of pollutant loads is necessary in order to determine the pollutant load reduction that is needed to restore the quality of an impaired waterbody. A pollutant load is defined as the mass of a pollutant being delivered per unit of time to a waterbody, usually expressed as pounds or kilograms per year. In order to identify where pollutant load reductions may be applied to improve water quality, it is necessary to quantify the pollutant load contributions from the watershed. Where water quality measurements are made, it is possible to determine pollutant loading directly. When no water quality data is available, the use of models can be used to estimate pollutant loading. It should be noted that due to the complexity of watershed processes, models are inherently imprecise, and should be used to guide watershed management decision-making and not as a predictor of future water quality.

6.1.1. Watershed Pollutant Loads

ECCD used the Watershed Treatment Model (2013 "Off the Shelf" edition), developed by the Center for Watershed Protection, to estimate watershed pollutant loads based on existing land use conditions. The Watershed Treatment Model (WTM) is based on the Simple Method (Schueler, 1987) which uses parameters including watershed area, annual rainfall, runoff coefficients and selected pollutant concentrations (in mg/l) to estimate annual pollutant loads. The Watershed Treatment Model incorporates additional elements into the Simple Method model, such as existing structural and behavioral management practices that may reduce existing pollutant loading, the effects of the adoption or implementation of future management practices on pollutant loading, and the effects of future development in the subject watershed on existing loading levels.

Based on potential bacteria sources identified in Section 5.1, the following land uses were included in the model:

- Low density residential (less than one dwelling unit per acre)
- Medium density residential (1-4 dwelling units per acre)
- High density residential (greater than four dwelling units per acre)
- Roadways
- Forest
- Pasture
- Cropland
- Open Water

In addition to pollutant loading from the land uses listed above, pollutant loading from other potential sources in the watershed were evaluated, including:

- On-site subsurface sewage disposal systems
- Livestock

Finally, existing structural and non-structural management practices were incorporated into the model, including:

- Riparian (stream corridor) buffers
- Bio-retention (use of a vegetated cell to remove contaminants from stormwater)
- Erosion and sediment controls
- Lawn management practices
- Pet waste management practices

Common NPS pollutants that were modeled using the Watershed Treatment Model include total phosphorus (TP), total nitrogen (TN), total suspended sediments (TSS) and fecal coliform (FC).

To facilitate the modeling process, the Ekonk Brook watershed was divided into ten subwatersheds. These ten watersheds correspond with the ECCD bacteria sampling sites. The subwatersheds are depicted in Figure 6-1. Modeled pollutant loads for the Ekonk Brook land use types are presented in Table 6-1. Modeled pollutant loads and annual pollutant yields by sub-watershed are presented in Table 6-2. Modeled pollutant loads in pounds per year are presented by subwatershed in Figures 6-2 to 6-5. Modeled pollutant yields, pounds of pollutant per acre per year per subwatershed, are presented in Figures 6-6 to 6-9. Modeled pollutant loads for each subwatershed by land use type are presented in Appendix B.

6.1.2. Bacteria Loads

As the primary cause of the water quality impairment in Ekonk Brook, fecal bacteria is the primary pollutant of concern in the watershed. ECCD and volunteers from The Last Green Valley Water Quality Monitoring program collected water samples under an approved water monitoring plan for fecal bacterial analysis in 2013. The water quality data was reviewed by ECCD and is summarized in Table 6-3. Fecal coliform load estimates (Table 6-2) were compared to the 2013 stream sampling results. It should be noted that the fecal bacteria sampling results are provided in concentrations (coliform forming units/100 ml) while the loading values estimate yields (billions of units/year). However, the modeled fecal coliform load estimates generally reflected observed E. coli bacteria levels in the sampled streams throughout the watershed (Figure 6-10).

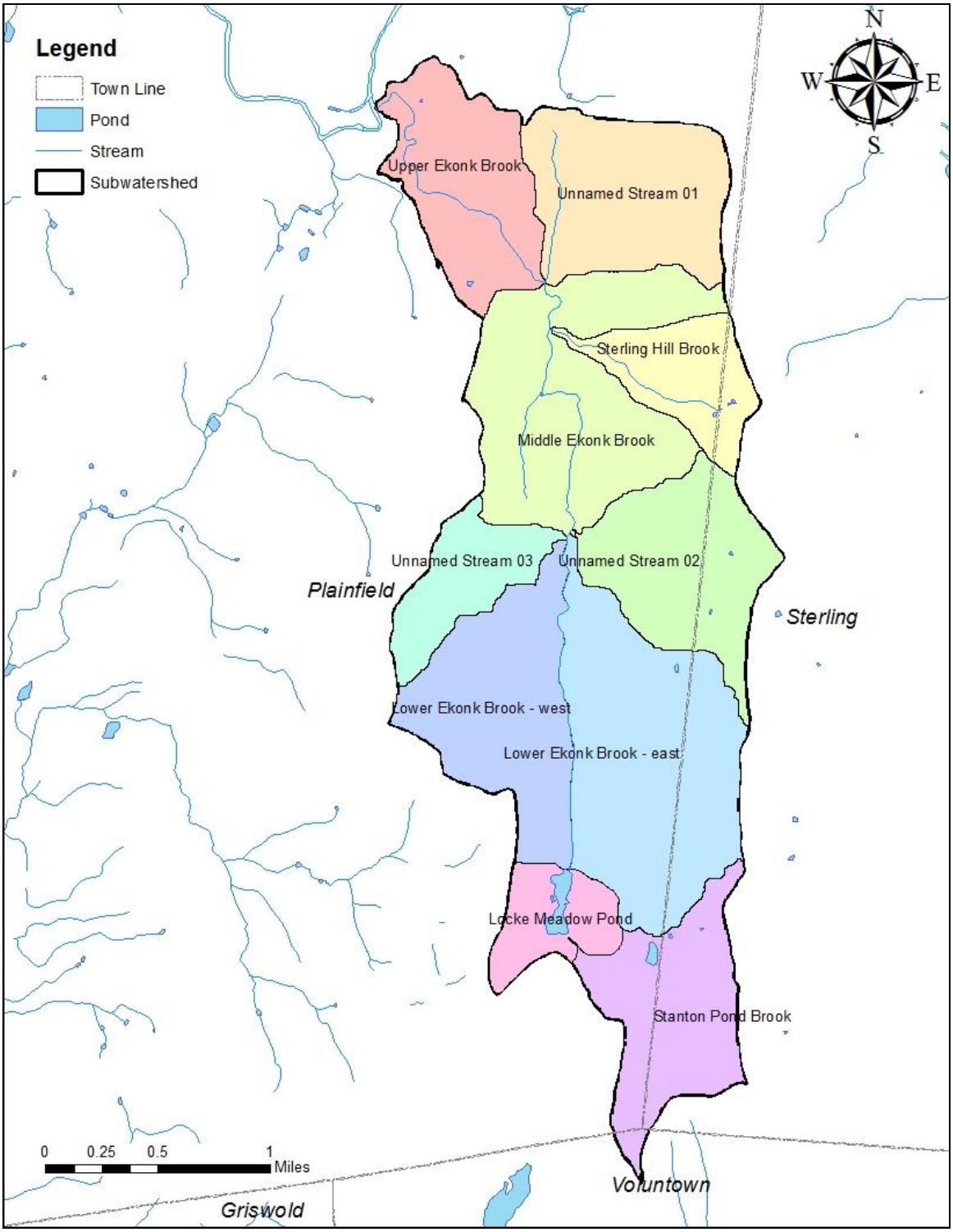


Figure 6-1. Ekonk Brook subwatersheds utilized in the Watershed Treatment Model.

Table 6-1. Ekonk Brook watershed modeled annual existing pollutant loads by source.

NPS Pollutant Source	TN (lb/year)	TP (lb/year)	TSS (lb/year)	Fecal Coliform (billion/year)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	1,557	230	36,338	67,596	273	16	18	10	46
MDR (1-4 du/acre)	44	6	1,019	1,896	8	0	0	0	1
HDR (>4 du/acre)	89	13	2,078	3,865	16	1	1	1	3
Roadway	465	54	28,539	19,413	78	5	4	8	13
Forest	4,945	487	243,719	29,246	363	51	39	64	20
Pasture	373	59	8,501	3,316	13	4	5	2	2
Cropland	2,074	403	57,536	22,439	88	21	32	15	15
Open Water	132	5	1,603	0	0	1	0	0	0
Land Use Total	**9,679**	**1,257**	**379,333**	**147,771**	**839**	-	-	-	-
Secondary NPS Sources									
Septic Systems	122	21	817	420	0	1	1	0	0
Stream Channel Erosion	0	0	116,119	0	0	0	0	23	0
Livestock	137	25	0	772	0	1	2	0	1
Load Reductions from Existing Practices	-223	-267	254	563	-14	-2	-17	0	0
Secondary Source Total	483	312	116,683	628	14	-	-	-	-
Total All Sources	**11,925**	**1,570**	**496,015**	**148,399**	**853**	-	-	-	-

Table 6-2. Ekonk Brook subwatershed modeled annual existing pollutant loads (in pounds per year) and yields (pounds per acre per year).

Ekonk Brook Subwatershed	Existing Pollutant Loads (lbs/year)				Existing Pollutant Yields (lbs/ac/year)			
	TN	TP	TSS	Fecal Coliform (billion/yr)	TN	TP	TSS	Fecal Coliform (% of load)
Upper Ekonk Brook (327 acres)	1,549	266	56,274	31,507	4.7	0.8	172	96
Unnamed Stream 01 (375 acres)	1,478	226	57,221	23,043	3.9	0.6	153	61
Sterling Hill Brook (191 acres)	682	93	27,578	8,573	3.6	0.5	144	45
Middle Ekonk Brook (546 acres)	1,666	195	78,296	19,413	3.1	0.4	143	36
Unnamed Stream 02 (346 acres)	1,355	203	54,908	22,142	3.9	0.6	159	64
Unnamed Stream 03 (170 acres)	598	87	27,017	10,704	3.5	0.5	159	63
Lower Ekonk Brook -West (399 acres)	1,015	86	52,296	5,720	2.5	0.2	131	14
Lower Ekonk Brook -East (597 acres)	1,935	219	79,187	13,480	3.2	0.4	133	23
Stanton Pond Brook (323 acres)	1,235	165	45,351	12,233	3.8	0.5	140	38
Lockes Meadow Pond (136 acres)	412	30	17,887	1,584	3.0	0.2	132	12
Total Ekonk Brook (3,410 acres)	**11,925**	**1,570**	**496,015**	**148,399**	-	-	-	-

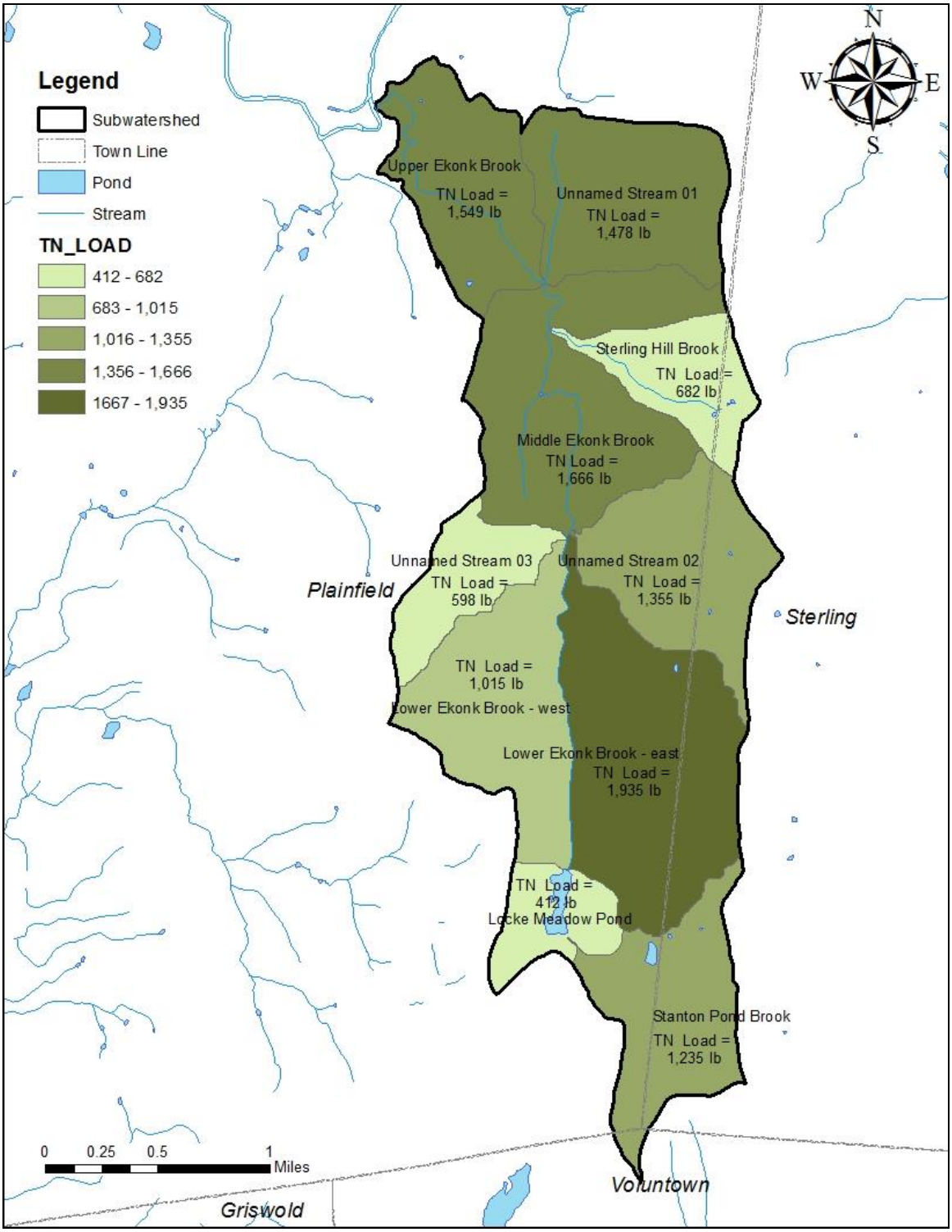


Figure 6-2. Estimated total nitrogen (TN) loads in the Ekonk Brook watershed, in pounds per year.

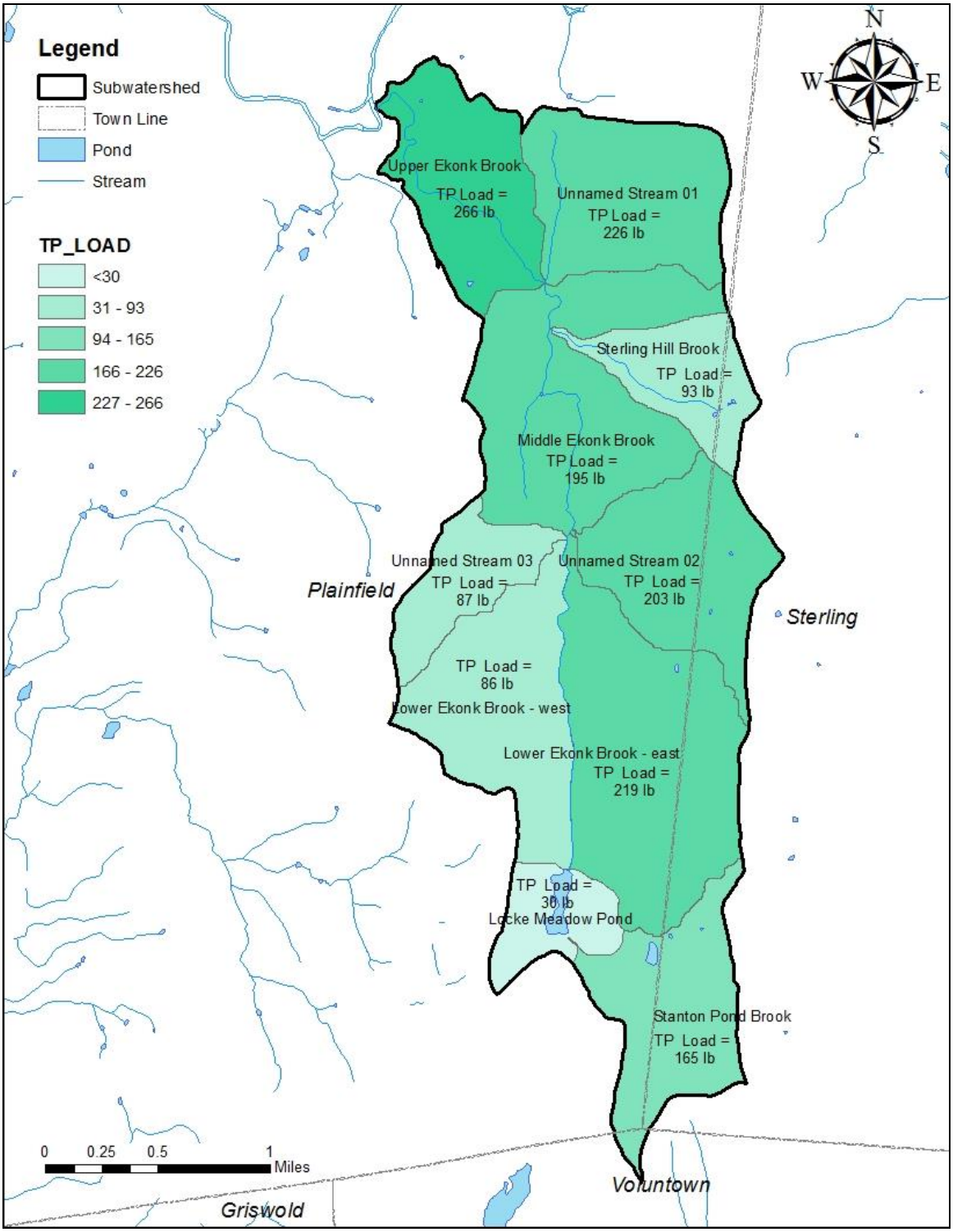


Figure 6-3. Estimated total phosphorus (TP) loads in the Ekonk Brook watershed, in pounds per year.

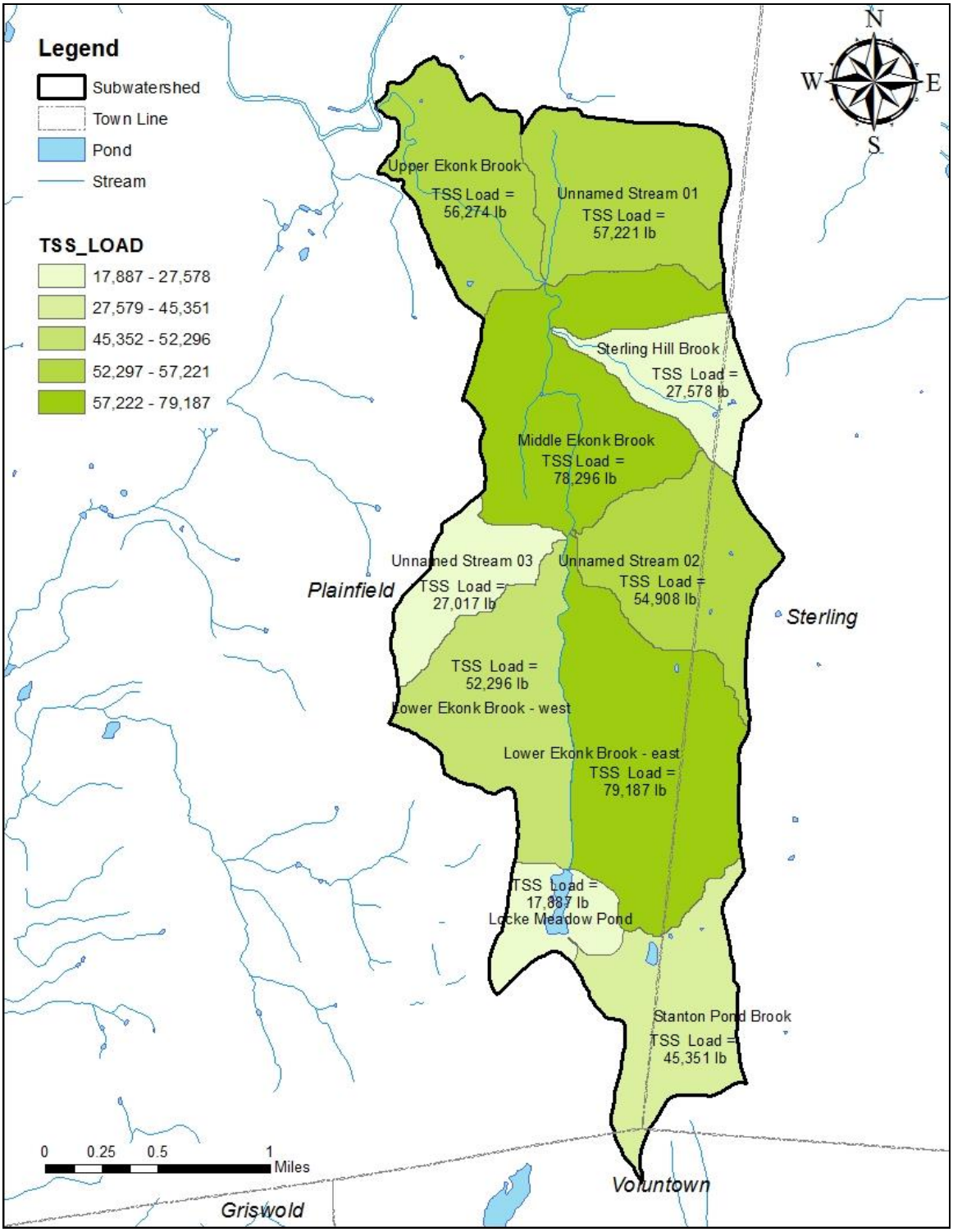


Figure 6-4. Estimated total suspended sediment (TSS) loads in the Ekonk Brook watershed, in pounds per year.

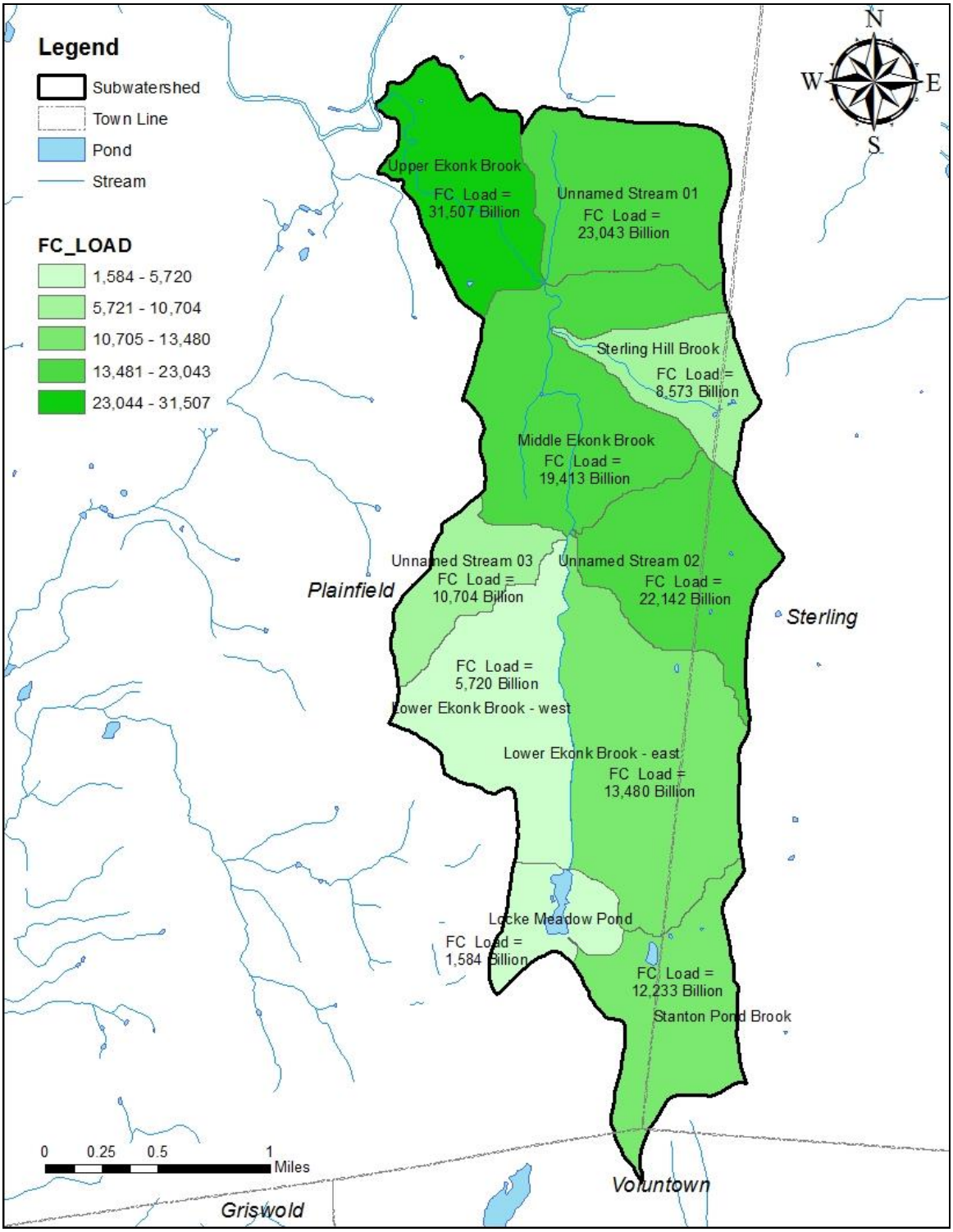


Figure 6-5. Estimated fecal coliform (FC) loads in the Ekonk Brook watershed, in billions per year.

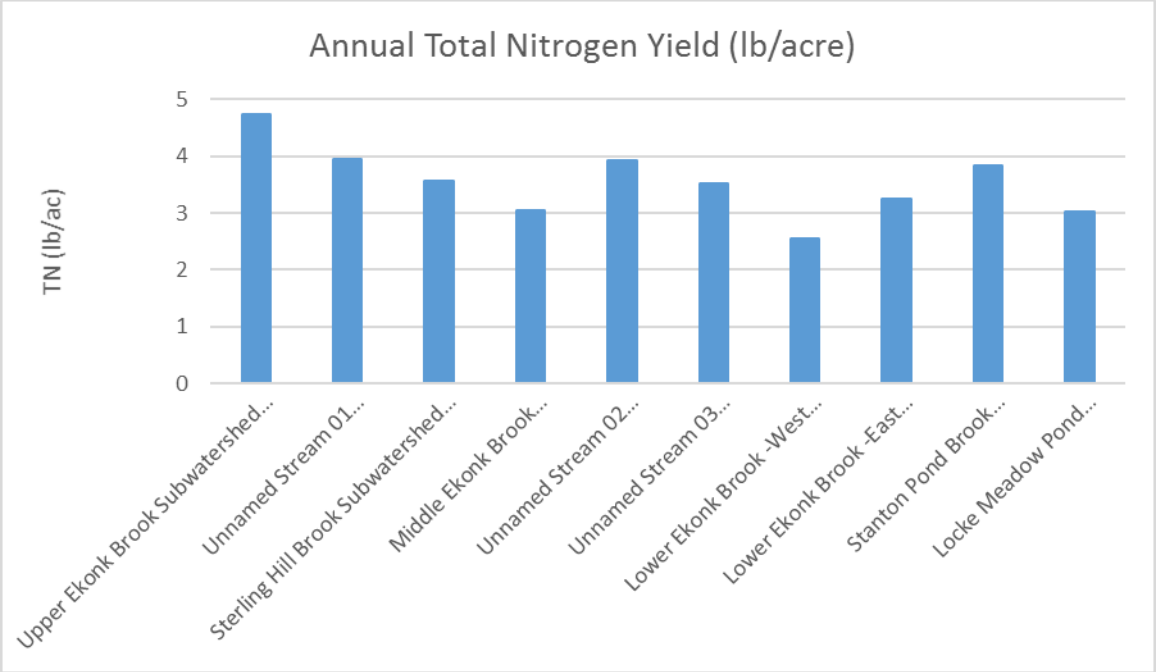


Figure 6-6. Estimated total nitrogen yields (pounds per acre per year) by subwatershed.

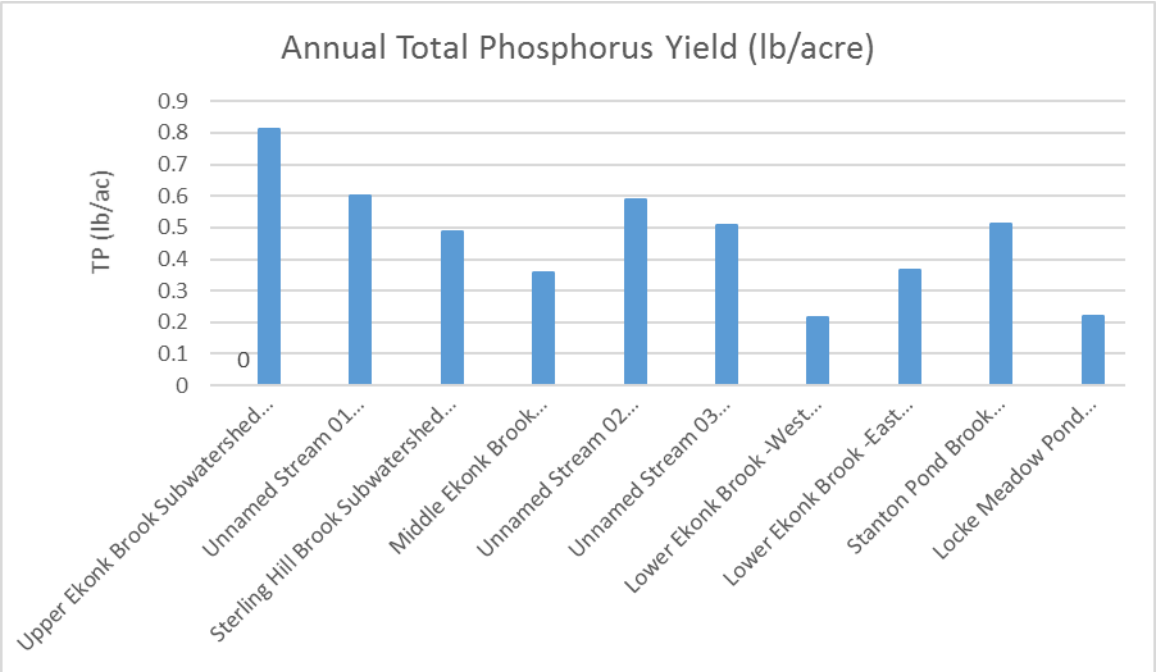


Figure 6-7. Estimated total phosphorus yields (pounds per acre per year) by subwatershed.

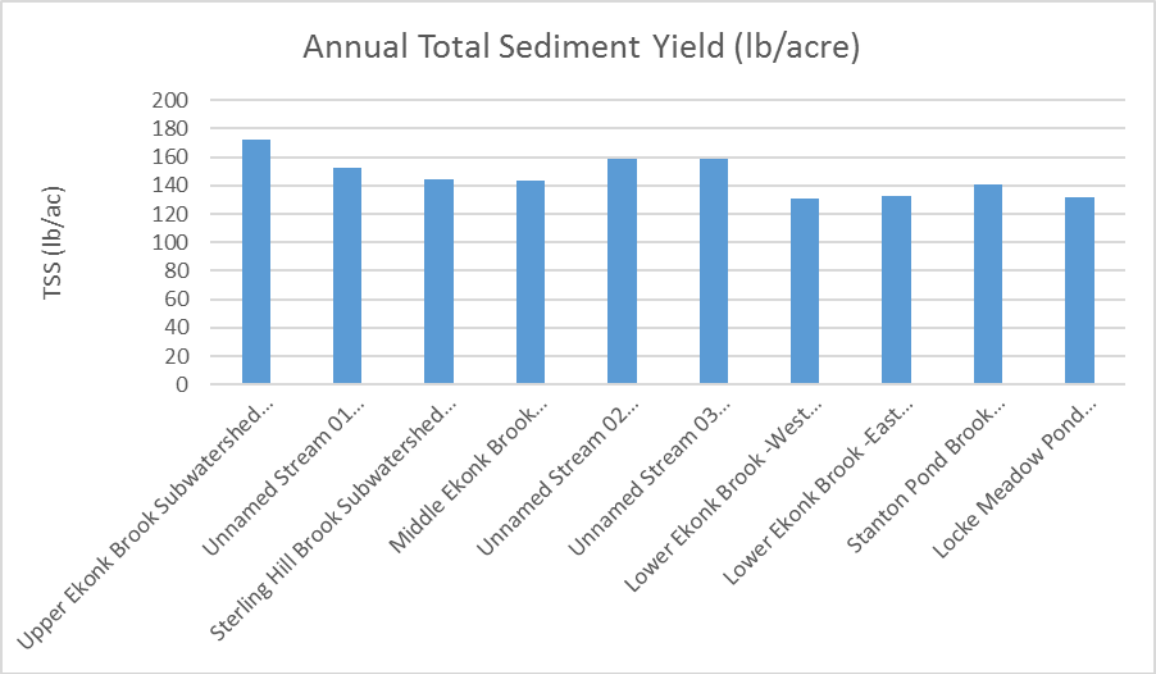


Figure 6-8. Estimated total suspended sediment yields (pounds per acre per year) by subwatershed.

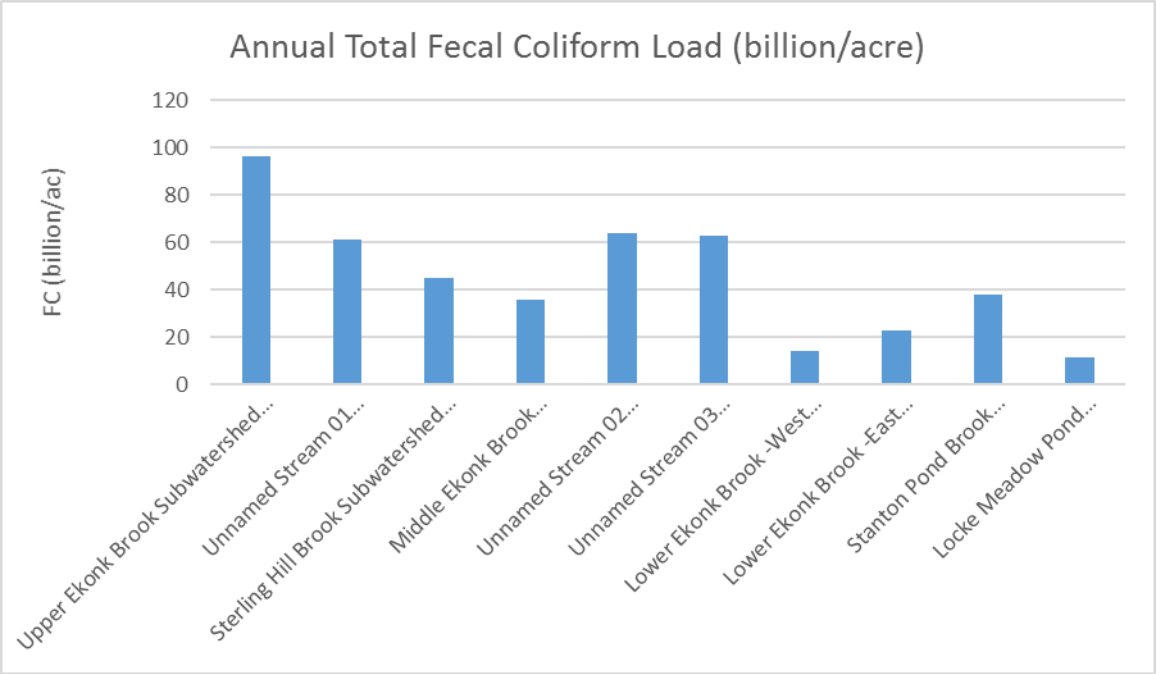


Figure 6-9. Estimated fecal coliform yields (billion per acre per year) by subwatershed.

Table 6-3. Geometric means of fecal bacteria concentrations collected from Ekonk Brook and tributary streams in 2013 by ECCD.

Sampling Site	*Site Description*	*Geometric Mean* (cfu/100ml)*
EB-01	Ekonk Brook – CT DEEP site #789 Moosup Garden Apartments	**772**
EB-02	Ekonk Brook at 79 Sterling Hill Road	117
EB-02.5	Ekonk Brook near Northern Drive	**170**
EB-03	Ekonk Brook upstream of Route 14A crossing	80
EB-04	Lockes Meadow Pond near pond outlet	24
UN-01-01	Unnamed stream #1 upstream of Sterling Hill Road crossing	**659**
UN-01-02	Unnamed stream #1 at powerline crossing near Goshen Road	**434**
SHB-01	Sterling Hill Brook downstream of Sterling Hill Road	41
UN-02-01	Unnamed stream #2 upstream of Route 14A crossing	**165**
UN-03-01	Unnamed stream #3 downstream of Route 14A crossing	**156**
SPB-01	Stanton Pond Brook at trail crossing in Pachaug State Forest	**204**

* The geometric mean (or geomean) is a type of average that uses the product rather than the sum of a series of values. It is useful when the number set has a very wide or different numerical range, and eliminates the tendency for a wide range to "weight" the results. The geometric mean is defined as the nth root of the product of n numbers.

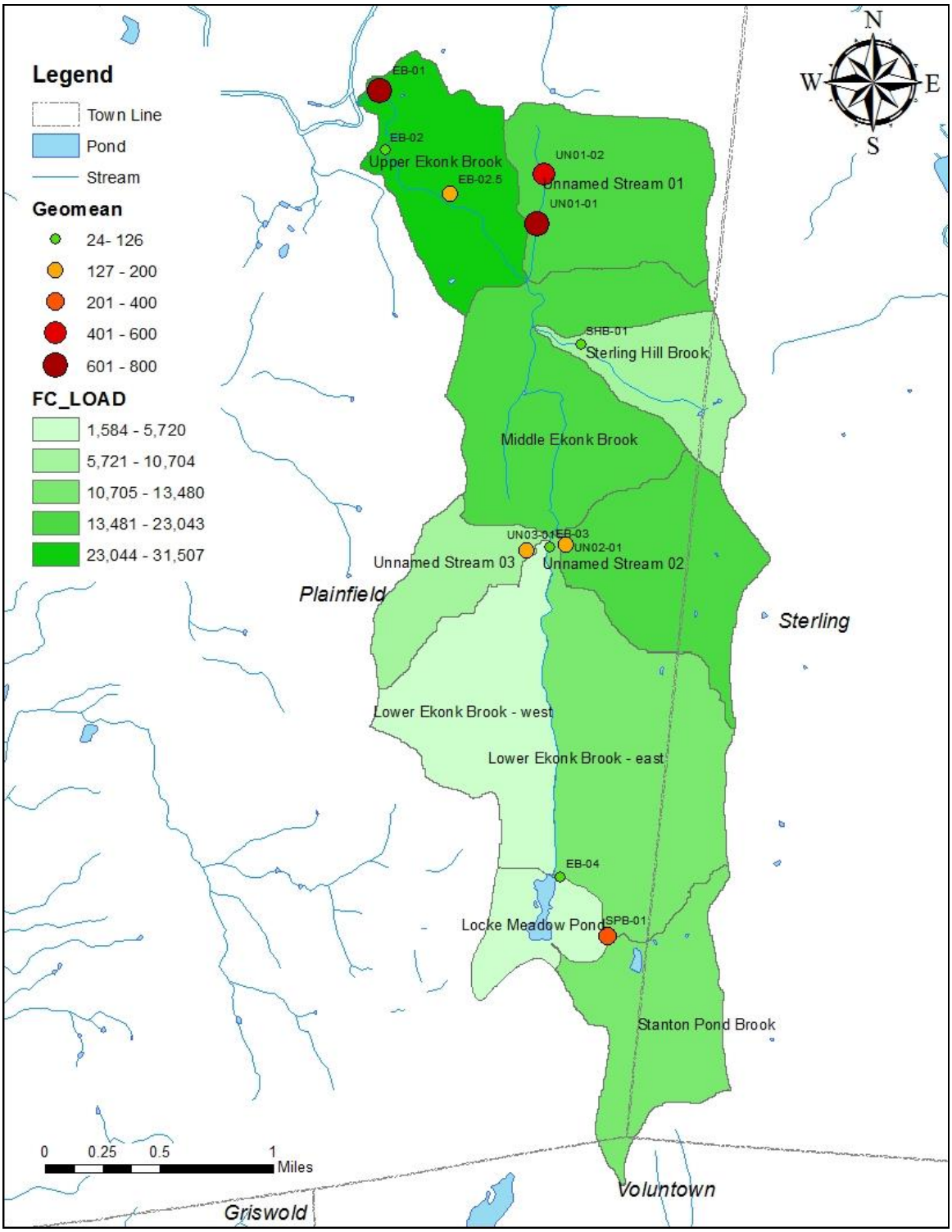


Figure 6-10. E. coli geometric mean values superimposed on estimated fecal coliform annual loads calculated by the Watershed Treatment Model for the Ekonk Brook subwatersheds. Where the model predicted low FC loading, the sampled streams met CT water quality standards for freshwater recreational activities.

6.2. Identification of Critical Areas

Critical areas are generally defined as areas that contain sensitive resources or that provide important or unique environmental functions or services. Critical areas can include wetlands, watercourses, fish and wildlife conservation areas, groundwater recharge areas, riparian areas, floodplains and shorelines. Critical areas can also include developed areas with extenuating conditions or physical characteristics such as seasonal flooding, high groundwater or poor soils that may result in detrimental environmental impacts, and areas that have been identified as pollutant sources.

The identification of critical areas is important when considering where management practices are needed and aids in determining what types of best management practices (BMPs) will provide the greatest benefit.

Critical areas identified in the Ekonk Brook watershed include:

- **Upper Ekonk Brook subwatershed**: This watershed is located along the northernmost reach of Ekonk Brook, from the confluence with unnamed stream 1 to the confluence of Ekonk Brook with the Moosup River. Sampling site EB-01 (DEEP site #789), located on Ekonk Brook behind Moosup Garden Apartments, had the highest fecal bacteria level documented in the Ekonk Brook watershed. This subwatershed is 325 acres in size and is the most heavily developed subwatershed in the Ekonk Brook watershed. Approximately 15% of the watershed is developed, including fairly dense development on the fringes of the mill village of Moosup. A little more than 22% of the subwatershed consists of agricultural land, and 51% of the watershed is forested.
- **Unnamed stream 1 subwatershed**: Unnamed stream 1 originates in a small (~4.5 acre) wetland system east of Goshen Road in Plainfield and flows south into Ekonk Brook, approximately 1300 feet south of Sterling Hill Road. The two sampling sites on this stream (UN-01-01 and UN-01-02) had the second and third highest fecal bacteria levels in the watershed. Only EB-01 (DEEP site #789), had higher documented bacteria levels. This watershed is approximately 380 acres in size. Approximately 53% of the watershed is forested, and another 31% of the subwatershed consists of agricultural land use. Approximately 7% of the watershed is developed. Rural residential development is scattered throughout the watershed; however, a cluster of older homes is located on Goshen Road near the headwater wetland area.

7. Watershed Goals and Objectives

7.1. Management Objectives

The purpose and overall goal of this management plan is to reduce fecal bacteria loading from the sources identified in Section 5 of this document so that Ekonk Brook will meet Connecticut Water Quality Standards for its intended uses, and is removed from CT DEEP's List of Impaired Waters. Whether or not this goal is met is dependent on the efforts of watershed managers and project partners to improve water quality conditions throughout the watershed.

7.2. Pollutant Load Reductions

A summary of recommended pollutant load reduction targets is provided in the following sections. Bacteria reductions are based on water quality data collected in 2013. Watershed NPS pollutant load reductions are based on the natural, undeveloped land cover for Connecticut.

7.2.1. Bacteria Load Reductions

One of the primary goals of this watershed plan is to estimate bacterial load reductions of the indicator fecal bacteria *E. coli* that has been documented in Ekonk Brook and several tributary streams. For the purposes of this investigation, ECCD utilized the *Connecticut Water Quality Standards* single sample criteria for "Freshwater – All other recreational uses" of 576 cfu/100ml and the maximum sample set geometric mean of less than 126 cfu/100 ml to evaluate the water quality data and determine the load reductions necessary to comply with established water quality standards.

E. coli load reductions are proposed in Table 6-1, and are based on the results of bacteria sampling conducted by ECCD and volunteers in 2014. ECCD utilized this data in lieu of data collected by CT DEEP from Ekonk Brook between 2007 and 2009 at DEEP site #789, located behind Moosup Garden Apartments, at or near ECCD's site EB-01. Although the DEEP bacteria data was used to develop a bacteria TMDL for Ekonk Brook, ECCD utilized the 2014 data because it is more recent, provides multiple samples per site over an extended geographic area, and is more representative of varying water conditions throughout the watershed as a whole.

The *Total Maximum Daily Load Analysis for Recreational Uses of the Ekonk Brook Sub-Regional Basin* cites a geometric mean of 151 cfu/100 ml and recommends a geomean reduction of 17% in Ekonk Brook at Moosup Garden Apartments. Based on data collected by ECCD in 2014, a reduction of 84% is required to meet water quality standards at the same site.

Table 7-1. Bacteria load reductions necessary to meet Connecticut Water Quality Standards for recreational activities in fresh water.

Sampling Site	*Site Description*	*Geometric Mean (cfu/100ml)*	*% Reduction Needed*
EB-01	Ekonk Brook – CT DEEP site #789 Moosup Garden Apartments	**772**	84%
EB-02	Ekonk Brook at 79 Sterling Hill Road	117	-
EB-02.5	Ekonk Brook near Northern Drive	**170**	26%
EB-03	Ekonk Brook upstream of Route 14A crossing	80	-
EB-04	Lockes Meadow Pond near pond outlet	24	-
UN-01-01	Unnamed stream #1 upstream of Sterling Hill Road crossing	**659**	81%
UN-01-02	Unnamed stream #1 at powerline crossing near Goshen Road	**434**	71%
SHB-01	Sterling Hill Brook downstream of Sterling Hill Road	41	-
UN-02-01	Unnamed stream #2 upstream of Route 14A crossing	**165**	24%
UN-03-01	Unnamed stream #3 downstream of Route 14A crossing	**156**	19%
SPB-01	Stanton Pond Brook at trail crossing in Pachaug State Forest	**204**	38%
Bold text indicates that the sample set exceeded the established geometric mean criteria of 126 colony forming units per 100 milliliters of water (cfu/100ml) for that sampling site.			

In addition to the required load reduction in Ekonk Brook at Moosup Garden Apartments (DEEP site #789 and ECCD site EB-01), bacteria reductions are required in Ekonk Brook downstream of the Northern Drive neighborhood (EB-02.5), in unnamed stream 1 (UN-01-01 and UN-01-02), which originates in a wetland system near Goshen Road and flows south to Ekonk Brook, and in unnamed streams 2 and 3 (UN-02-01 and UN-03-01, respectively), which originate in wooded wetlands south of State Route 14A and flow north to Ekonk Brook. One additional site, Stanton Pond Brook (SPB-01), located in Pachaug State Forest downstream of Stanton Pond (located west of Ekonk Hill Road), requires a 38% reduction to meet water quality standards. However, only three water samples were collected from Stanton Pond Brook for analysis before it ceased to flow due to very dry weather conditions. Additional sampling is recommended to provide a more representative sample set.

7.2.2. Watershed Pollutant Load Reduction

Pollutant load reduction recommendations have been provided in Table 7-2 to provide guidance to watershed managers regarding the potential reduction of common NPS pollutants in the Ekonk Brook watershed, including total nitrogen (TN), total phosphorus (TP) and total suspended sediment (TSS). Unlike fecal bacteria, which has a specific numerical water quality standard, Connecticut does not currently have numeric standards for nutrients or suspended sediments. Therefore, these load reduction recommendations are provided to allow watershed managers to evaluate loading from the various NPS pollutants, and determine where beneficial loading reductions may be made. Watershed managers should keep in mind that these recommended pollutant load reductions utilize watershed load values calculated by the Watershed Treatment Model based on existing land use practices in the Ekonk Brook watershed and do not represent physical water quality measurements.

In order to provide a baseline against which current pollutant loading could be compared, pre-developed watershed loads were calculated for each of the subwatersheds, using a forested condition as a typical pre-development land cover for Connecticut. No net gain of wetlands was assumed, and an impervious cover of 1% was used to represent ledge and naturally barren land. Current condition land cover and land uses were derived from the 2010 CLEAR land cover dataset and the Multi-Resolution Land Characteristics Consortium (MRLC) 2006 National Land Cover Dataset (NLCD).

Based on nutrient loads associated with various land covers and land uses that were determined using the Watershed Treatment Model, total nitrogen load reductions ranging from 1 – 47% are recommended throughout the sub-watersheds to bring nutrient loads within the pre-developed load range of the Ekonk Brook watershed. Total phosphorus load reductions ranging from 4 – 76% are recommended to bring nutrient loads within the pre-developed load range of the Ekonk Brook watershed. Total suspended sediment load reductions ranging from 1 – 37% are recommended to bring sediment loads within the pre-developed load range of the Ekonk Brook watershed.

Table 7-2. Recommended NPS load reductions based on existing and pre-developed land cover conditions.

Sub-watershed	Existing TN Load (lb/yr)	Pre-developed TN Load (lb/yr)	TN Load Reduction (%)	Existing TP Load (lb/yr)	Pre-developed TP Load (lb/yr)	TP Load Reduction (%)	Existing TSS Load (lb/yr)	Pre-developed TSS Load (lb/yr)	TSS Load Reduction (%)
Upper Ekonk Brook	1,549	813	47	266	65	76	56,274	42,289	25
Unnamed Stream 1	1,478	950	36	226	76	66	57,221	38,017	34
Sterling Hill Brook	682	479	30	93	38	59	27,578	24,788	10
Middle Ekonk Brook	1,666	1,369	18	195	109	44	78,296	70,974	9
Unnamed Stream 2	1,355	872	36	203	70	66	54,908	34,794	37
Unnamed Stream 3	598	425	29	87	34	61	27,017	16,931	37
Lower Ekonk Brook - West	1,015	999	2	86	80	7	52,296	51,929	1
Lower Ekonk Brook - East	1,935	1,487	23	219	119	46	79,187	59,480	25
Stanton Pond Brook	1,235	829	33	165	65	60	45,351	32,424	29
Lockes Meadow Pond	412	407	1	30	29	4	17,887	17,887	0

8. Best Management Practice Recommendations

Best management practices (BMPs) are control measures that are used to “manage the quantity and improve the quality of stormwater runoff” (US EPA, 2012), typically caused by changes in land use. Generally, BMPs focus on water quality problems caused by increased impervious surfaces from land development. BMPs are designed to reduce stormwater volume, peak flows, and/or nonpoint source pollution through evapotranspiration, infiltration, detention, and filtration or biological and chemical actions (Debo and Reese, 2003).

Stormwater BMPs can be classified as "structural" (i.e., brick and mortar devices installed or constructed on a site), or "non-structural" (procedures such as modified landscaping practices, preservation of open space, behavioral changes, and revisions to municipal regulations and practices.). There are a variety of BMPs available; selection typically depends on site characteristics and pollutant removal objectives. The US Environmental Protection Agency (EPA) has published a list of stormwater BMPs for use by local governments, builders and property owners (US EPA, 2012). To assist water quality managers with understanding and selecting stormwater BMPs, DEEP promotes Low Impact Development (LID) practices through newer appendices of the CT Erosion & Sediment Control Guidelines (DEEP, 2002) and through the CT Stormwater Quality Manual (DEEP 2004).

This section outlines management strategies that, if implemented, are intended to restore stream water quality conditions in the Ekonk Brook watershed so that streams meet the recreational use criteria by reducing the loading of bacteria and other nonpoint source (NPS) pollutants as enumerated in Sections 6 and 7 of this Plan. A variety of management strategies are provided to target the pollutant sources identified in Section 5. Management strategies include short and long-term, non-structural and structural controls and actions that vary in relative effort and cost, and that can be adopted and implemented by a wide variety of stakeholders. Management recommendations are intended to address and reduce existing pollutant loads and prevent future sources of pollutant loading to waterbodies in the Ekonk Brook watershed.

None of these recommendations taken in isolation will measurably improve water quality conditions. It will take a unified watershed-wide management approach to affect water quality improvements. Therefore, prior to the implementation of this Plan it is strongly recommended that stakeholders form a watershed management team to coordinate the implementation of the Plan recommendations.

Best management practices that may be adopted by land managers and decision-makers in the Ekonk Brook watershed are described in the following sections.

8.1. Establish a Watershed Management Team

As a first step to the implementation of this Plan, it is strongly recommended that stakeholders form a watershed management team. This team should be comprised of watershed stakeholders – individuals, groups or organizations that may be affected by or have an interest in the project's outcome. By forming, monitoring and maintaining constructive relationships, the team plays a vital role in ensuring that the watershed plan's goals and objectives will be achieved in an organized and expeditious manner. It is impossible to understate the importance of the management team to the successful implementation of a watershed plan. Without a strong, organized management team, watershed plan goals and objectives will not be achieved.

The watershed management team will be responsible for:

- coordinating the implementation of the Plan recommendations;
- developing a work plan that identifies water quality goals and objectives for Ekonk Brook and its contributing watershed;
- identifying funding sources and in-kind services, prospective partners and technical assistance;
- reviewing, prioritizing and implementing Plan recommendations; and
- evaluating the results to determine if revisions to the implementation approach are required.

It is intended that the watershed management team take an adaptive approach to implementing the recommendations contained in this Plan, evaluating implementation measures as they are conducted, and making necessary adjustments based on the results to improve outcomes. The management team should devise a method to track the progress of Plan implementation, and should seek feedback from land owners, municipal staff/leaders and other stakeholders. The watershed management team will also be responsible for reporting initial steps and results to stakeholders and the broader community, and for celebrating successes throughout the community.

A well-balanced watershed management team should consist of a variety of members of the community, and may include municipal officials and commissioners from all municipalities within the watershed, business owners, landowners, environmental and civic organizations, as well as any other organizations, agencies or individuals with an interest in the preservation and improvement of water quality and water uses in the watershed. It is recommended that at a minimum, the Ekonk Brook watershed management team include a land-use planner or similarly trained professional, members of the Plainfield, Sterling and Voluntown land use commissions, watershed residents and local watershed businesses, including the many agricultural producers who live and farm in the Ekonk Brook watershed. To aid the watershed management team, watershed management guidance may be found at the CT DEEP Watershed Management web page:

http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325628&deepNav_GID=1654

It should be noted that the involvement of various watershed stakeholders may change throughout the planning and implementation phases, depending on their interests, expertise and availability.

Potential watershed team members are listed in Table 8-1. Watershed management team capacity building recommendations are provided in Table 8-2. These tables can be used as a preliminary plan or guideline for the establishment of a watershed team.

Table 8-1. Suggested Watershed Management Team Members and their roles and/or responsibilities.

Team Member	Roles/Responsibilities
Towns of Plainfield, Sterling and Voluntown (land use staff and regulatory and non-regulatory commissions)	Review, update and enforcement of land use regulations and/or ordinances; coordination with Plan of Conservation & Development; site plan review/permitting; public utilities maintenance; development of incentive programs to encourage adoption of BMPs; staff training
Northeast District Department of Health	Review and approval of septic systems; identification and repair of failing systems
Local Businesses & Community Organizations	Conformance with local regulations; adoption of BMPs; assistance with outreach and education; support and sponsorship of community events/activities
Watershed Residents	Conformance with local regulations; adoption of BMPs; diversity of perspectives, priorities and opportunities
Agricultural Producers & Non-commercial Farmers	Adoption of agricultural BMPs to manage nutrient/manure applications; peer to peer outreach; interface with local agriculture commissions
Northeastern Connecticut Council of Governments	Regional land use planning; grant writing; sharing of regional plan and implementation resources
Eastern Connecticut Conservation District	Technical assistance; plan implementation; site plan reviews
Thames River Basin Partnership or other watershed organization	Plan implementation; guidance; outreach and education; regional conservation network connection
CT Department of Energy and Environmental Protection	Bacteria TMDL; Ambient WQM program; SWGP and MS4 programs; technical support
CT Department of Transportation	Operation and maintenance of state highways/stormwater systems; adoption of stormwater BMPS and other division programs (e.g. Office of Environmental Planning, Office of Design)

Table 8-2. Watershed Management Team Establishment Recommendations

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Create watershed management team: • Identify team members • Obtain team member "buy in " • Organize/conduct initial meeting • Identify team member roles • Establish regular meetings	Watershed municipalities, DEEP, ECCD, land use commissions, ag. producers, other stake-holders	2017-2018	Identification of team members; establishment of mgmt. team; establishment of regular meetings	$3,000 (printing costs / staff time)	N/A	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, DEEP, regional planning agency
2. Identify watershed management goals: • Review watershed plan • Identify goals and objectives • Prioritize goals	Watershed management team	2017-2018	Identification & prioritization of clear goals and objectives	$3,000	N/A	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, DEEP, regional planning agency
3. Identify sources of technical assistance: • Review goals to determine type of technical assistance needed • Identify organizations/agencies offering needed technical assistance • Contact and/or partner with appropriate organization/agency to obtain needed technical assistance	Watershed management team	2017-2018	List of agencies/ organizations to provide technical assistance (see Table 9-1)	$5,000	N/A	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, DEEP, regional planning agency
4. Identify sources of funding: • Review goals to determine type/level of funding needed • Review funding for applicability to goal • Prepare and submit application for funding	Watershed management team	2017-2018	List of potential funding sources (see Table 9-2)	$5,000	N/A	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, DEEP, regional planning agency

Table 8-2. Watershed Management Team Establishment Recommendations (cont.)

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
5. Identify and establish a mechanism for outreach: • Identify key outreach elements to disseminate to public • Establish an outreach mechanism (website, report card, brochure, etc.) • Identify a point person to lead outreach efforts • Organize and implement an outreach campaign	Watershed management team	2017-2018	Identification of outreach needs; identification/ establishment of mechanism for outreach; type/amount of outreach conducted	$7,500 (printing/ mailing costs; webpage develop-ment; etc.)	N/A	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, ECCD, DEEP, regional planning agency
6. Implement management plan: • Identify and prioritize implementation projects • Identify /assign managing entity • Identify and obtain funding • Identify and obtain technical assistance, as required • Development implementation design/plans • Obtain required materials • Promote municipal and other local champions project for high visibility or technical transfer elements.	Watershed management team	2018-2027	Number of successfully completed implementation projects	$1000 - $50,000 or more. Cost will vary by impleme ntation.	N/A	Watershed municipalities, community foundation grants, private corporate grants, CWA 319 & 604b grants, NRCS programs	Municipal staff, ECCD, DEEP, NRCS, regional planning agency
7. Develop an assessment framework: • Identify plan elements to be evaluated • Develop an evaluation methodology • Identify/establish assessment metrics • Identify a timeline for evaluation/assessment	Watershed management team	2018-2027	Establishment of viable assessment procedure	$5,000	N/A	Watershed municipalities, community foundation grants, private corporate grants,	Municipal staff, ECCD, DEEP, regional planning agency
8. Assess implementation effectiveness: • Create an implementation completion tracking database • Review completed implementations • Evaluate implementation effectiveness utilizing previously established methodology • Determine if intended goals and objectives have been achieved • Identify alternative actions if goals/objectives have not been achieved	Watershed management team	2018-2027	Periodic review/ evaluation of implementation; evaluation of implementation effectiveness; refinement of goals and objectives	$5,000	N/A	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 319 and 604b watershed grants	Municipal staff, ECCD, DEEP, regional planning agency

8.2. Review/Revise Municipal Land-use Regulations and Policies

Municipalities determine how a town will be developed, and consequently how it will look, in large part through the codification of land-use regulations. Land-use regulations are enacted through the passage of municipal ordinances, and through review and revision by the land-use commissions, often in response to legislative changes at the state level. It is incumbent upon municipal decision-makers, including the board of selectmen and land-use boards and commissions, to ensure that regulations and policies both reflect and support the municipality's plans for future growth as defined by the municipal Plan of Conservation and Development; are up-to-date with current state land-use legislation; and are representative of current land-use planning practices, including agriculture. At a minimum, regulatory land use commissions should:

- Adopt recommendations pertaining to land-use management and regulation proposed in each municipality's Plan of Conservation and Development.

- Review and strengthen existing land-use regulations pertaining to erosion and sediment control and stormwater management to comply with the *2002 CT Erosion & Sediment Guidelines* and the *2004 Stormwater Quality Manual and Appendices*.

- Incorporate language to encourage or require the use of green infrastructure (GI) and low impact development (LID) practices into site plan design and development. These practices seek to mimic the pre-development hydrology of a site and encourage site design that utilizes the natural features of the landscape in a way that minimizes runoff and promotes resource protection.

    - Identify and evaluate existing or perceived institutional barriers to GI and LID, and investigate opportunities where incentives can be developed to encourage the inclusion of GI and LID into site planning and development. Land-use commissions may benefit from reviewing municipal land-use evaluation projects in the Farmington and Salmon River watersheds, which assessed institutional barriers and evaluated how they may be removed. Additional information on municipal outreach for GI and LID is available at CT DEEP's website at: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=464958&deepNav_GID=1654 . Watershed managers should also review The State of LID in Connecticut: Policies, Drivers, and Barriers at the UConn Center for Landuse Education and Research website (http://clear.uconn.edu).

- Evaluate the consistency of planning and zoning regulations and municipal ordinances with existing and future farming activities, including farm-friendly policies and regulations and identification of potential barriers to farms and farming practices. Excellent resources for municipal leaders, land-use regulators and

agriculture commissions can be found at the Planning for Agriculture website (a collaboration between Connecticut Conference of Municipalities and American Farmland Trust) at www.ctplanningforagriculture.com, including *Planning for Agriculture, A Guide for Connecticut Municipalities* (2016 Edition) and *Guidance and Recommendations For Connecticut Municipal Zoning Regulations and Ordinances for Livestock* (2012).

The Town of Plainfield is additionally tasked with the complying with the 2016 MS4 Stormwater General Permit. Although the general permit is typically administered through public works departments, elements will come under the regulatory authority of land-use commissions, including construction site stormwater runoff control and post-construction stormwater management. The legal authority to administer the MS4 permit will reside in the regulations and land-use policies of the land-use commissions. The towns of Sterling and Voluntown are encouraged to review the general permit minimum stormwater management measures for potential incorporation within their own communities as a voluntary, watershed partner action.

Municipal land-use recommendations are provided in Table 8-3.

Table 8-3. Municipal Land-use Regulation and Policies Review

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Adopt land-use planning recommendations proposed in Plans of Conservation and Development: • Review Plans of Conservation and Development • Develop proposed regulatory language • Review and revise existing regulations	Watershed management team, land-use commissions, staff	2016-2017	List of proposed recommendations; development of proposed regulatory language; adoption of POCD recommendations	$4,000	N/A	Municipal general budget	Municipal staff, NECCOG
2. Adopt farm-friendly land-use regulations: • Create a regulation review team • Review existing land-use regulations and policies related to farming • Review recommended guidance documents • Prepare and revise existing regulations	Watershed management team, land-use commissions, agriculture commissions, staff, farmers	2017-2018	Identification of relevant regulations; preparation of proposed farm-friendly revisions	$4,000	N/A	Municipal general budget	Municipal staff, UConn Extension, CT Farmland Trust, DoAg, DEEP, CT RC&D
3. Review and strengthen existing land-use regulations pertaining to erosion and sediment control and stormwater management: • Form a regulation review team • Review existing land-use regulations/ ordinances • Review sample/model regulations pertaining to E&S controls, stormwater management • Work with land-use staff and boards to develop revised regulations • Adopt new regulations	Watershed management team, land-use commissions, staff	2017-2018	Formation of review team; review of regulations; proposed regulations revisions; adoption of revised regulatory language	$4,000	N/A	Municipal general budget	Municipal staff, CT NEMO, DEEP, NECCOG
4. Incorporate language to encourage or require the use of green infrastructure (GI) and low impact development (LID) practices into site plan design and development: • Review existing land-use regulations/ ordinances • Review sample/model regulations pertaining to GI/LID • Work with land-use staff and boards to develop revised regulations • Adopt new regulations	Watershed management team, land-use commissions, staff	2018-2019	Review of existing regulations/ ordinances; review of model regulations; development of proposed revisions; adoption of revised regulations	$4,000	N/A	Municipal general budget	Municipal staff, CT NEMO, DEEP, NECCOG

Table 8-3. Municipal Land-use Regulation and Policies Review (cont.)

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
5. Identify and evaluate any existing or perceived institutional barriers to GI and LID: • Form a review team • Review existing studies on barriers to GI/LID • Review existing land-use regulations for barriers to GI/LID • Interview land-use managers/decision makers about knowledge/attitudes regarding GI/LID • Evaluate results of interviews • Develop outreach to remove barriers • Disseminate outreach material	Watershed management team, land-use commissions, staff	2018-2020	Formation of review team; regulation review; completion of interviews; analysis of results; development and dissemination of outreach material	$5,000	N/A	Municipal general budget, community foundation grants, private corporate grants, CT DEEP 319 and/or 604b grants	Municipal staff, DEEP, CT NEMO
6. Promote use of/offer incentives for inclusion of GI/LID in site development: • Identify eligible practices • Prepare and disseminate information about GI/LID practices • Identify eligible incentives • Create a mechanism to authorize incentives (regulation or ordinance) • Adopt authorizing mechanism	Watershed management team, land-use commissions, staff	2020-2022	List of eligible practices, GI/LID outreach, identification of incentives, identification and adoption of mechanism for incentive program	$4,000	N/A	Municipal general budgets, community foundation grants, private corporate grants, CT DEEP 319 and/or 604b grants	Municipal staff, CT NEMO, DEEP, NECCOG
7. Implement MS4 General Permit (Plainfield only): • Review permit requirements • Develop stormwater management plan • Develop land-use regulatory language to authorize required activities • Adopt proposed regulatory language	Land-use commissions, staff	2016-2017	Understanding of permit reqts, development of SWMP, development of regulatory language, adoption of regulations	$5,000	N/A	Plainfield general budget	Municipal staff, DEEP, CT NEMO, NECCOG, ECCD

8.3. Stormwater Runoff/NPS Best Management Practices

As discussed in Section 5.1.1, stormwater runoff can be a vector for considerable pollutant loading to surface waters in a watershed. Roadways contribute approximately 5% of the total nitrogen load, 4% of the total phosphorus load, 8% of the total sediment load, and 13% of the fecal coliform load to surface waters in the Ekonk Brook watershed. Much of this runoff is delivered to waterways via stormdrain systems associated with roadways. There are approximately 9.9 miles of roadway in the Ekonk Brook watershed, including 6.6 miles of local surface roads owned and maintained by the towns of Sterling or Plainfield, and 3.3 miles of state highway, including State Routes 49 and 14A, which are maintained by the Connecticut Department of Transportation. It is the responsibility of the municipal and state highway departments to maintain transportation infrastructure, including stormdrain systems and stormwater outfall areas.

8.3.1. CT Department of Transportation Stormwater Runoff/NPS BMPS

Plainfield and Sterling are part of the Connecticut Department of Transportation (CT DOT) District 2, headquartered in Norwich. CT DOT maintains about 3.3 miles of highway in the Ekonk Brook watershed, including State Routes 14A and 49. CTDOT is required to manage stormwater runoff from the state's transportation network under a National Pollutant Discharge Elimination System (NPDES) Phase ll MS4 Stormwater general permit. Under the general permit, CTDOT must develop and implement a Stormwater Management Plan (SWMP), a monitoring program to identify discharges contributing to stream impairments, and submit annual reports to DEEP to track the progress of the implementation of the Plan. CTDOT is also required to provide public education and outreach on issues related to stormwater pollution, including pet waste, fertilizers, herbicides, and pesticides, and impacts of illicit discharges and improper disposal of waste, and solicit and respond to public input in the development of the Stormwater Management Plan. A new *General Permit for the Discharge of Stormwater from Department of Transportation Separate Storm Sewer Systems* has been prepared and will become effective on July 1, 2017. A fact sheet describing the CTDOT MS4 general permit is available at: http://www.ct.gov/deep/lib/deep/water_regulating_and_discharges/stormwater/dot/160226_draft_dot_ms4_general_permit_fact_sheet.pdf.

Under the current stormwater general permit DOT does not sample any outfalls in the Ekonk Brook watershed. There are no direct stormwater outfall discharges to Ekonk Brook or tributary streams from Routes 14A or 49. However, based on pollutants loads calculated by the Watershed Treatment Model, roadways in the subwatersheds along Route 14A (Unnamed Streams 02 and 03 subwatersheds) contribute approximately 14% of the total sediment load and about 18-19% of the fecal bacteria load. DOT should continue to implement good housekeeping practices on state routes in the Ekonk Brook watershed including street sweeping and stormdrain cleaning to minimize pollutant loading. CT DOT stormwater/NPS management recommendations are provided in Table 8-4.

Table 8-4. CT DOT Stormwater Runoff/NPS Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Implement Good Housekeeping practices in compliance with MS4 general permit: • Develop a street sweeping priority database • Determine frequency of street sweeping Develop a catch basin cleaning priority database • Determine frequency of catch basin cleaning and inspection • Dispose of street sweeping and catch basin wastes according to recommended practices	CT DOT	2017-2027	Miles of street swept, number of catch basins cleaned	Street sweeping - $40/mile Catch basin cleaning- $300 /unit	No	DOT general budget	CT DOT, US DOT, Federal Highway Admin.
2. Conduct NPS education and outreach in compliance with Stormwater General Permit: • Identify municipal and watershed team outreach partners • Identify appropriate outreach topics based on Ekonk Brook water quality data • Identify target audience for outreach • Develop outreach material • Identify appropriate mechanism to deliver outreach content (web, mailing, , etc.) • Disseminate outreach material	CT DOT, municipalities, watershed team	2018-2020	Outreach material created, number of members of public reached	$7,500 (printing/ mailing costs; webpage develop-ment; etc.)	Yes	DOT general budget; municipal general budgets; community foundation grants; private corporate/local business grants; CWA §319 grants	CT DOT, municipal staff, ECCD, DEEP. NEMO, CLEAR, NECCOG

8.3.2. Municipal Stormwater Runoff/NPS BMPs

Municipalities are responsible for maintaining much of the impervious surfaces within their jurisdictional boundaries, including roads, sidewalks, municipal buildings and parking lots. Municipal facilities can create NPS pollutants from normal activities such as structure, vehicle and equipment maintenance and grounds management. Vehicle fueling, material loading, unloading and storage can also be sources of NPS.

Municipalities should adopt good housekeeping practices (GHPs) to minimize the impacts of NPS from these activities and should train staff to follow these practices (US EPA, 2014). Employment of municipal "Good Housekeeping" or Best Management Practices, such as frequent street sweeping and storm drain cleaning may reduce the amount of NPS discharging to local waterways. These activities remove accumulated sediment, trash and leaves that may otherwise end up in waterways.

Municipal highway departments should be informed about and trained to utilize the most current advances and technologies in stormwater management and should incorporate these advances into their regular stormwater management practices. The use of LID and green infrastructure practices to manage and treat stormwater as well as the use of erosion and sediment control measures as recommended in the Connecticut Stormwater Quality Manual (DEEP, 2004) and the Connecticut Guidelines for Soil Erosion and Sediment Control (DEEP, 2002), respectively, should be incorporated into regular DPW maintenance practices.

Municipalities should develop outreach programs that inform the public about the causes and consequences of water quality impairments and should support educational programs that encourage positive behavioral changes. Educational programs may address simple behavioral changes that will protect and improve water quality such as properly managing animal waste, reducing the use of lawn chemicals, washing cars on lawns (rather than paved surfaces where runoff may enter the storm drain system) or using commercial carwash facilities.

Municipalities can also protect water quality (particularly groundwater quality, which is important since most residents in the Ekonk Brook rely on private wells for their drinking water) by sponsoring hazardous materials collections days and partnering with the local health district (NDDH), pharmacies and local or state police to establish a drop-off program for unused medicines. These programs promote the safe and proper handling and disposal of unwanted chemicals, hazardous materials and pharmaceuticals that might otherwise be disposed of improperly.

The Town of Plainfield will be required to comply with the Small Municipal Separate Storm Sewer System (MS4) General Permit in 2017. Under the general permit, the Town will need to develop and implement a Stormwater Management Plan (SWMP), a stormwater outfall monitoring program, and submit annual progress reports to DEEP.

The SWMP includes six *Minimum Control Measures* that the permittee must implement, including:

- Public education and outreach
- Public participation
- Illicit discharge detection and elimination (IDDE)
- Construction stormwater management
- Post-construction stormwater management
- Pollution prevention and good housekeeping.

Illicit discharges may be of particular concern in the Ekonk Brook watershed because they can contain significant amounts of pollutants, depending on their source. An illicit discharge is, simply put, any discharge to an MS4 that is not composed entirely of stormwater. Illicit discharges can occur as a result of cross-connections with sewer lines or unauthorized or unintentional connections with footing drains or other discharge pipes, spills that enter the storm drain system or deliberate dumping of non-stormwater fluids or materials.

Municipal stormwater/NPS management recommendations are provided in Table 8-5.

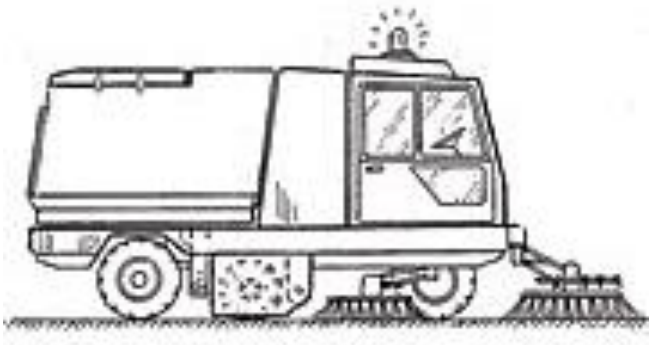


Table 8-5. Municipal Stormwater Runoff/NPS Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Employ municipal Good Housekeeping Practices: • Conduct review of existing practices • Review recommended GHPs • Train DPW staff to implement GHPs • Incorporate GHPs into municipal maintenance practices	Municipal highway/public works depts	2017-2019	DPW staff trained to utilize GHP practices, GHP practices incorporated into regular DPW procedures	$115.000	Yes	Municipal DPW budget, DEEP CWA §319 program	CTDOT, DEEP, regional planning agency
2. Stormwater BMPS: • Evaluate current stormwater management practices • Identify practices to incorporate into municipal practices • Institute DPW staff training • Incorporate BMPs in capital improvement projects/regular maintenance/repairs	Municipal highway/public works depts	2018-2020	DPW staff trained to implement stormwater BMPs practices, stormwater BMPs incorporated into regular DPW procedures	$115,000	Yes	Municipal DPW budget, DEEP CWA §319 program	CTDOT, DEEP, regional planning agency
3. Conduct community outreach: • Identify outreach partners • Identify outreach topics • Prepare outreach materials • Identify best method for dissemination • Conduct public outreach utilizing selected outreach vector • Sponsor Hazardous Waste Collection Day • Partner with NDDH and others to establish a medicine drop-off program	Watershed team Municipal highway/public works depts., Conservation Commissions, NDDH, local/state police, local pharmacies, DPH	2018-2020	Identification of outreach topics, preparation of outreach material, dissemination of outreach material, number of residents reached	$40,000	Yes	Municipal DPW budget, DEEP CWA §319 program	DEEP, regional planning agency
4. Implement MS4 General Permit (Plainfield only): • Review MS4 General Permit • Prepare stormwater management plan • Inventory stormwater infrastructure • Select stormwater outfalls for sampling • Prepare and implement Minimum Control Measures specified in GP	Town of Plainfield – DPW, land-use commissions	2016-2017		$45,000	Yes	Municipal general budget	DEEP Stormwater Management Division, EPA

8.3.3. Single Family Residential Stormwater Runoff/NPS BMPs

Residential land comprises only about 8.5% (188 acres) of the Ekonk Brook watershed, yet contributes the third highest percentages of total nitrogen (17%), total phosphorus (20%) and total sediment (10%) loads, and the highest load of fecal coliform (50%) to surface waters in the watershed. The upper Ekonk Brook subwatershed, which incorporates suburban development in the Sterling Hill Road and Northern Drive neighborhoods and urban development at the edge of the village of Moosup contributes relatively higher loads of NPS pollutants than the less developed subwatersheds which are characterized by rural residential development.

Landowners can exert considerable influence on NPS loading through their choices of land management practices and behaviors. The adoption of practices that reduce the amount of stormwater runoff from their properties can reduce NPS significantly. These practices include:

- installation of rain gardens and vegetated swales to catch and infiltrate runoff,
- use of rain barrels, rain planter boxes or drywells to capture and store roof runoff for non-potable uses, and
- reduction and/or disconnection of impervious surfaces through the installation of pervious paving materials or elimination of unneeded paved surfaces.

Property owners can improve water quality by reducing the amounts of chemicals, including herbicides, pesticides and fertilizers, they put on lawns and gardens by:

- composting and careful utilization of compost as an alternative to chemical fertilizers,
- testing soils to determine soil nutrient levels and needs,
- utilizing proper fertilizer application rates and timing, and
- utilizing integrated pest management (IPM) as an alternative to the application of herbicides and pesticides.

Property owners can also reduce the amount of NPS generated by general household activities by adopting water-friendly practices such as:

- use of non-phosphate dish and laundry detergents,
- use of septic system-friendly cleaning chemicals,
- awareness of what is safe to put down the drain
- washing of cars on the lawn or using a commercial car wash, and
- regular maintenance and inspections of septic systems.

Single family residential stormwater/NPS management recommendations are provided in Table 8-6.

Table 8-6. Single Family Residential Stormwater Runoff/NPS Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Promotion of homeowner NPS awareness: • Identify NPS outreach partners • Identify NPS outreach topics • Develop best methods for NPS outreach dissemination • Develop municipal NPS outreach webpages • Prepare NPS outreach materials • Initiate NPS outreach programs	Watershed team, Municipalities (Plainfield MS4 outreach)	2017-2019, ongoing thereafter	Development of outreach team, Development & dissemination of outreach material, # of homeowners reached	$3,000	Yes	Municipal general funds, Community foundation grants, private corporate grants CWA §319 grants	Municipalities, Land use commissions, CT NEMO, ECCD, DEEP, EPA
2. Manage stormwater runoff: • Develop educational material • Develop methods for dissemination • Identify funding sources for outreach activities and materials • Conduct outreach activities • Identify funding for implementations • Recruit homeowners • Conduct implementations	Watershed team, Municipalities (Plainfield MS4 outreach)	2017-2019, ongoing thereafter	Development of outreach team, Development & dissemination of outreach material, # of homeowners reached	$3,000	Yes	Municipal general funds, Community foundation grants, private corporate grants CWA §319 grants	Municipalities, Land use commissions, CT NEMO, ECCD, DEEP, EPA
3. Manage use of lawn chemicals: • Identify outreach partners • Identify outreach topics • Identify funding sources for outreach activities and materials • Prepare outreach materials • Conduct outreach activities • Disseminate outreach materials	Watershed team, Municipalities (Plainfield MS4 outreach)	2017-2019, ongoing thereafter	Development of outreach team, Development & dissemination of outreach material, # of homeowners reached	$3,000	Yes	Municipal general funds, Community foundation grants, private corporate grants CWA §319 grants	Municipalities, Land use commissions, CT NEMO, UConn Extension, NOFA, ECCD, DEEP, EPA
4. Adopt general household BMPs: • Identify outreach partners • Identify outreach topics • Identify funding sources for outreach activities and materials • Prepare outreach materials • Conduct outreach activities • Disseminate outreach materials	Watershed team, Municipalities (Plainfield MS4 outreach)	2017-2019, ongoing thereafter	Development of outreach team, Development & dissemination of outreach material, # of homeowners reached	$3,000	Yes	Municipal general funds, Community foundation grants, private corporate grants CWA §319 grants	Municipalities, Land use commissions, CT NEMO, ECCD, DEEP, EPA

8.3.4. Commercial Residential Stormwater Runoff/NPS BMPs

Commercial residential properties, such as Moosup Garden Apartments, are faced with different challenges than single family residences when managing NPS. Commercial residential complexes have the potential for the contribution of higher nonpoint source pollutant loads than single family residential development due to greater development density and amount of impervious cover. NPS from commercial residential complexes is associated with the use and maintenance of lawns and landscaped areas, parking lots, driveways and sidewalks and waste management (dumpster) areas. Common pollutants include sediment, especially from winter sanding and de-icing, pollutants associated with motor vehicles, and fertilizers and pesticides applied to lawns and landscaping. These pollutants are conveyed via on-site stormwater infrastructure located in the parking lots and driveways to nearby waterways.

Good housekeeping management activities can be adopted by commercial residential complexes to reduce NPS pollution from driveways, parking lots and dumpsters areas, including:

- spring and fall parking lot and driveway sweeping
- spring and fall catch basin cleaning
- institution of a recycling program
- dumpster and dumpster area management, including the periodic cleaning, and replacement of corroded/leaking dumpsters in coordination with waste management contractor

Best management practices that can reduce the volume of stormwater runoff from impervious surfaces, including rooftops, driveways and parking lots, include:

- installation of rain gardens and vegetated swales to catch and infiltrate runoff
- use of rain barrels, rain planter boxes or drywells to capture and store roof runoff for non-potable uses
- reduction of impervious surfaces through the installation of pervious paving materials or elimination of unneeded paved surfaces

Complex managers can improve water quality by reducing the amounts of chemicals, including herbicides, pesticides and fertilizers, they put on lawns and landscaping by:

- composting and utilizing compost as an alternative to chemical fertilizers
- placement of lawn and landscape waste away from nearby waterbodies
- testing soils to determine soil nutrient levels and needs
- utilizing proper fertilizer application rates and timing
- utilizing integrated pest management (IPM) as an alternative to the application of herbicides and pesticides

Tenants can also reduce the amount of NPS generated by general household activities by adopting water-friendly practices such as:

- properly securing trash to prevent leakage or spillage
- recycling waste materials
- disposing hazardous materials at municipal hazardous materials collection events
- picking up and properly disposing of dog waste
- awareness of what is and what is not safe to put down the drain
- washing of cars at commercial car washes

If tenants are not sure how to dispose of an item, they can visit DEEP's "What do I do with…?" webpage at http://www.ct.gov/deep/cwp/view.asp?a=2718&q=325496.

During the watershed investigation, ECCD identified high fecal bacteria levels in stormwater discharging to Ekonk Brook from storm drains located near several dumpsters at Moosup Garden Apartments. As a result, ECCD worked with Moosup Garden Apartments to install rain gardens next to the dumpsters. Contaminated runoff from each dumpster was diverted from the nearby catch basin into a rain garden where it could soak into the ground.

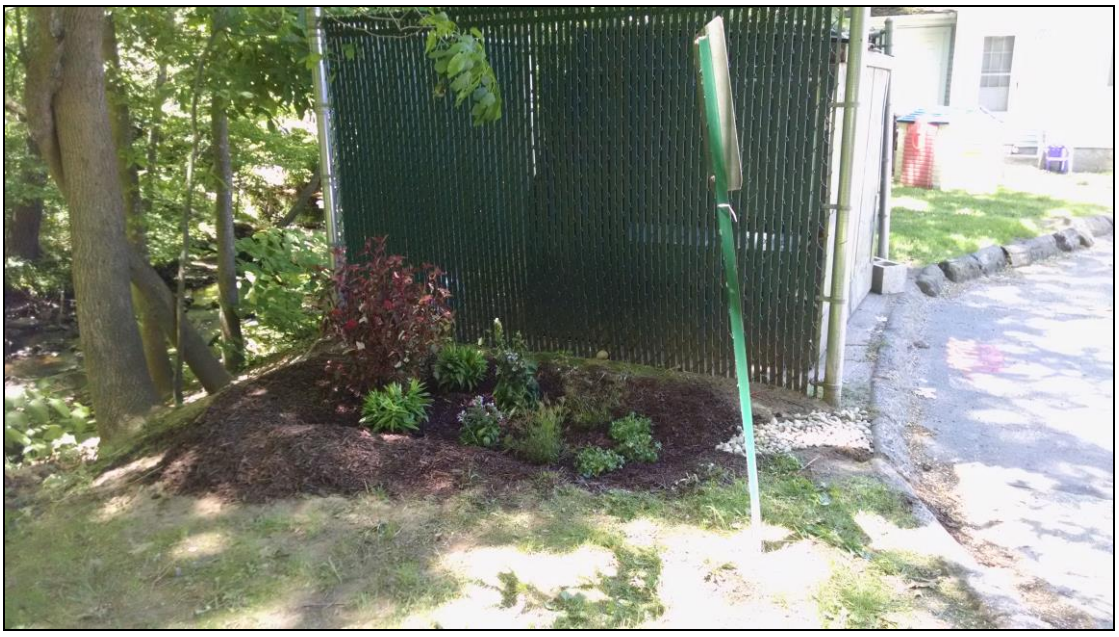


Figure 8-1. A rain garden installed at Moosup Garden Apartments to infiltrate contaminated runoff from the adjacent dumpster.

Commercial residential stormwater/NPS management recommendations are provided in Table 8-7.

Table 8-7. Commercial Residential Stormwater Runoff/NPS Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Adoption of good housekeeping practices as part of facility maintenance: • Evaluate existing maintenance practices • Review recommended GHPs including spring/fall parking lot sweeping and catch basin cleanouts • Identify/secure contractor to conduct sweeping/cleaning • Initiate spring/fall GHP	Commercial residential complexes	2017-2019, ongoing thereafter	Identification of GHPs, integration of GHPs into regular maintenance practices	Parking lot sweeping: $40-$80/hr Catch basin cleaning: $200-$250	Yes	General operating budget	Municipal DPW, ECCD, DEEP. NECCOG
2. Manage/reduce stormwater runoff: • Evaluate complex for potential installation of BMPs, such as rain planters, rain gardens, rain barrels • Identify funding sources for BMP implementation • Identify project partners/technical assistance • Obtain any necessary municipal permits • Conduct implementation outreach	Commercial residential complexes	2017-2019, ongoing thereafter	Identification of potential BMP sites, selection of BMPs, # BMPs installed	Rain barrels - $125-$200 ea. Rain Planters: $85 - !50 ea. Rain Gardens: $15-$20/sf	Yes	General operating budget rants, Community foundation grants, private corporate grants CWA §319 grants	CT NEMO, ECCD, DEEP, EPA
3. Encourage recycling/institute dumpster management program: • Encourage recycling through waste management company • Prepare/disseminate recycling outreach material for tenants • Participate in municipal hazardous waste collection day • Coordinate dumpster management with waster mgmt company	Commercial residential complexes	2017-2019, ongoing thereafter	Encourage tenant recycling, # recycled material separated from general trash, replacement of leaking dumpsters	Recycling initiative, preparation of outreach material: $1,000	Yes	General operating budget	Waste mgmt. provider, DEEP, EPA NDDH
4. Adopt lawn/landscape BMPs: • Test soils to determine nutrient levels and needs • Utilize proper fertilizer application rates and timing • Consider use of IPM as an alternative to pesticide application • Store yard waste away from waterways	Commercial residential complexes	2017-2019, ongoing thereafter	Adoption of Landscaping/ lawn BMPs, # fertilizer saved through use of BMPs	Soil tests $12 - $20 ea.	Yes	General operating budget	NOFA, UConn Extension, ECCD, DEEP

8.4. Municipal Sewer BMPs

Municipal sanitary sewer service is provided to Northern Drive, Gendron Road, River Street and Gorman Road (including the Moosup Garden Apartment complex) in Plainfield. Sewer lines are owned and maintained by the Plainfield Water Pollution Control Authority (WPCA). Older lines, including those in vicinity of River Street, tend to be comprised of vitrified clay pipe. Newer sewer lines, including those at Northern Drive, are comprised of concrete pipe. Those sections of clay sewer lines with known problems are inspected twice a year. The WPCA does not typically inspect concrete sewer mains unless there is a suspected problem. There are no municipal sewers in the Ekonk Brook watershed in Sterling or Voluntown.

Regular inspections and maintenance by water pollution control authorities is critical to ensuring the proper functioning of municipal sewer systems and to identify and repair damaged or leaking sewer lines. Regular inspections may also identify cross-connections with stormwater systems, particularly in older sewer systems, and illicit hook-ups. Illicit hook-ups can include footing, roof and yard drains that discharge clean water to the sewer system and which can overwhelm the system's capacity during very heavy storms. Detection of illicit discharges will be a required component of the Plainfield MS4 general permit when it takes effect in 2017.

The replacement of aging sewer infrastructure, including the older clay sewer lines, should be conducted as part of the WPCA general maintenance plan. As an alternative to costly sewer main replacement, older sewer mains can be lined with resin-saturated cured-in-place felt liners.

Public outreach efforts by the WPCA can be an effective way to educate the public about household practices that will prevent sewer line problems, including clogs and back-ups. Residents should be informed about what should not be poured down a drain, including solids like diapers and other sanitary materials, pharmaceuticals, oil and grease, and toxic chemicals such as paint, solvents and petrochemicals. The WPCA should be notified promptly if a sewer line break, leak or backup is suspected or observed.

Municipal sewer best management recommendations are provided in Table 8-8.

Table 8-8. Municipal Sewer Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Conduct regular inspection /maintenance of sewer mains: • Develop an inventory of sewer infrastructure • Identify inspection criteria • Develop inspection methodology • Prepare inspection/maintenance documentation (procedures and checklist) • Develop an inspection schedule	Plainfield WPCA	2017-2019	Sewer main database, inspection checklist, inspection schedule	$50,000	Yes	WPCA operating budget, Clean Water Fund, STEAP program, DEEP CWA §319 program	WPCA, CT DEEP, NECCOG
2. Repair/replacement of aging infrastructure: • Identify aging infrastructure • Develop a ranking system for repairs • Rank sewer lines • Identify the appropriate repair • Prepare repair/replacement plans • Identify funding sources • Obtain funding to conduct repair/replacement	Plainfield WPCA	2017-2027	Repair ranking database, engineered plans, identification of funding sources	$100,000 to $500,000 or more depending on type and size of sewer line repair/ replacement	Yes	WPCA operating budget, Clean Water Fund, STEAP program, DEEP CWA §319 program	WPCA, CT DEEP, NECCOG
3. Conduct public outreach & education: • Identify outreach partners • Identify outreach concerns • Identify best outreach approach (workshop, flyer, etc.) • Prepare outreach material • Disseminate outreach material • Add outreach/education component to WPCA website	Plainfield WPCA, watershed management team, Health District	2017-2019	Creation of outreach team. Identification of outreach topics, preparation and dissemination of outreach materials, outreach webpage on WPCA website	$4,0000	Yes	WPCA operating budget, STEAP program, DEEP CWA § 319 program	WPCA, CT DEEP, NDDH, NECCOG

8.5. Septic Systems BMPS

Septic systems in the Ekonk Brook watershed may be contributing to pollutant loading to surface waters, although to what degree is not currently known. A review of watershed soils indicated that in general, the watershed appears to be dominated by soils that have low septic potential, necessitating the need for engineered septic systems to ensure effluent is treated properly. As a result, older septic systems may not be providing adequate pollutant renovation. Any new septic systems being installed in these soils should be designed using the most current engineering methods to ensure that adequate effluent treatment takes place. Of note is a cluster of older homes on Goshen Road in the unnamed stream 01 subwatershed. Fecal bacteria levels at two sampling sites in unnamed stream 01 (UN-01-01 and UN-01-02) exceeded allowable limits. No livestock were noted on the portion of Goshen Road within the Ekonk Brook watershed. However, the older residences, coupled with a seasonally high water table as evidenced by a nearby wetland, indicate that older, underperforming septic systems may be contributing to bacteria loading.

It may not be practical or financially feasible for property owners to replace their existing septic systems with more modern engineered systems. Therefore, it is important that existing septic systems be maintained in order to function to their maximum efficiency. Homeowners should be educated about septic system best management practices and encouraged to develop a recordkeeping system to document important routine system maintenance, including regular pumping of their holding tanks in accordance with the manufacturer or installer's recommendations (usually every two years), and periodic inspections to ensure the leach field is functioning properly. The Northeast District Department of Health (www.nddh.org) should promote or institute a system of regular septic system inspections to educate and assist homeowners with the maintenance of their septic systems. The health district, watershed municipalities and watershed management team may want to review initiatives undertaken in the region to encourage and/or require septic system maintenance. These include regulations adopted by Chatham Health District (www.chathamhealth.org) requiring renewal of permits to discharge wastewater to septic systems and a septic system maintenance pilot project in the Mashamoquet Brook watershed in Pomfret, Brooklyn, Woodstock and Eastford by ECCD. Homeowners should also be educated on what is safe and not safe to put down the drain in order to keep their systems operating at maximum efficiency.

Finally, underperforming or failing septic systems should be replaced. Ekonk Brook watershed municipalities should investigate whether they qualify for the Connecticut Department of Economic and Community Development (DECD) Small Cities Program, which can provide assistance to property owners to support septic systems repairs and/or replacements on a case by case basis. NDDH may also be a source for additional suggestions regarding financial assistance to repair and/or replace septic systems.

Management recommendations for septic system maintenance are listed in Table 8-9.

Table 8-9. Septic System Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Develop a record keeping system: • Determine or document septic system location, including tank and leach field • Determine septic system capacity • Determine septic system age • Develop a maintenance checklist • Document maintenance/upkeep	Watershed management team, property owners, Health District	2018-2020	Identification of septic system location, capacity and age; establishment of maintenance record keeping	$3,000	Yes	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 319 grants	Municipal staff, Health District, NECCOG
2. Establish regular maintenance: • Develop and/or distribute a septic system Operation & Maintenance Guide for homeowners • Establish regular maintenance schedule including tank pumping, per installer recommendations • Inspect tank and leach field to ensure proper functioning	Watershed management team, property owners, Health District	2018-2020	O&M Guide, maintenance/ inspection schedule	$6,000	Yes	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, Health District, NECCOG
3. "Down-the-Drain" outreach & education: • Identify outreach partners • Develop a database of materials that should not be dumped in septic systems • Develop outreach materials • Conduct outreach to educate homeowners on materials and chemicals that are not safe to dump in septic systems	Watershed management team, Municipalities, Health District	2017-2018	Identification of outreach partners, material database, outreach material	$4,000	Yes	Watershed municipalities, community foundation grants, private corporate grants, CT DEEP 604b watershed planning grants	Municipal staff, Health District, NECCOG
4. Establish a municipal program to assist with septic system repairs/replacement: • Identify state/federal funding sources (such as Small Cities program) • Establish a review mechanism • Create a review board • Develop a public notification process • Award funding based on established criteria	Watershed management team, Municipalities, Health District	2018-2027	Identification of funding sources, establishment of review protocol, establishment of review board	To be determined by municipal-ities	Yes	Watershed municipalities, Clean Water Fund, STEAP grants< Small Cities grant program	Municipal staff, Health District, NECCOG, OPM, CEDC

8.6. Agricultural BMPs

Agriculture is the predominant land use activity in the Ekonk Brook watershed. Approximately 685 acres of land in the watershed (20%) are under agricultural use. Based on loads calculated by the Watershed Treatment Model, agricultural land uses, including pasture and cropland, contribute approximately 25% of the total nitrogen load, 37% of the total phosphorus load, 17% of the total sediment load, and 17% of the fecal coliform load to surface waters in the Ekonk Brook watershed. Agricultural operations are located primarily along Sterling Hill Road in Plainfield and Ekonk Hill Road in Sterling, and include several large farms including dairy and poultry producers. Additionally, feed corn and hay fields were noted throughout the watershed in both Plainfield and Sterling.

The poultry producer participates in USDA Natural Resource Conservation (NRCS) programs, including the Comprehensive Nutrient Management Plan (CNMP) program and utilizes composting facilities to manage animal waste, including manure and offal. Once composted, all waste is exported off-site. The farm also practices rotational grazing for its free-range turkeys. The dairy does not currently have a CNMP, but does utilize other BMPs including no-tillage and cover cropping. These practices rebuild soil fertility, reduce the amounts of chemicals needed to manage the fields, and reduce soil loss through erosion.

Figure 8-2. Manure composting facility at a poultry farm in Sterling, CT.

In order to manage NPS loading from agricultural activities, producers should incorporate practices that reduce the amount of runoff from their operations. These practices may include:

- Preparation and implementation of a Comprehensive Nutrient Management Plan (CNMP) to quantify and manage on-site nutrient loads and needs
- Adoption of no-till or limited tillage systems to improve soil water infiltration, soil water-holding capacity and microbial biomass, leading to reductions in nutrient loss and water runoff
- Soil, manure and crop nutrient testing to quantify and manage on-site nutrient loads and needs
- Fertilizer and manure spreader calibration to ensure proper application
- Proper application rates and timing to manage nutrient and chemical loads and reduce potential for loss through run-off

- Retention of crop residue and use of cover crops to cycle nutrients, retain soil moisture, reduce or eliminate soil erosion, and sequester residual nitrogen and phosphorus for use by the following crop
- Use of strip and contour farming to prevent soil erosion
- Use of buffer strips along riparian corridors to reduce or eliminate sediment transport in run-off and allow nutrient uptake by riparian vegetation
- Adoption of adaptive grazing to improve soil structure and root depth, increase soil microbial biomass, and reduce or eliminate nutrient-laden run off from fields, while improving soil productivity
- Livestock exclusion from sensitive areas such as wetlands and streams to reduce or eliminate nutrient and bacteria loading from manure and sediment loading from erosion.

USDA does not have a size requirement for farms. As a result, small farms may not be aware that they are eligible for USDA programs as long as they meet a minimum production threshold ($1,000 annually). Non-commercial farms (i.e. backyard farms that do not produce a crop) are not eligible for many USDA programs, and therefore may not receive information and technical support about farm best management practices that might benefit them.

There are a number of agencies, including the USDA Natural Resources Conservation Service (NRCS), USDA Farm Services Agency (FSA), Connecticut Department of Agriculture, Connecticut Department of Energy and Environmental Protection (DEEP), the University of Connecticut College of Agriculture, Health and Natural Resources and Extension, and the Connecticut Conservation Districts, that can provide financial and/or technical assistance to producers and private farm owners to manage their properties and businesses. Additionally, peer-to-peer farmer networking promoted or supported by the watershed management team or local conservation and agriculture commissions or programs like the AGvocate program (www.facebook.com/AGvocate) can potentially be a significant source of information and assistance.

Management recommendations for agricultural activities and livestock management are listed in Table 8-10.

Table 8-10. Agricultural Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Conduct agriculture BMP education and outreach to commercial and small farm owners: • Identify outreach partners • Identify outreach topics • Prepare outreach material • Identify best method for dissemination • Prepare outreach activities • Disseminate outreach to target audience	Watershed team, Agriculture Commissions	2017-2019	Preparation of outreach material, outreach events held, # producers reached	$4,000	Yes	Municipalities, DoAg, NRCS programs, DEEP CWA §319 program	Agriculture Commissions, NRCS, CT RC&D, ECCD, DEEP, DoAg, UConn Extension
2. Promote enrollment in NRCS programs: • Identify project partners • Identify eligible producers • Prepare/compile outreach material • Conduct NRCS program outreach and education • Enroll eligible producers in NRCS programs	Agriculture producers, Agriculture Commissions, NRCS, ECCD, TLGV, CT RC&D	2017-2027	Database of eligible producers, Outreach material disseminated, # producers reached, # producers enrolled, # practices implemented	$50,000	Yes	NRCS programs	Agriculture Commissions, NRCS, CT RC&D, ECCD, DEEP, DoAg,
3. Adopt nutrient best management practices: • Identify project partners • Identify eligible producers • Prepare nutrient BMP material • Conduct nutrient BMP outreach and education • Provide nutrient BMP support and technical assistance	Agriculture producers, Agriculture Commissions, NRCS, ECCD, TLGV, CT RC&D	2019-2021	Database of eligible producers, Outreach material disseminated, # producers reached, # practices implemented	$5,000	Yes	Municipalities, DoAg, NRCS programs, DEEP CWA §319 program	Agriculture Commissions, NRCS, CT RC&D, ECCD, DEEP, DoAg, UConn Extension
4. Adopt practices that reduce pollutant transport/soil erosion: • Identify project partners • Identify eligible producers • Prepare outreach material • Conduct outreach and education • Provide BMP support and education	NRCS, Eligible agriculture producers	2019-2021	Database of eligible producers, Outreach material disseminated, # producers reached, # practices implemented	$5,000	Yes	Municipalities, DoAg, NRCS programs, DEEP CWA §319 program	Agriculture Commissions, NRCS, CT RC&D, ECCD, DEEP, DoAg, UConn Extension

8.7. Pets

Pets, particularly dogs, were not noted to be particularly prevalent in the Ekonk Brook watershed and the number of dog licenses issued in 2016 indicated animal densities were fairly low (Connecticut state law requires that dog owners are required by State law to register all dogs over the age of six months be of age annually with the town clerk's office). However, as a general practice, dog owners should employ good housekeeping practices and pick up after their pets to prevent the input of nutrients and bacteria from pet waste into nearby waterbodies.

Towns ordinances related to the management of pet waste should be enforced on a case by case basis to reduce the impact of pet waste on water quality. Because there were no discernible gathering areas for dogs, such as dog parks, pet waste management would be most effective on a watershed-wide scale. Brochures and other outreach material related to water quality problems associated with pet waste should be made available at locations frequented by pet owners, including local veterinarians, kennels, retail pet supply centers and town hall license centers.

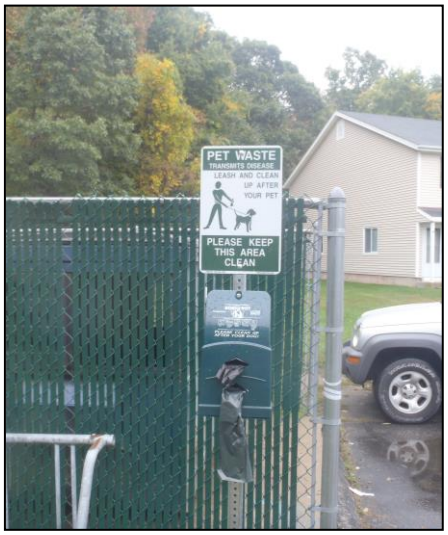


Figure 8-3. Pet waste stations located at Moosup Garden Apartments encourage dog owners to pick up after their pets.

A small colony of feral cats (approximately 15-20 animals) was observed at Moosup Garden Apartments, living in the wooded area alongside Ekonk Brook. Waste from these animals may be a source of pathogens and nutrients to Ekonk Brook. It is believed that some of these cats may have been abandoned by their owners when they moved out of the apartment complex. Others may have been attracted by food left out for the animals by residents. It was reported by residents that some of the cats had been spayed or neutered to prevent reproduction, but receive no other veterinary care. Apartment residents should be encouraged to find suitable homes for unwanted pets. Participation in a trap, neuter, release program for any cats not otherwise suitable for adoption will prevent proliferation of the animals.

Pet management recommendations are provided in Table 8-11.

Table 8-11. Pet Best Management Practices

BMP Implementation Actions/ Milestones	Responsible Entity(ies)	Schedule	Deliverable/ Evaluation Criteria	Cost Estimate	Critical Area	Potential Funding Source	Technical Assistance
1. Encourage pet waste management BMPs: • Review and enforce town ordinances related to pet waste • Prepare and distribute outreach material to educate residents about the link between pet waste and water quality • Continue use of pet waste stations at Moosup Garden Apartments	Municipalities, watershed management team, Moosup Garden Apts. management	2017	Reduction in observed amount of animal waste, distribution of outreach material	$2,000	Yes	Municipal general budgets, community foundation grants, private organizational grants, Moosup Garden Apartments general budget	Animal control officer, local council of govt
2. Reduce or eliminate feral cat colony at Moosup Garden Apartments: • Encourage pet owners to find suitable homes for unwanted pets • Catch and adopt out suitable cats • Participate in Trap, Neuter, Release programs to prevent proliferation	Moosup Garden Apartments management, Plainfield Animal Control, local animal shelters, local veterinarians	2017-2019	Reduction in feral cat population, number of cats adopted, number of cats neutered	$1,500	Yes	Municipal general budget, community foundation grants, private organizational grants, Moosup Garden Apartments general budget	Animal control officer, NECCOG animal shelters, veterinarians

9. Financial and Technical Assistance Needed

Most, if not all, of the management practices provided in Section 8 will require some financial investment. Reasonable financial estimates for each management practice have been provided in the tables above. However, costs associated with the development and implementation of each proposed measure will need to be estimated individually as management strategies are undertaken. Watershed managers should be advised that cost estimates may change over time.

Watershed municipalities have local funding options, including bonding, capital improvement budgets, and department budget line items that can be utilized to fund water quality improvement implementations and municipal outreach efforts. Town planning and land use departments can establish open space set-aside funds for the purchase of open space, if they do not already have them. Highway/public works departments include annual budget line items for infrastructure repair, maintenance and improvements. Conservation Commission and Park & Recreation Commission budgets can include line items for environmental education and outreach programs/campaigns and materials. The establishment and growth of this local capacity is important. When municipalities apply for outside grants, loans and/or foundation support, they can leverage local funds as match. Additionally, numerous grant applications are strengthened by the availability of in-kind services provided by municipal staff.

Financial assistance in the form of grants and cost-sharing is available from multiple sources, including federal, state, and local sources. These include, but are not limited to, US Environmental Protection Agency (Clean Water Act §319 Non-Point Source program); Connecticut Department of Economic and Community Development (Small Cities grant program), the Connecticut Office of Policy and Management (STEAP grants); CT Department of Energy and Environmental Protection (Open Space grants, CWA grants); Long Island Sound program grants, and National Fish and Wildlife Fund grants. The US Department of Agriculture Natural Resources Conservation Service (NRCS) offers cost-share programs for qualified agricultural producers, including comprehensive nutrient management planning (CNMP) and environmental quality incentive programs (EQIP). The Connecticut Department of Agriculture offers several grant programs to assist agricultural producers, including farm restoration and agriculture viability grant programs. Local and regional sources may include banks, chambers of commerce, civic/social organizations (such as Lions or Rotary), private, commercial and institutional foundations, and environmental/ professional organizations grants. Funds and support may also be available in the form of donations and in-kind services provided by local businesses, community and environmental organizations, and local volunteers. A sampling of potential funding opportunities is provided in Table 9-1. These funding sources are subject to the availability of funding and changes in funding cycles and should be reviewed by the applicant for applicability and availability.

Table 9-1. Potential funding sources for watershed plan implementations.

Funding Source	Award Amount	Contact Information
CT DEEP CWA §319 Grant Program	Varies by project	Eric Thomas (860) 424 -3548
Website: www.ct.gov/dep/cwp/view.asp?a=2719&q=325588&depNav_GID=1654		
CT DEEP Clean Water Fund		Susan Hawkins (860) 424-3325
Website: www.ct.gov/dep/cwp/view.asp?a=2719&q=325578&depNav_GID=1654		
CT DEEP Open Space and Watershed Land Acquisition Grant Program	40-60% of fair market value	Dave Stygar (860) 424-3016
Website: www.ct.gov/deep/cwp/view.asp?A=2687&Q=322338		
Ct Dept of Agriculture Environmental Assistance Prgm	Varies by practice	(860) 713-2511
Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398986		
Ct Dept of Agriculture Agriculture Viability Grant	Varies by project	(860) 713-2500
Website: www.ct.gov/doag/cwp/view.asp?a=3260&q=398982		
Ct Dept of Agriculture Farmland Restoration Program	Varies by project	Cam Weimer/Lance Shannon (860) 713-2511
Website: www.ct.gov/doag/cwp/view.asp?a=3260&Q=498322&PM=1		
CT DECD Small Cities Program	Varies by town	Jim Watson (860) 270-8182
Website: www.ct.gov/doh/cwp/view.asp?a=4513&q=530474		
CT OPM Regional Performance Incentive Program		Sandy Huber (860) 418-6293
Website: www.ct.gov/opm/cwp/view.asp?q=487924		
CT OPM Small Town Economic Assistance Program	Varies by project	Barbara Rua (860) 418-6303
Website: www.ct.gov/opm/cwp/view.asp?a=2965&q=382970&opmNav_GID=1793		
Community Foundation of Eastern Connecticut	Varies by program	Jennifer O'Brien (860) 442-3572
Website: www.cfect.org/		
US EPA Healthy Communities Grant Program		Jennifer Padula (617) 918-1698
Website: www.epa.gov/region1/eco/uep/hcgp.html		
NOAA Coastal Management Programs		
Website: http://coastalmanagement.noaa.gov/funding/welcome.html		
US EPA Five Star Restoration Grant Program	$20,000 average	Myra Price (202) 566-1225
Website: www.epa.gov/owow/wetlands/restore/5star		
NFWF Long Island Sound Futures Fund	Varies by project	Lynn Dwyer lynn.dwyer@nfwf.org
Website: www.nfwf.org/		
NRCS Agricultural Conservation Easement program		Ray Covino (860) 779-0557 x102
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/easements/acep/		
NRCS Environmental Quality Incentives Program	$450,000 over 6 yrs	Ray Covino (860) 779-0557 x102
Website: www.ct.nrcs.usda.gov/programs/eqip/eqip.html		
NRCS Conservation Stewardship Program (CSP)	$200,000 over 5 yrs	Ray Covino (860) 779-0557 x102
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/financial/csp/		
NRCS Agricultural Management Assistance Program	$50,000/yr	Ray Covino (860) 779-0557 x102
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ct/programs/financial/?cid=nrcs142p2_011027		
Rivers Alliance of CT Watershed Assistance Small Grants Program	$5000, req. 40% non-federal funding match	Rivers Alliance of CT (860) 361-9349
Website: www.riversalliance.org/watershedassistancegrantrfp.cfm		

The planning, design and execution of complex water quality improvement projects may require expertise that small towns, watershed groups and civic organizations do not have access to. As a result, assistance from organizations or agencies that have the technical capacity will be critical to the successful implementation of the management recommendations. Organizations such as the US Department of Agriculture Farm Services Agency (FSA) and Natural Resources Conservation Service (NRCS), CT DEEP, the CT Department of Agriculture, the Northeastern Connecticut Council of Governments (NECCOG), the Connecticut Conservation Districts, the University of Connecticut Cooperative Extension Service, US Fish & Wildlife Service, and others may provide technical assistance to project managers and watershed stakeholders that will ensure project success.

Table 9-2. Potential sources of technical assistance

Agency/Organization	Type of Assistance Available
CT Department of Agriculture www.ct.gov/doag	Technical assistance/permitting
CT DEEP www.ct.gov/deep	Water quality, technical assistance
CT Department of Transportation www.ct.gov/dot	Maintenance of State highways/stormwater systems and maintenance facilities
CT Resource Conservation & Development Council www.ctrcd.org	Farm energy program, soil health education
Eastern CT Conservation District www.ConserveCT.org/eastern	Water quality investigation, BMP implementations, technical and resource assistance
Northeast District Department of Health www.NDDH.org	Review and approval of septic systems, repairs
Local Businesses/Associations http://nectchamber.com/ http://plainfieldbusinessassociation.org/	Potential funding and partnership opportunities
NECCOG www.neccog.org	Regional land use planning support and assistance
The Nature Conservancy www.nature.org	Outreach/education, technical assistance
Town of Plainfield – including staff & land use commissions www.plainfieldct.org	Enforcement of land use regulations, site plan review/permits, public utilities maintenance
Town of Sterling – including staff, land use commissions www.sterlingct.us	Enforcement of land use regulations, site plan review/permitting, public utilities maintenance
USDA/Natural Resources Conservation Service (NRCS) http://www.nrcs.usda.gov/wps/portal/nrcs/site/ct/home/	Technical assistance/cost-share funding for agricultural BMPs
USDA Farm Service Agency (FSA) www.fsa.usda.gov/	Technical/financial assistance for agricultural producers
University of Connecticut – Center for Land Use Education and Research (CLEAR) http://clear.uconn.edu	Technical assistance/implementation of LID/GI
University of Connecticut - Nonpoint Education for Municipal Officials (NEMO) http://nemo.uconn.edu	NPS education and support for municipal land use organizations
University of Connecticut Extension www.extension.uconn.edu	Technical assistance/education/outreach for land use and agricultural practices

10. Education/Outreach

The objective of the education/outreach component of this plan is to provide watershed stakeholders with guidelines on how to raise awareness of the water quality issues associated with Ekonk Brook, in order to create an educated populace that understands the issues of nonpoint source pollution, its effects on water quality, and actions that can be taken to address the problem. By successfully engaging and educating the public, including students, watershed property and business owners, municipal staff and land use commissioners, this plan should lead to behavioral change that should result in the adoption of land use practices that will be supportive of good water quality in Ekonk Brook and the watershed as a whole.

Outreach efforts may be watershed-scale, and seek to address issues that are watershed-wide. Such efforts may include the creative integration of watershed and water quality lessons into local school science curriculums, possibly including an examination of local water quality conditions; or the promotion of homeowner best management practices such as encouraging recycling, washing cars on lawns or using a carwash, properly disposing of pet waste, encouraging composting, reducing the use of lawn chemicals, and discouraging the dumping or depositing of chemicals or other waste in storm drains. These efforts may target a broad spectrum of watershed residents through activities such as presentations at meetings or conferences (land-use commissions, civic organizations, schools), news articles or feature stories in local or regional newspapers or other media outlets, displays at local festivals or field days, and work days, such as community clean-up days.

Outreach efforts may also be more small-scale or focused, and may be tied to specific implementation projects or target a water quality issue in a specific locale. Examples of these types of outreach efforts may include a rain garden workshop conducted in tandem with the installation of a rain garden at a targeted location with a known water quality issue; a workshop directed to a specific target audience, such as a manure management workshop for horse owners; or the installation of educational signage at a location with a specific resource concern such as cleaning up animal (dog) waste in a public park, not feeding geese or other waterfowl, or carrying out trash.

Table 10-1 reiterates outreach topics included above and suggests potential outreach partners.

Table 10-1. Public education topics and potential partners.

Outreach Topic	Audience	Potential Outreach Partner(s)
Agricultural BMPs, including soil health, tillage practices, and cover cropping	Agricultural producers	NRCS, UConn Cooperative Extension System, ECCD, Agricultural Commissions, CT RC&D
Agricultural Nutrient Management	Agricultural producers & private farm owners	ECCD, NRCS, UConn Cooperative Extension System
Farm Energy Efficiency	Agricultural producers	CT RC&D Council
Homeowner lawn, garden and stormwater BMPS	Residents/property owners	ECCD, UConn Cooperative Extension System
Implementation of MS4 program	Municipalities/DPWs	CT DEEP Stormwater Management, DPWs, CT NEMO
Land use commissioner roles and responsibilities	Land use staff and commissions	CT NEMO, CLEAR, CACIWC, municipal land use commissions
Low impact development (LID)/ Green Infrastructure (GI)	Land use staff and commissions/DPWs	CT NEMO, CLEAR, DEEP, ECCD
Municipal "Good Housekeeping" Public Works practices	Municipalities/DPWs	CT DOT, DPWs
Open space planning, acquisition and management	Land use staff and commissions	CT DEEP, CT NEMO, CLCC, local land trusts, TLGV
Organic lawn/garden care	Residents/property owners	UConn Cooperative Extension System, NOFA
Pet waste management	Residents/property owners	Towns of Plainfield and Sterling, Northeast District Department of Health, veterinarians, pet stores
Rain Gardens and Native Plants	Residents/property owners Land use staff and commissions	CT NEMO, UConn Extension, ECCD, area plant nurseries, garden clubs and beautification committees
Recycling	Residents/property owners	WPCA, municipalities, waste mgmt. companies
Septic System BMPs for Homeowners	Residents/property owners	Local Health District, CT Dept. of Health, local septic services companies
Trash/litter management	Residents/property owners	Local Conservation Commissions, DPWs, waste mgmt. companies
Understanding Non-Point Source (NPS) Pollution	Residents/property owners Land use staff and commissions	CT NEMO, municipal Conservation Commissions, DEEP
What not to flush down drains	Residents/property owners	WPCA, Northeast District Department of Health, ECCD

11. Monitoring and Assessment

The monitoring of water quality conditions is an essential component of any watershed management plan. The collection of water quality data allows watershed managers to assess whether water quality improvement measures are having the intended effect, or whether adjustments need to be made within the adaptive management framework. Water quality monitoring should be coordinated with the implementation of management measures in order to determine if the management measure goals (e.g. a reduction in the amounts of indicator bacteria) are being achieved. Baseline fecal bacteria levels have been documented by CT DEEP and ECCD, and have been used to identify fecal bacteria reductions required to meet state water quality standards, including the establishment of a fecal bacteria TMDL for Ekonk Brook. This baseline data can be used to evaluate the effectiveness of management measures as they are implemented.

Several opportunities exist for the future collection of water quality data in the Ekonk Brook watershed. As part of the 2016 Small Municipal Separate Storm Sewer Systems (MS4) general permit, the Town of Plainfield will be required to establish a stormwater monitoring program. The Town of Sterling may want to voluntarily support a similar stormwater monitoring program. With careful planning, water quality data from this program can be used to evaluate BMP effectiveness. The CT DEEP Ambient Water Quality Probabilistic Bacteria Monitoring program conducts sampling by basin throughout Connecticut on a five-year rotation in support of a biennial assessment of water quality conditions across Connecticut per requirement of the federal Clean Water Act. Sampling at the Ekonk Brook sampling site (#789) should continue to determine whether the implementation of this watershed management plan is having a positive impact on water quality in Ekonk Brook and the watershed as a whole. Finally, water quality monitoring volunteers can be recruited and trained through programs such as The Last Green Valley Water Quality Monitoring program, to collect water quality data on a project basis. If desired, future bacteria monitoring can incorporate microbial source tracking to determine the likely bacteria host animal.

The following items should be included as part of the monitoring and assessment component of watershed plan implementations as they are undertaken:

- coordination of monitoring activities among the watershed project partners;
- continuation of CT DEEP Ambient Water Quality Probabilistic Bacteria Monitoring program of Ekonk Brook at station #789, as part of the five-year rotational basin assessments;
- bacteria DNA source tracking at station #789 and at UN-01-01 and UN-01-02 to identify the bacteria host animal;
- collection of pre- and post-implementation water quality data to determine the effectiveness of the BMP in reducing pollutant loading, if existing data is not available;

- comparison of post-BMP water quality monitoring data to bacteria TMDL targets to determine if bacteria load reductions have been achieved; and
- comparison of post-BMP implementation data collection to NPS pollutant load targets to determine if NPS pollutant load reductions have been achieved.

12. Plan Implementation Effectiveness

The implementation of a watershed management plan is necessarily an iterative process. As implementations are undertaken and completed, water quality data should continue to be collected, evaluated and compared to the desired water quality goals to determine if the implementations are achieving the desired results. Implementation should be considered complete when the targets are reached or exceeded. Once water quality targets have been achieved, periodic water quality sampling should be continued in Ekonk Brook and the tributary streams to ensure water quality improvements are sustained.

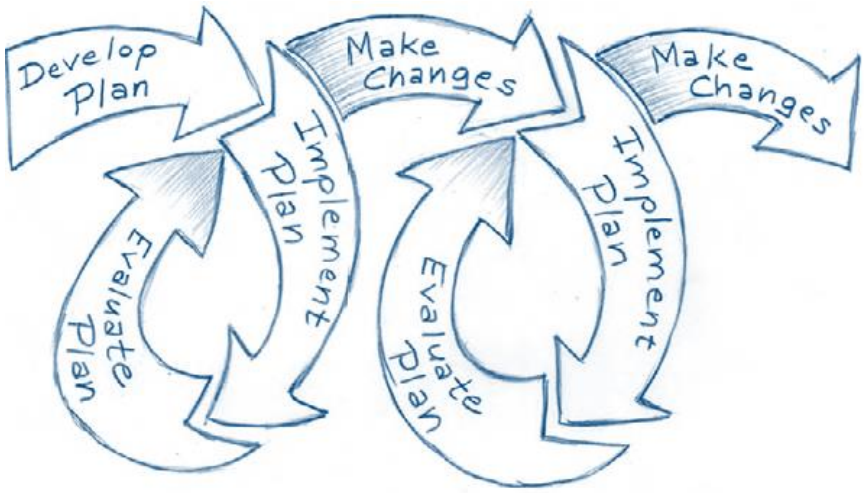


Figure 12-1. This graphic from the USEPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters depicts the iterative nature of the watershed planning process (USEPA 2008).

If implementations are not as effective as planned, e.g., implementation milestones are not being met, or progress is not being made toward reducing pollutant loads, watershed stakeholders should review the implementation program. The review should include an examination of the effectiveness of selected BMP practices, a review of goals and objectives to determine if they are realistic and achievable, and an evaluation of the selected implementations to ensure they are adequate to achieve those goals. If it is determined that the implementation of goals and objectives are not resulting in a positive water quality change, watershed team members may need to make adjustments or revisions to the watershed plan. Additionally, watershed stakeholders should review this Management Plan periodically vis-à-vis changes and/or improvements to the watershed, and revise or update the Plan accordingly.

13. Next Steps

Addressing Ekonk Brook's water quality issues will be a long term effort. It will take the actions of many individuals, community leaders and decision makers to address current water quality issues and reduce the levels of fecal bacteria and other NPS pollutants currently entering Ekonk Brook. Periodic public events should be scheduled by the watershed management team to reach out to residents of the Ekonk Brook watershed and the broader Plainfield and Sterling communities to promote the watershed plan, and inform the community about efforts being undertaken to restore watershed conditions to meet CT water quality standards in Ekonk Brook and its tributaries.

Following the acceptance of the Ekonk Brook Watershed-based Plan by CT DEEP, this Plan should be distributed to all watershed stakeholders for implementation, including but not limited to the watershed municipalities, Council of Government, the Northeast District Department of Health, local utilities (including the Plainfield Water Pollution Control Authority), CT Department of Transportation, agricultural producers, and business and land owners. The plan should be made available to the general public via postings on the CT DEEP, ECCD and Towns of Plainfield and Sterling municipal websites. Efforts should be made to publicize the watershed plan using multiple approaches and media platforms to reach different audiences, in order to raise public awareness of water quality issues associated with the lower Ekonk Brook, and steps being taken to improve water quality.

It will be incumbent upon all watershed stakeholders to review, understand and adopt the plan recommendations. Since the Ekonk Brook watershed spans municipal boundaries, inter-municipal co-operation, potentially including the adoption of a non-binding conservation compact in support of measures and actions to protect and restore the ecological health of the Ekonk Brook watershed, may be considered.

The Eastern Connecticut Conservation District intends to remain an active participant and central point of contact as implementations recommended by this Watershed-Based Plan are undertaken.

Any comments or questions regarding this Plan should be directed to:

Eastern Connecticut Conservation District
238 West Town Street
Norwich, CT 06360
(860) 887-4163 ext. 400

(This page intentionally left blank)

14. References

A Bird's-eye View of Moosup, Connecticut History.org. Accessed 12/09/15. http://connecticuthistory.org/a-birds-eye-view-of-moosup/

A Total Maximum Daily Load Analysis for Recreational Uses of the Ekonk Brook Sub-regional Basin, Connecticut Department of Energy and Environmental Protection, Hartford, CT. September, 2011.

Alderisio, K.A., and DeLuca, N. 1999. Seasonal enumeration of fecal coliform bacteria from the feces of ring-billed gulls (Larus delawarensis) and Canada geese (Branta canadensis). Appl. Environ. Microbiol. (65):5628-5630.

Bellucci, C.J., M. Beauchene, and M. Becker. 2008. Physical, Chemical, and Biological Attributes of Moderately Developed Watersheds within Connecticut. Connecticut Department of Environmental Protection, Hartford, CT. 06106.

Brownfield Sites in Connecticut. Connecticut Department of Energy and Environmental Protection. Hartford, CT. Retrieved 1/22/16. http://www.ct.gov/deep/cwp/view.asp?a=2715&q=324930&deepNav_GID=1626

CERC Town Profile Town of Plainfield, CT. October 2014. Connecticut Economic Resource Center, Inc. www.cerc.com

CERC Town Profile Town of Sterling, CT. October 2014. Connecticut Economic Resource Center, Inc. www.cerc.com

CERC Town Profile Town of Voluntown, CT. October 2014. Connecticut Economic Resource Center, Inc. www.cerc.com

Connecticut Department of Energy and Environmental Protection. Stream survey data, Inland Fisheries Division (no date).

Connecticut Geological and Natural History Survey, Bedrock Geological Map of Connecticut, 1985. Connecticut Department of Environmental Protection. Hartford, CT. 06106.

Connecticut Guidelines for Soil Erosion & Sediment Control. 2002. DEP Bulletin 34. CT Department of Environmental Protection. Hartford, CT.

Connecticut Stormwater Quality Manual. 2004. CT Department of Environmental Protection. Hartford, CT.

Connecticut's Trout Management Plan. Connecticut Department of Energy and Environmental Protection. Retrieved 4/10/14.
http://www.ct.gov/deep/lib/deep/fishing/freshwater/troutbroc.pdf

Connecticut Water Quality Standards. 10/10/13. Connecticut Department of Energy and Environmental Protection, Hartford, CT.

Connecticut Watershed Response Plan for Impervious Cover. 2015. Connecticut Department of Energy and Environmental Protection. Hartford, CT.

Conservation & Development Policies: The Plan for Connecticut - 2013- 2018, Connecticut Office of Policy and Management, 2013. Hartford, CT.

Debo, Thomas N.; Reese, Andrew J. 2003. *Municipal Stormwater Management* (2nd ed.). Boca Raton, FL: CRC Press.
Draft Stormwater Management Plan, February 2015. CT Department of Transportation. Retrieved 12/7/15.
http://www.ct.gov/dot/lib/dot/documents/dpolicy/waternoisecompliance/stormwatergeneralpermits/February_2015_SWMP_DRAFT.pdf

Endangered, Threatened and Special Concern Species in Connecticut. (n.d.) Connecticut Department of Energy and Environmental Protection. Accessed 1/04/16.
http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323486&deepNav_GID=1628

Esteemed Men of Plainfield Connecticut History. 9 Aug 2011. Connecticut Geneology. Accessed 1-07-16. http://www.connecticutgenealogy.com/windham/plainfield_esteemed_men.htm

FIRM Flood Insurance Rate Map Town of Plainfield, Connecticut, Windham County, Community Panel Numbers 090116 0005B and 090116 0010B. June 17, 1991. Federal Emergency Management Agency. Washington, DC. Accessed 12/2/15. http://www.fema.gov/flood-zones.

Guidance and Recommendations for Connecticut Municipal Zoning Regulation and Ordinances for Livestock. June 2012. Eastern Connecticut Resource Conservation & Development Area, Inc. Available from www.ctplanningforagriculture.com.

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

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354.

How are Wetlands and Watercourse Defined in Connecticut? (n.d.) Connecticut Department of Energy and Environmental Protection. Accessed 12/30/15. http://www.ct.gov/deep/cwp/view.asp?a=2720&q=325684

"Hydrologic Unit Maps." *USGS Water Resources: About USGS Water Resources*. N.p., 9/02/2015. Web. 02 Feb. 2016.

List of Contaminated or Potentially Contaminated Sites. 7/27/2016. Connecticut Department of Energy and Environmental Protection Hartford, CT. Retrieved 1/22/14. http://www.ct.gov/deep/cwp/view.asp?a=2715&q=325018&deepNav_GID=1626

Listing of High, Significant, and Moderate Hazard Dam Owners and Dams in Connecticut (updated on December 30, 2013). Connecticut Department of Energy and Environmental Protection. Hartford, CT.

Local Historic District and Property Commissions in Connecticut, Sterling Hill Historic District. Connecticut Trust for Historic Preservation. 10/31/11. Accessed 1/07/16. Website: http://www.lhdct.org/district/sterling-hill-historic-district

National Menu of Stormwater Best Management Practices. 2012. US Environmental Protection Agency, Washington, DC. Retrieved 4/29/14. http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/

Planning for Agriculture, A Guide for Connecticut Municipalities. 2016 edition. American Farmland Trust, Wethersfield, CT., and Connecticut Conference of Municipalities, New Haven, CT. Available from www.ctplanningforagriculture.com .

Regional Councils of Governments (RCOGs) in Connecticut (n.d.). Connecticut Office of Policy and Management. Accessed 12/8/15 from http://www.ct.gov/opm/cwp/view.asp?q=383046. Regional Hazard Mitigation Plan. 2015. Northeastern Connecticut Council of Governments. Killingly, CT.

Schueler, Thomas, 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban Best Management Practices*. MWCOG. Washington, D.C.

Schueler, Thomas, 1994. The Importance of Imperviousness. Watershed Protection Techniques 1(3): 100-111.

Sharpley, A.N., T. Daniel, G. Gibson, L. Bundy, M. Cabrera, T. Sims, R. Stevens, J. Lemunyon, P. Kleinman, and R. Parry. Best Management Practices to Minimize Agricultural Phosphorus Impacts on Water Quality, July 2006. United States Department of Agriculture, Agricultural Research Service ARS–163.

Skinner, John F., Joseph Guzman, John Kappeler, 2010, July-August. Regrowth of Enterococci and Fecal Coliform in Biofilm, Stormwater Magazine, 28-34.

Sterling Inland Wetlands and Watercourses Regulations. 3/29/2012. Town of Sterling, CT.

Stormwater Management Plan, 2004. CT Department of Transportation. Retrieved 3/31/14. http://www.ct.gov/dot/cwp/view.asp?a=1383&q=386458.

Stormwater Program Cost Evaluation for Massachusetts. Technical Memorandum, January 18, 2016. WaterVision LLC.

The State of Low Impact Development in Connecticut: Policies, Drivers and Barriers. February 2016. Center for Landuse Education and Research, University of Connecticut, Storrs, CT.

Town of Plainfield Inland Wetlands and Watercourses Regulations. 11/13/12. Town of Plainfield, CT.

Town of Plainfield Plan of Conservation and Development 2008 – 2016. 8/12/08. Town of Plainfield, CT.

Town of Plainfield, Connecticut Planning and Zoning Commission Subdivision Regulations. 4/1/13. Town of Plainfield, CT.

Town of Plainfield, Connecticut Planning and Zoning Commission Zoning Regulations. 10/1/14. Town of Plainfield, CT.
Subdivision Regulations. 3/23/10. Sterling Planning Commission, Town of Sterling, CT.

Sterling 2009 Plan of Conservation and Development. June 2009. Town of Sterling, CT.

Soil Survey of the State of Connecticut. (n.d.). US Department of Agriculture Natural Resources Conservation Service. Washington, DC.

University of Connecticut Center for Land Use Education and Research. 2010 Connecticut Land Cover Data. 2011. Storrs, CT.

University of Connecticut Center for Land Use Education and Research, Connecticut's Changing Landscape project. 2008. Storrs, CT. http://clear.uconn.edu.

University of Connecticut, Connecticut Environmental Conditions Online, Farmland Soils, April 2011, accessed 12/30/15.
http://cteco.uconn.edu/guides/resource/CT_ECO_Resource_Guide_Soils_Farmland.pdf

US Department of Agriculture Natural Resources Conservation Service. Soils – Hydric Soils-Introduction. 2015. Accessed 12/30/15. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/?cid=nrcs142p2_053961

US Environmental Protection Agency. Antidegradation. USEPA website, October 5, 2015. Accessed 2.22.2013 from http://www.epa.gov/wqs-tech/key-concepts-module-4-antidegradation.

US Environmental Protection Agency. Clean Water Act Section 303(d) Webpage [Internet]. United States Environmental Protection Agency. [cited 2014/10/06]. Available from: http://water.epa.gov/type/watersheds/laws.cfm

US Forest Service, Ecological Subregions of the US, Chapter 16, Section 221A – Lower New England (n.d.), http://www.fs.fed.us/land/pubs/ecoregions/ch16.html, accessed 12-18-15.
Walker, Mark and Lynell Garfield, Dog Wastes and Water Quality: Evaluating the Connection at Lake Tahoe. University of Nevada Cooperative Extension Fact Sheet 08-18, 2008. Retrieved 3/5/14. http://www.unce.unr.edu/publications/files/nr/2008/fs0818.pdf.

Vision 2020 - The Next Ten Years. 2010. The Last Green Valley, Inc. Danielson, Connecticut 06239-0029

Wharton, Eric H., Richard H. Widmann, Carol L. Alerich, Charles J. Barnett, Andrew J. Lister, Tonya W. Lister, Don Smith, Fred Borman. The Forests of Connecticut. United States Department of Agriculture, Forest Service, Northeastern, Research Station, Resource Bulletin NE-160, April 2004.

Wilson, Emily and Chester Arnold, University of Connecticut Center for Landuse Education and Research, *Forest Fragmentation in Connecticut: 1985 – 2006*, September 2009. Website: http://clear.uconn.edu/projects/landscape/forestfrag/index.htm , accessed 1-05-16.

Zoning Regulations. 4/4/15. Sterling Planning and Zoning Commission, Town of Sterling, CT.

"2006/2007 Aerial Deer Survey Indicates Stable Deer Population." CT DEEP, Connecticut Wildlife, May/June 2007.

(This page intentionally left blank)

Appendix A

Ekonk Brook Sub-Regional Basin TMDL

(This page intentionally left blank)

A Total Maximum Daily Load Analysis for Recreational Uses of the Ekonk Brook Sub-Regional Basin

FINAL

This document has been established pursuant to the requirements of Section 303(d)of the Federal Clean Water Act

_/s/ Betsey Wingfield_____ _ 9/19/11___
Betsey Wingfield Date
Bureau Chief
Bureau of Water Protection and Land Reuse

/s/ Macky McCleary
Deputy Commissioner_____ _9/22/11____
Daniel Esty Date
Commissioner

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

TABLE OF CONTENTS

TABLES

APPENDICES

INTRODUCTION

The Total Maximum Daily Load (TMDL) analysis is a management tool used to restore impaired waters by establishing the maximum amount of a pollutant that a waterbody can receive without adverse impacts to fish, wildlife, recreation, or other public uses. A TMDL takes into account pollutant loadings from point sources, nonpoint sources, background levels and incorporates a margin of safety. The completed analysis provides guidance for responsible parties to use as a framework for developing an implementation plan to reduce pollutants in impaired waters.

A Total Maximum Daily Load (TMDL) analysis was completed for indicator bacteria in the Ekonk Brook Sub-Regional Basin (Figure 1 of Appendix A). This waterbody is included on the most recent *List of Connecticut Waterbodies Not Meeting Water Quality Standards* (Chapter 3 of the *2010 State of Connecticut Integrated Water Quality Report*[1]) due to exceedences of the indicator bacteria criteria contained within the State *Water Quality Standards*[2] (WQS). Under section 303(d) of the Federal Clean Water Act (CWA), States are required to develop TMDLs for waters impacted by pollutants that are included on their Impaired Waters Lists, and for which technology-based controls are insufficient to achieve water quality standards.

In general, the TMDL represents the maximum loading that a waterbody can receive without exceeding the water quality criteria, which have been adopted into the WQS for that parameter. Federal regulations specify that TMDL loadings may be expressed as a mass per time, toxicity, or other appropriate measure[3]. In this TMDL, loadings are expressed as the average percent reduction from current loadings that must be achieved to meet water quality standards. The U.S. Environmental Protection Agency's (EPA) most recent guidance recommends that all TMDLs and associated load allocations and wasteload allocations be expressed in terms of daily time increments[4]. The percent reduction TMDL for Ekonk Brook is applicable each and every day until recreational use goals are attained. Federal regulations require that the TMDL analysis identify the portion of the total loading which is allocated to point source discharges (termed the Wasteload Allocation or WLA) and the portion attributed to nonpoint sources (termed the Load Allocation or LA), which contribute that pollutant to the waterbody. In addition, TMDLs must include a Margin of Safety (MOS) to account for uncertainty in establishing the relationship between pollutant loadings and water quality. Seasonal variability in the relationship between pollutant loadings and WQS attainment is also considered in TMDL analysis.

The Ekonk Brook Sub-Regional Basin extends through the municipality of Plainfield with small areas of the watershed in Sterling and Voluntown. At this time these municipalities are not required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 permit) (see Appendix E). This general permit is applicable to municipalities that are identified in Appendix A of the MS4 permit, that contain designated urban areas and discharge stormwater via a separate storm sewer system to surface waters of the State. Sterling and Voluntown are exempt from this permit because they do not have any designated urban areas as defined by the U.S. Census Bureau [5]. Plainfield has designated urban areas, however the population within these areas is less than 1,000 people. The Connecticut Department of Energy and Environmental Protection (DEEP) has granted a waiver for Plainfield and other towns that meet that criteria; they are not required to register for the MS4 permit (Figure 2 of Appendix A). The MS4 permit requires municipalities to develop a

Stormwater Management Plan (SMP) to reduce the discharge of pollutants, as well as to protect water quality. The MS4 permit is discussed further in the "TMDL Implementation Guidance" section of this permit. Additional information regarding stormwater management and the MS4 permit can be obtained on DEEP's website (see Appendix E).

TMDLs that have been established by states are submitted to the EPA Regional Office for review. The EPA can either approve the TMDL or disapprove the TMDL and act in lieu of the State. TMDL analyses for indicator bacteria in the Ekonk Brook Sub-Regional Basin are provided herein. As required in a TMDL analysis, load allocations are determined, a margin of safety is included, and seasonal variation is considered. This document also includes recommendations for TMDL implementation as well as a water quality monitoring plan.

PRIORITY RANKING

Within the Integrated Water Quality Report (Table 3-8)[1], DEEP indentifies water body segments for which TMDLs are expected to be prepared in the near term. Waters are prioritized for TMDL development based on a variety of reasons such as threats to human health, the potential for a TMDL analysis to result in improved water quality, coordinating with or providing support to regulatory programs designed to improve water quality and comments received during the public review of the proposed 303(d) list. Changes may be made from this list based on data availability, the need to revise priorities to address additional water quality concerns or staff and other resource constraints.

Table 1. The impairment status and TMDL development priority for the Ekonk Brook Sub-Regional Basin based on the *2008 State of Connecticut Integrated Water Quality Report*[1]**.**

Waterbody Name	Waterbody Segment	Waterbody Segment Description	303(d) Listed	Impairment Use / Cause	Priority
Ekonk Brook Sub-Regional Basin (Sterling, Plainfield, Voluntown)	CT3503-00_01	From mouth at confluence with Moosup River (DS of River Street crossing), US to headwaters at Lockes Meadow Pond outlet dam, Plainfield.	Yes	Recreation / *Escherichia coli*	2011

DESCRIPTION OF THE WATERBODY

See "Site Specific Information" in Appendix B.

POLLUTANT OF CONCERN AND POLLUTANT SOURCES

Potential sources of indicator bacteria include point and nonpoint sources, such as stormwater runoff, agriculture, sanitary sewer overflows (collection system failures), illicit discharges and inappropriate discharges (powerwashing) to the waterbody. Potential sources that have been

tentatively identified based on land-use (Figure 3 of Appendix A) and site survey work for each of the waterbodies are presented in Table 2 below. However, the list of potential sources is general in nature and is not comprehensive. There may be other sources not listed here which contribute to the observed water quality impairment. More detailed evaluation of sources is expected to become available as activities are conducted to implement this TMDL.

Table 2. Potential sources of bacteria for the Ekonk Brook Sub-Regional Watershed.

Waterbody Name	Nonpoint Sources	Point Sources
Ekonk Brook	Failed Septic Systems, Residential, agricultural and urban runoff	Unregulated stormwater runoff, illicit connections to storm sewers, Animal waste

There are no facilities registered in the Industrial, Commercial or Construction Stormwater General Permit programs and there are no Underground Injection permits in the Ekonk Brook Sub-Regional Basin. There are numerous farms and agricultural fields in the basin that can be seen from aerial photos (figure 2 Appendix B) but they are not required to register for a permit or complete monitoring.

APPLICABLE SURFACE WATER QUALITY STANDARDS

Connecticut's WQS establish criteria for bacterial indicators of sanitary water quality that are based on protecting recreational uses such as swimming (both designated and non-designated swimming areas), kayaking, wading, water skiing, fishing, boating, aesthetic enjoyment and others. Indicator bacteria criteria are used as general indicators of sanitary quality based on the results of EPA research conducted in areas with known human fecal material contamination[6]. The EPA established a statistical correlation between levels of indicator bacteria and human illness rates, and set forth guidance for States to establish numerical criteria for indicator bacteria organisms so that recreational use of the water can occur with minimal health risks. However, it should be noted that the correlation between indicator bacteria densities and human illness rates varies greatly between sites and the presence of indicator bacteria does not necessarily indicate that human fecal material is present since indicator bacteria occur in all warm-blooded animals.

The applicable water quality criteria for indicator bacteria to the Ekonk Brook Sub-Regional Regional Basin are presented in Table 4. These criteria are applicable to all recreational uses established for these waters. However, it should be noted that the water quality classification and criteria should not be considered as a certification of quality by the State or an approval to engage in certain activities such as swimming. Full body contact should be avoided immediately downstream of wastewater treatment plants, in areas known to have high levels *E. coli*, and during times when *E. coli* levels are expected to be particularly high, such as during and following storm events. The general recreational criteria listed in the WQS for "all other recreational uses" are applicable throughout the watershed since there are no designated or non-designated swimming areas located in segments covered by the TMDL.

Table 3. Applicable indicator bacteria criteria for the subject waterbodies.

Waterbody Name	Waterbody Segment ID	Class	Bacterial Indicator	Criteria
Ekonk Brook Sub-Regional Basin (Plainfield, Voluntown, Sterling)	CT3503-00_01	A	*Escherichia coli* (*E. Coli*)	Geometric mean less than 126 col/100ml Single sample maximum 576 col/100ml

NUMERIC WATER QUALITY TARGET

TMDL calculations were performed consistent with the analytical procedures presented in the guidelines for *Development of TMDLs for Indicator Bacteria in Contact Recreation Areas Using the Cumulative Frequency Distribution Function Method*[7] included in Appendix D. All data used in the analysis and the results of all calculations are presented in Appendix B. In addition, Appendix B contains a summary of the TMDL analyses for the waterbody. The results are summarized in Table 4.

Table 4. Summary of TMDL analysis.

Waterbody Name	Waterbody Segment Description	Waterbody Segment	Monitoring Site	Average Percent Reduction to Meet Water Quality Standards			
				TMDL	WLA	LA	MOS
Ekonk Sub-Regional Basin (Plainfield, Voluntown, Sterling)	From mouth at confluence with Moosup River,(DS of River Street crossing), US to headwaters at Lockes Meadow Pond outlet dam, Plainfield.	CT3503-00_01	789	17	27	11	Implicit

MARGIN OF SAFETY

TMDL analyses are required to include a margin of safety (MOS) to account for uncertainties regarding the relationship between load and waste load allocations, and water quality. The MOS may be either explicit or implicit in the analysis.

The analytical approach used to calculate the TMDL incorporates an implicit MOS. Sampling results that indicate quality better than necessary to achieve consistency with the criteria are assigned a percent reduction of "zero" instead of a negative percent reduction. This creates an excess capacity that is averaged as a zero value thereby contributing to the implicit MOS. The indicator bacteria criteria used in this TMDL analysis were developed exclusively from data derived from studies conducted by EPA at high use designated public bathing areas with known

human fecal contamination[6]. Therefore, the criteria provide an additional level of protection when applied to waters not used as designated swimming areas or contaminated by human fecal material. As a result, achieving the criteria results in an "implicit MOS". Additional explanation concerning the implicit MOS incorporated into the analysis is provided in Appendix D.

SEASONAL ANALYSIS

Previous investigations by DEEP into seasonal trends of indicator bacteria densities in surface waters indicate that the summer months typically exhibit the highest densities of any season[8]. This phenomenon is likely due to the enhanced ability of indicator bacteria to survive in surface waters and sediment when ambient temperatures more closely approximate those of warm-blooded animals, from which the bacteria originate. In addition, resident wildlife populations are likely to be more active during the warmer months and more migratory species are present during the summer. These factors combine to make the summer, recreational period representative of "worst-case" conditions. Achieving consistency with the TMDLs through the summer months will result in achieving full support of recreational uses throughout the remainder of the year.

TMDL IMPLEMENTATION GUIDANCE

There are two major approaches to identifying and implementing changes within a watershed to address water quality impairments and incorporate the recommendations of the TMDL: management of stormwater under the stormwater permitting program and development of watershed based plans. The percent reductions established in this TMDL can be achieved by implementing control actions where technically and economically feasible that are designed to reduce *E. coli* loading from nonpoint sources (Load Allocation) and point sources (Waste Load Allocation).

DEEP advocates that a watershed based plan for the Ekonk Brook Basin be developed to implement the TMDL. The following guidance offers suggestions regarding BMP implementation, however the goal is to allow responsible parties flexibility in developing a TMDL implementation plan. DEEP supports an adaptive and iterative management approach where reasonable controls are implemented and water quality is monitored in order to evaluate for achievement of the TMDL goals and modification of controls as necessary.

The TMDLs establish a benchmark to measure the effectiveness of BMP implementation. Achievement of the TMDL is directly linked to incorporation of the provisions of the MS4 permit by municipalities, as well as the implementation of other BMPs to address nonpoint sources. Improper disposal of pet waste and waste from wildlife are potential nonpoint sources of bacteria in the Basin. Information on nuisance wildlife control and pet waste disposal can be found on DEEP website (see Appendix E). It is expected that as progress is made implementing BMPs, bacteria levels will decrease and the water quality criteria for recreational use will be achieved and maintained. For additional information on Source Control and Pollution Prevention please refer to Chapter 5 of DEEP's Stormwater Manual (see Appendix E). Some

point source discharges may be easier to control through identification and regulation, however some sources such as wildlife living in stormdrains or birds nesting under bridges could prove more difficult to control.

DEEP encourages the use of Low Impact Development (LID) techniques as a management measure that may address a variety of nonpoint source issues. LID is a site design strategy intended to maintain or replicate predevelopment hydrology through the use of small-scale controls integrated throughout the site to manage stormwater runoff as close to its source as possible. Infiltration of stormwater through LID helps to remove sediments, nutrients, heavy metals, and other types of pollutants from runoff. Examples of these recommendations can be found in Connecticut's approved watershed based plans (see Appendix E).

It is important to note that the TMDLs are applicable to the entire watershed because they are a measurement of compounded impacts at a single point. As such, corrective actions must be undertaken at the source(s) throughout the watershed whether it is a tributary or illicit discharge pipe, in order to achieve the required percent reductions. Also, the approach to TMDL implementation is anticipated to be on a watershed wide scale, which will require that all sources within the regional basin that are contributing to the in-stream impairment be addressed. Action may be taken by State and Local government, business, academia, volunteer citizens groups, and individuals to promote effective watershed management.

Stormwater Permits

Potential point sources to Ekonk Brook and its tributaries include unregulated stormwater. There are no registered point source stormwater discharges to the Ekonk Sub-Regional Basin and the towns in this basin are not covered under the MS4 permit at this time. Plainfield, as a town with a population less than 1,000 in the Urbanized Area, is not required to register under the MS4 Permit but may be required to register in the future. Under this permit, municipalities are required to implement minimum control measures in their Stormwater Management Plan (SMP) to reduce the discharge of pollutants, protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act. The six minimum control measures are:

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control (>1 acre)
- Post-construction Runoff Control
- Pollution Prevention/Good Housekeeping

The minimum control measures include a number of Best Management Practices (BMP) for which an implementation schedule must be developed and submitted to DEEP as Part B Registration. Under the MS4 permit, all minimum control measures must be implemented by January 8, 2009. Each regulated municipality must identify, implement, and assess the effectiveness of measures utilized to comply with SMP requirements. Information regarding Connecticut's MS4 permit can be found on DEEP's website (see Appendix E). In addition, the EPA has developed fact sheets, which provide an overview of the Phase II final rule and MS4

permit, and provide detail regarding the minimum control measures, as well as optional BMPs not required in Connecticut's MS4 permit. The fact sheets can be found on the EPA's website (see Appendix E). Some of the information includes guidance for the development and implementation of Stormwater Management Plans, as well as guidance for establishing measurable goals for BMP implementation.

Upon approval of a TMDL by EPA, Section 6(k) of the MS4 Permit requires the municipality to review its SMP to determine if its stormwater discharges contribute the pollutant(s) for which the TMDL had been designated. If the municipality contributes a pollutant(s) in excess of the designated TMDL allocation, the municipality must modify its SMP to implement the TMDL within four months of TMDL approval by EPA. For the discharges to the TMDL waterbody(ies), the municipality must assess the six minimum measures of its SMP and modify the plan to implement additional necessary controls for each appropriate measure. Particular focus should be placed on the following plan components: public education program, illicit discharge detection and elimination, stormwater structures cleaning, priority for the repair, upgrade, or retrofit of storm sewer structures.

Watershed Based Plans

One approach to TMDL implementation would be to develop a watershed based plan for the Ekonk Brook Sub-Regional Basin. A watershed based plan formulated at the local level will most efficiently make use of local resources by assigning tasks to responsible parties and serving as an agreed roadmap to reducing bacteria levels in the Basin. DEEP encourages all local stakeholders to continue their efforts by working together to formulate a watershed based plan to implement the TMDL.

Watershed Based Plans funded under the Clean Water Act Section 319 grant program require incorporation of EPA's 9 Planning Elements (see Appendix E). Identification of impairments, load reduction, management measures, technical and financial assistance, public information and education, schedule, milestones, performance and monitoring. The Watershed Based Plan should include a flexible schedule and future implementation of management measures recommended to reduce nonpoint source pollution within the watershed. In some cases, implementation efforts included in the Section 319 funded Watershed Based Plan and the TMDL may be scheduled and coordinated together.

Members of DEEP's Watershed Management Program will continue to provide technical and educational assistance to the local municipalities and other stakeholders, as well as identify potential funding sources, when available, for implementation of the TMDL and monitoring plan. Please see Appendix E for a link to contact information for involved DEEP staff .

WATER QUALITY MONITORING PLAN

A comprehensive water quality monitoring program is necessary to guide TMDL implementation efforts and should be designed, at a minimum, to accomplish two major objectives; source detection and tracking water quality improvements. Monitoring is needed to

identify specific sources of bacterial loading which will, in turn, direct BMP implementation efforts. As changes are made within the watershed and BMPs applied, additional monitoring is needed to quantify progress in achieving TMDL established goals.

Water quality monitoring can be incorporated into any implementation activity, however, it is explicitly required under the MS4 permit. Stormwater monitoring is required under Section 6(h)(1)(A) of the MS4 Permit which specifies the following monitoring requirement:

> *"Stormwater monitoring shall be conducted by the Regulated Small MS4 annually starting in 2004. At least two outfalls apiece shall be monitored from areas of primarily industrial development, commercial development and residential development, respectively, for a total of six (6) outfalls monitored. Each monitored outfall shall be selected based on an evaluation by the MS4 that the drainage area of such outfall is representative of the overall nature of its respective land use type."*

This type of monitoring may be referred to as event monitoring because it is scheduled to coincide with a stormwater runoff event. Event monitoring can present numerous logistical difficulties for municipalities and may not be the most efficient way to measure progress in achieving water quality standards. This is particularly true for streams draining urbanized watersheds where many sources contribute to excursions above water quality criteria.

However, a comprehensive water quality monitoring program is necessary to guide TMDL implementation efforts. Therefore, the monitoring program should be designed to accomplish two objectives; source detection to identify specific sources of bacterial loading and direct BMP implementation efforts with fixed station monitoring to quantify progress in achieving TMDL established goals. In order to customize their monitoring plan to better identify TMDL pollutant sources and track the effectiveness of TMDL pollutant reduction measures, the municipality may request written approval from DEEP for an alternative monitoring program as allowed by Section 6(h)(1)(B) of the permit:

> *"The municipality may submit a request to the Commissioner in writing for implementation of an alternate sampling plan of equivalent or greater scope. The Commissioner will approve or deny such a request in writing."*

DEEP advises municipalities with discharges that contribute pollutant(s) for which a TMDL(s) has been designated to request approval for an alternative monitoring program to address both source detection and track the effectiveness of TMDL pollutant reduction measures. Source detection monitoring may include visual inspection of storm sewer outfalls under dry weather conditions, event sampling of individual storm sewer outfalls, and monitoring of ambient in-stream conditions at closely spaced intervals to identify "hot spots" for more detailed investigations leading to specific sources of high bacteria loads. Such monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. Further guidance for alternative municipal monitoring is attached as Appendix C.

Progress in achieving TMDL established goals through BMP implementation may be most effectively gauged through implementing a fixed station ambient monitoring program. DEEP

strongly recommends that routine monitoring be performed at the same sites used to generate the data to perform the TMDL calculations. Sampling should be scheduled at regularly spaced intervals during the recreational season (May 1- Sept 30). In this way the data set at the end of each season will include ambient values for both "wet" and "dry" conditions in relative proportion to the number of "wet" and "dry" days that occurred during that period. As additional data is generated over time it will be possible to repeat the TMDL calculations and compare the percent reductions needed under "dry" and "wet" conditions to the percent reductions needed at the time of TMDL adoption.

All pollutant parameters must be analyzed using methods prescribed in the Code of Federal Regulations[9]. Electronic submission of data to DEEP is highly encouraged. Results of monitoring that indicate unusually high levels of contamination or potentially illegal activities should be forwarded to the appropriate municipal or State agency for follow-up investigation and enforcement. Consistent with the requirements of the MS4 permit, the following parameters should be included in any monitoring program:

pH (SU)
Hardness (mg/l)
Conductivity (umos)
Oil and grease (mg/l)
Chemical Oxygen Demand (mg/l)
Turbidity (NTU)
Total Suspended Solids (mg/l)
Total Phosphorous (mg/l)
Ammonia (mg/l)
Total Kjeldahl Nitrogen (mg/l)
Nitrate plus Nitrite Nitrogen (mg/l)
E. coli (col/100ml)
Precipitation (in)

DEEP is committed to providing technical assistance in monitoring program design and establishing procedures for electronic data submission.

REASONABLE ASSURANCE

The MS4 Permit is a legally enforceable document that provides reasonable assurance that the municipalities will take steps towards achieving the target TMDL and reducing point sources of stormwater containing bacteria. If portions of a watershed are not subject to the Connecticut's MS4 Permit Program, DEEP has the authority to include those additional municipally-owned or municipally-operated Small MS4s located outside an Urbanized Area as may be designated by the Commissioner. This option could be pursued if future monitoring indicates non-attainment of recreational goals in the Ekonk Brook Sub-Regional Basin.

In addition, DEEP continues to work with watershed stakeholders to draft Watershed Based Management Plans (WBMPs) under the CWA 319 program (see Appendix E). As part of these

WBMPs, watershed stakeholders are required to investigate impairments and promote the implementation of nonpoint source pollution best management practices and stormwater management practices in the watershed. DEEP approves CWA 319 Watershed Based Plans, including those that address management measures to reduce bacteria and source mitigation in order to support the TMDLs. WBMPs include watershed-wide and place-based recommendations aimed at reducing nonpoint sources of pollution, including bacteria. These recommended WBMP projects may be eligible for CWA 319 funding, as long as such projects are not used for permit compliance.

PROVISIONS FOR REVISING THE TMDL

DEEP reserves the authority to modify the TMDL as needed to account for new information made available during the implementation of the TMDL. Modification of the TMDL will only be made following an opportunity for public participation and will be subject to the review and approval of the EPA. New information, which will be generated during TMDL implementation, includes monitoring data, new or revised State or Federal regulations adopted pursuant to Section 303(d) of the Clean Water Act, and the publication by EPA of national or regional guidance relevant to the implementation of the TMDL program. DEEP will propose modifications to the TMDL analyses only in the event that a review of the new information indicates that such a modification is warranted and is consistent with the anti-degradation provisions in Connecticut Water Quality Standards. The subject waterbodies of this TMDL analysis will continue to be included on the *List of Connecticut Waterbodies Not Meeting Water Quality Standards* until monitoring data confirms that recreation use is fully supported.

PUBLIC PARTICIPATION

This TMDL document will be public noticed for review and comment by the general public. It is expected that open forums will continue as implementation of the TMDL occurs.

Connecticut Department of Energy and Environmental Protection
Bureau of Water Protection and Land Reuse
Planning and Standards Division
79 Elm St
Hartford, CT 06106

REFERENCES

1 – Connecticut Department of Environmental Protection, 2010. Table 3-2: List of Connecticut Water bodies Not Meeting Water Quality Standards. In: *Integrated Water Quality Report to Congress. Bureau of Water Protection and Land Reuse*, 79 Elm Street, Hartford, CT 06106-5127.

2 - Connecticut Department of Environmental Protection, 2011 *Connecticut Water Quality Standards*. Bureau of Water Management, 79 Elm Street, Hartford, CT.

3 - Code of Federal Regulations, Title 40, CFR, section 130.2(i).

4 – United States Environmental Protection Agency. November 15, 2006 memorandum. *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No.05-5015, (April 25, 2006) and Implications for NPDES Permits*.

5 - U.S. Census Bureau, March 2002. www.census.gov/geo/www/ua/ua_2k.html.

6 - United States Environmental Protection Agency, 1986. *Ambient Water Quality Criteria for Bacteria -1986.* EPA 440/5-84-002.

7 - Connecticut Department of Environmental Protection, 2005. *Development of Total Maximum Daily Loads (TMDLs) for Indicator Bacteria in Contact Recreation Areas Using the Cumulative Distribution Function Method*. Bureau of Water Management, 79 Elm Street, Hartford, CT.

8 - Connecticut Department of Environmental Protection, 2002. *Water Quality Summary Report for Sasco Brook, Mill River, Rooster River, Fairfield County Connecticut*. November 2002. Bureau of Water Management, 79 Elm Street, Hartford, CT.

9 - Code of Federal Regulations, Title 40, CFR, Part 136.

Appendix A. Regional Basin Maps

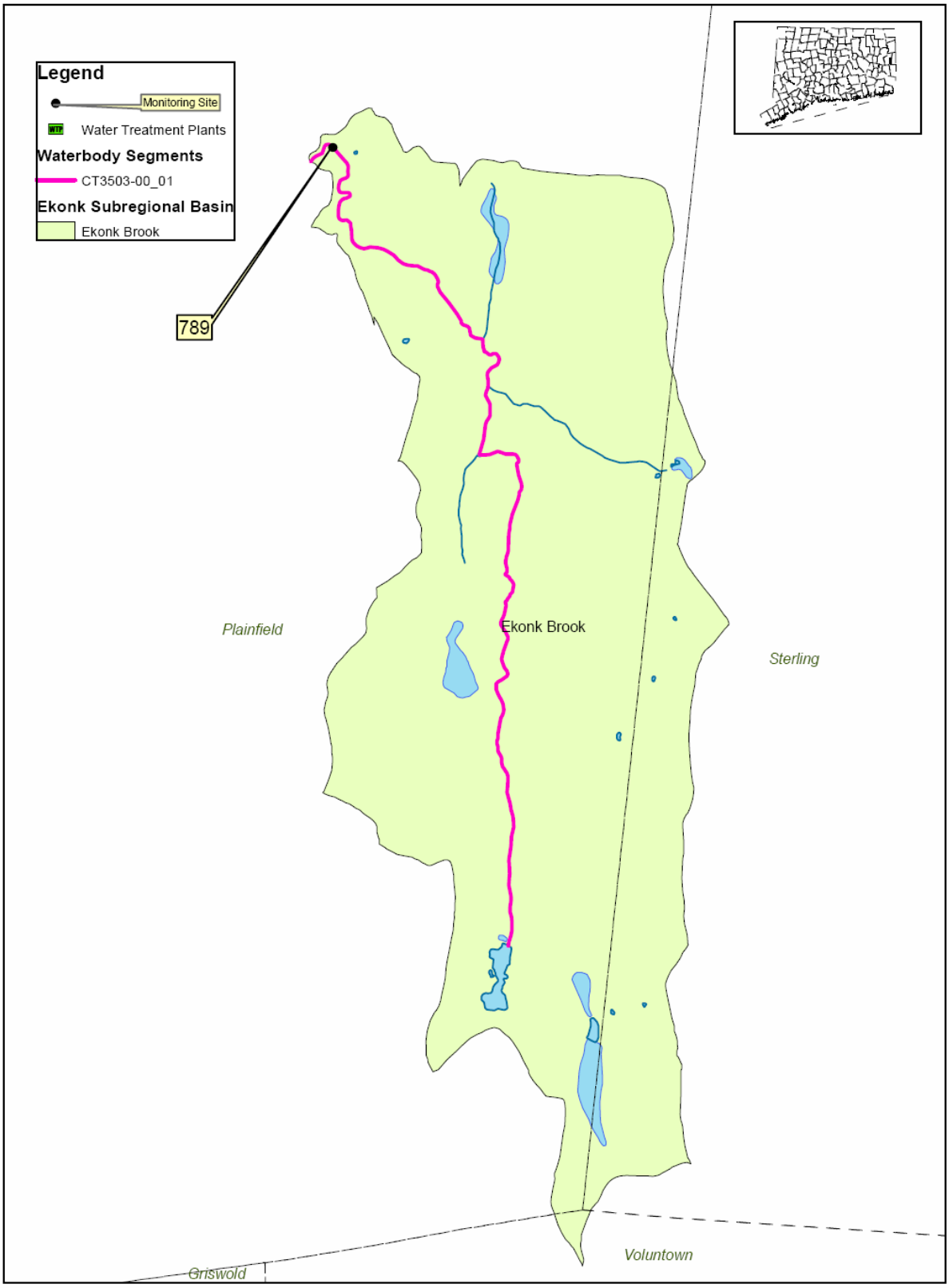


Figure 1: Ekonk Brook Regional Basin Location Map

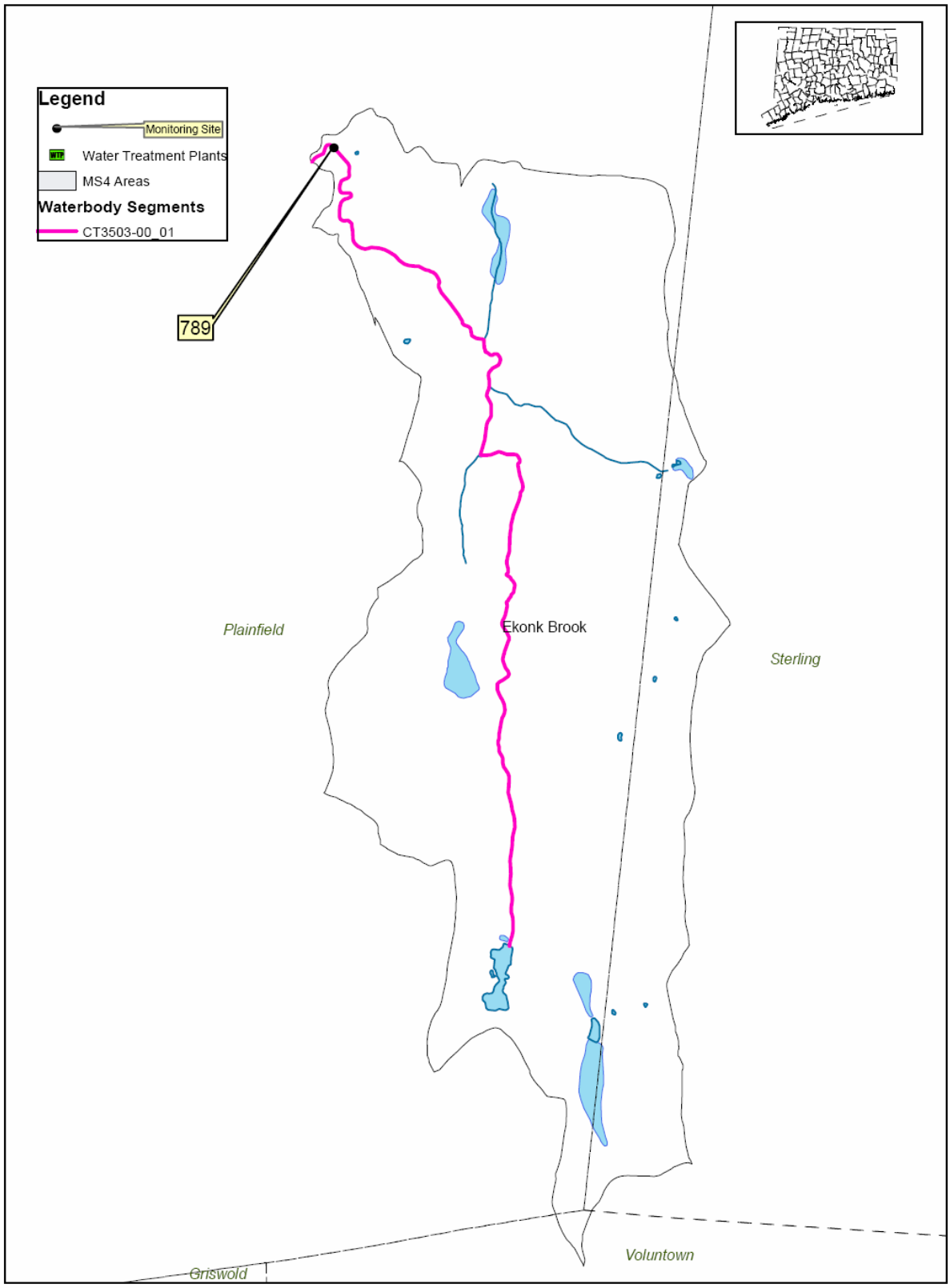


Figure 2: Ekonk Brook Regional Basin Designated MS4 Map

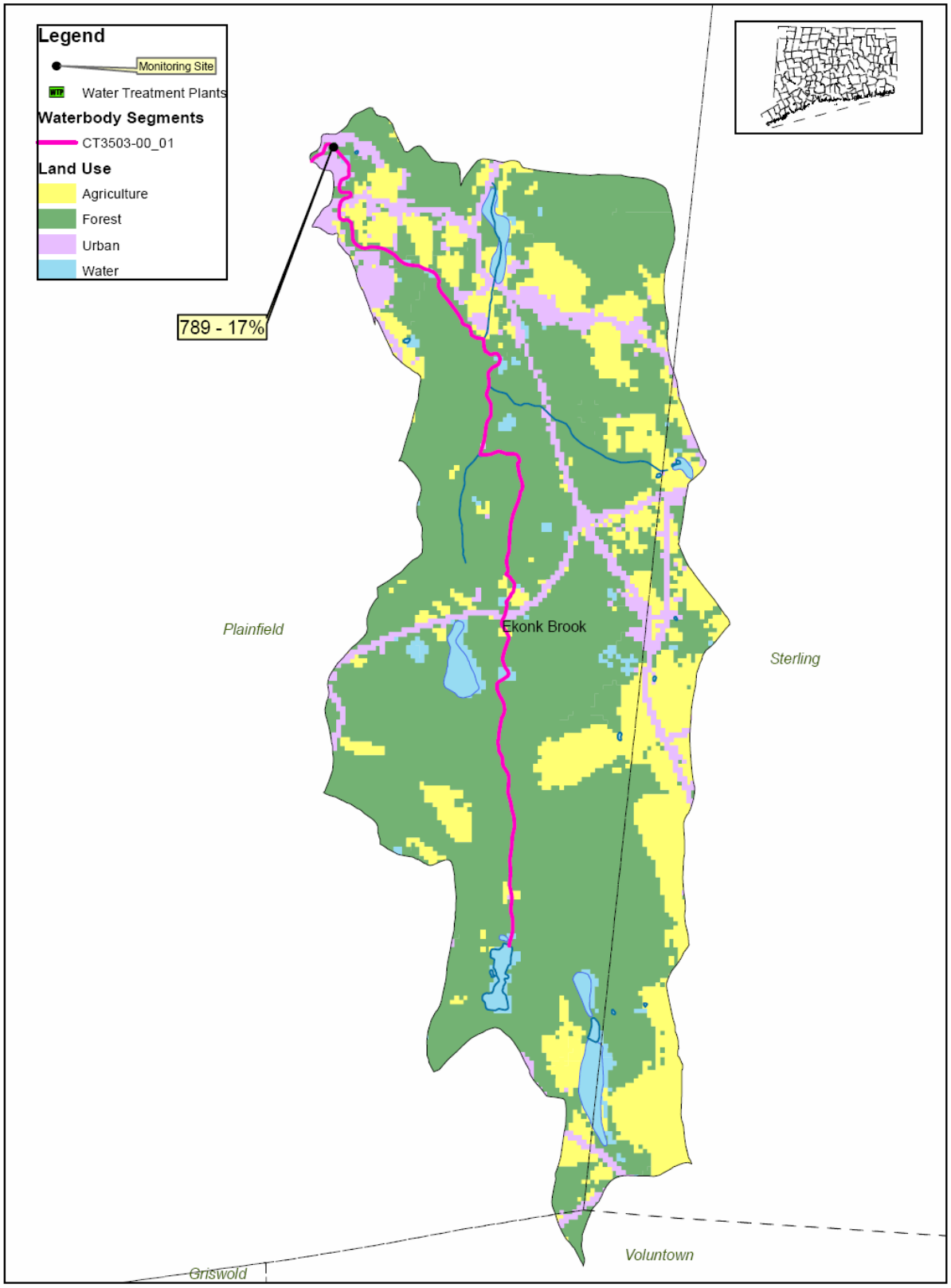


Figure 3: Ekonk Brook Regional Basin Land Use and TMDL % Reduction Map

Appendix B. Site Specific Information and TMDL Calculations

Ekonk Brook Sub-Regional Basin
Waterbody Specific Information

Impaired Waterbody
Waterbody Name: Ekonk Brook Sub-Regional Basin
Waterbody Segment IDs: CT3503-00_01
Waterbody Description: From mouth at confluence with Moosup River (DS of River Street crossing), US to headwaters at Lockes Meadow Pond outlet dam, Plainfield.
Waterbody Segment Size: 4.5 miles

Impairment Description:
Designated Use Impairment: Recreation
Surface Water Classification: Class A

Watershed Description:
Total Drainage Basin Area: 3409.75 acres
Subregional Basin Name & Code: Ekonk Brook Sub-Regional Basin, 3503
Regional Basin: Moosup Regional Basin
Major Basin: Thames Major Basin
Watershed Towns: Plainfield, Voluntown, Sterling
MS4 applicable? No
Applicable Season: Recreation Season (May 1 to September 30)
Sub-Regional Basin Land Use*:

Land Cover Category	Percent Composition
Agriculture	20% (698 acres)
Forest	70% (2380 acres)
Urban	7% (243 acres)
Water	3% (89 acres)

*Data Source: 2002 Land Cover, CLEAR - Center for Land Use Education and Research.

Ekonk Brook

CT3503-00_01

Data Used in the Analysis

Monitoring Site: 789, Between buildings 6 & 7 at condos

Date	Precip.(in)[1] 24h	48h	96h	Condition[2] (WET/DRY)	E. coli (col./100 ml)	Rank	Proportion	Criteria Value	% Reduction
6/6/2007	0.00	0.00	1.07	DRY	130	17.0	0.4857	122	6
6/13/2007	0.00	0.01	0.02	DRY	260	23.0	0.6571	183	30
6/20/2007	0.02	0.02	0.02	DRY	120	14.0	0.4000	100	17
7/11/2007	0.00	0.00	0.00	DRY	31	4.5	0.1286	44	0
7/19/2007	0.72	1.00	1.01	**WET**	270	25.0	0.7143	212	21
7/26/2007	0.01	0.01	0.13	DRY	150	20.0	0.5714	149	1
8/9/2007	0.00	0.45	0.45	**WET**	320	28.0	0.8000	274	15
8/23/2007	0.00	0.00	0.13	DRY	10	1.5	0.0429	26	0
9/4/2007	0.00	0.00	0.00	DRY	52	9.0	0.2571	69	0
9/12/2007	0.00	1.84	1.84	**WET**	3700	34.0	0.9714	576	84
6/4/2008	0.31	0.31	0.32	**WET**	140	19.0	0.5429	139	1
6/11/2008	0.00	0.06	0.44	DRY	96	10.0	0.2857	75	22
6/19/2008	0.01	0.12	0.24	DRY	320	28.0	0.8000	274	15
6/25/2008	0.00	0.05	0.09	DRY	41	7.0	0.2000	58	0
7/2/2008	0.00	0.00	0.05	DRY	1100	32.0	0.9143	444	60
7/9/2008	0.00	0.00	0.00	DRY	130	17.0	0.4857	122	6
7/16/2008	0.00	0.00	0.49	DRY	110	12.0	0.3429	87	21
7/23/2008	0.98	1.05	1.23	**WET**	370	31.0	0.8857	382	0
7/30/2008	0.00	0.01	0.87	DRY	41	7.0	0.2000	58	0
8/6/2008	0.39	0.39	0.40	**WET**	5800	35.0	1.0000	576	90
8/13/2008	0.00	0.03	0.34	DRY	98	11.0	0.3143	81	18
8/21/2008	0.01	0.01	0.02	DRY	130	17.0	0.4857	122	6
6/3/2009	0.03	0.03	0.06	DRY	120	14.0	0.4000	100	17
6/11/2009	0.21	0.24	0.76	**WET**	270	25.0	0.7143	212	21
6/25/2009	0.01	0.03	0.04	DRY	360	30.0	0.8571	337	6
7/1/2009	0.23	0.23	0.31	**WET**	1400	33.0	0.9429	540	61
7/9/2009	0.00	0.51	0.98	**WET**	160	21.0	0.6000	159	1
7/16/2009	0.16	0.17	0.17	**WET**	320	28.0	0.8000	274	15
7/23/2009	0.98	1.00	1.37	**WET**	31	4.5	0.1286	44	0
7/29/2009	0.30	0.30	0.69	**WET**	270	22.0	0.6286	170	37
7/29/2009	0.30	0.30	0.69	**WET**	200	25.0	0.7143	212	0
8/6/2009	0.00	0.00	0.01	DRY	41	7.0	0.2000	58	0
8/13/2009	0.04	0.04	0.35	DRY	120	14.0	0.4000	100	17
8/20/2009	0.00	0.00	0.00	DRY	10	1.5	0.0429	26	0
8/20/2009	0.00	0.00	0.00	DRY	30	3.0	0.0857	36	0

Statistics

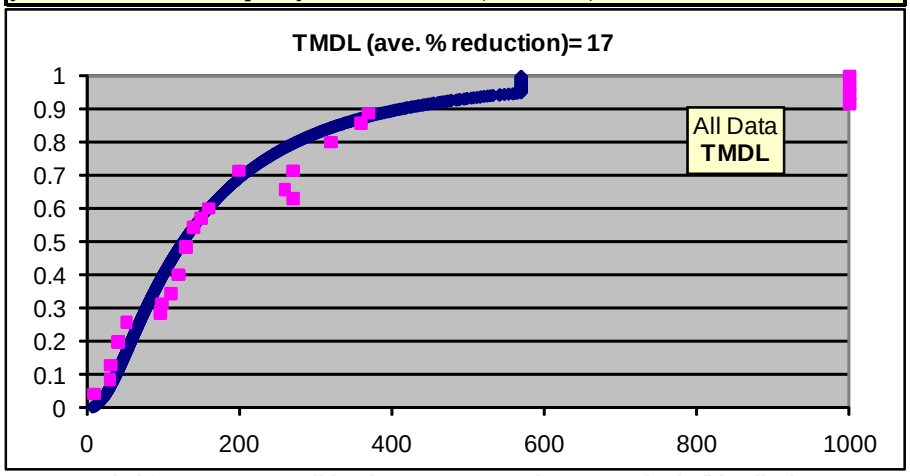
# Samples DRY	**22**
# Samples WET	**13**
# Samples Total	**35**
Geomean	**151**
Log std deviation	**0.6070**

Avg % Reduction

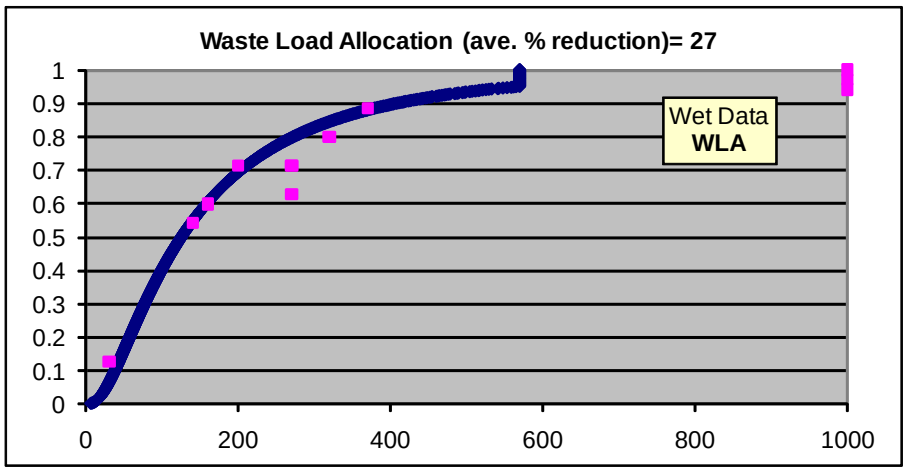
Wet (WLA)	**27**
Dry (LA)	**11**
Total (TMDL)	**17**

Precipitation data provided by NOAA and Weather underground. E.coli data provided by DEEP. **WET** Condition defined as greater than 0.1" precipitation in 24 hours or 0.25" precipitation in 48 hours, or 2.0" precipitation in 96 hours.

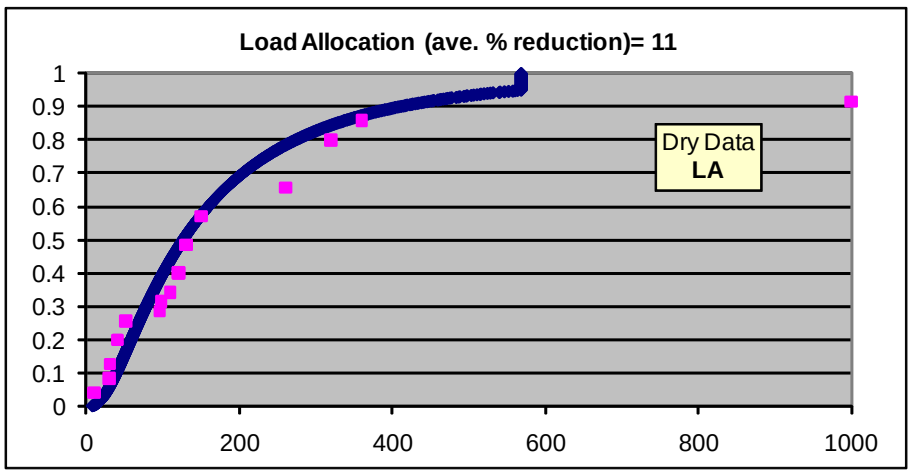
Criteria Curve for Monitoring Site 789
y axis = cumulative frequency; x axis = *E.coli* (col/100mL)



TMDL needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry and wet weather data.



Waste Load Allocation (WLA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on wet weather data.



Load Allocation (LA) needed from current condition (magenta squares) to meet criteria (blue line). Current condition based on dry weather data.

Ekonk Brook Sub-Regional Basin
TMDL Summary

The TMDL analysis for the Ekonk Brook Sub-Regional Basin was conducted at one representative site, site 789 (figure 1). This site is influenced by sources of bacteria active under both wet weather and dry weather conditions. Generally, percent reductions for wet weather conditions were found to be slightly higher than dry weather conditions. Reductions in the Waste Load Allocation (WLA) can be achieved through the detection and elimination of illicit discharges to the storm sewers and the upgrade of failed sanitary infrastructure. The WLA also includes unregulated municipal and industrial stormwater and can be further reduced by the installation of engineered controls to minimize the surge of stormwater to the river, promote groundwater recharge, and improve water quality will also reduce inputs of bacteria to the river. Since illicit discharges and failed sanitary collection systems may also be active at some sites during dry conditions, it is likely that corrective actions aimed at eliminating these sources will also reduce the Load Allocation (LA). Other contributors to the LA include domestic animal waste, wildlife, and stormwater input as sheet flow.

Figure 1: Station 789 in the Ekonk Brook Sub-Regional Basin. Map available at www.Bing.com

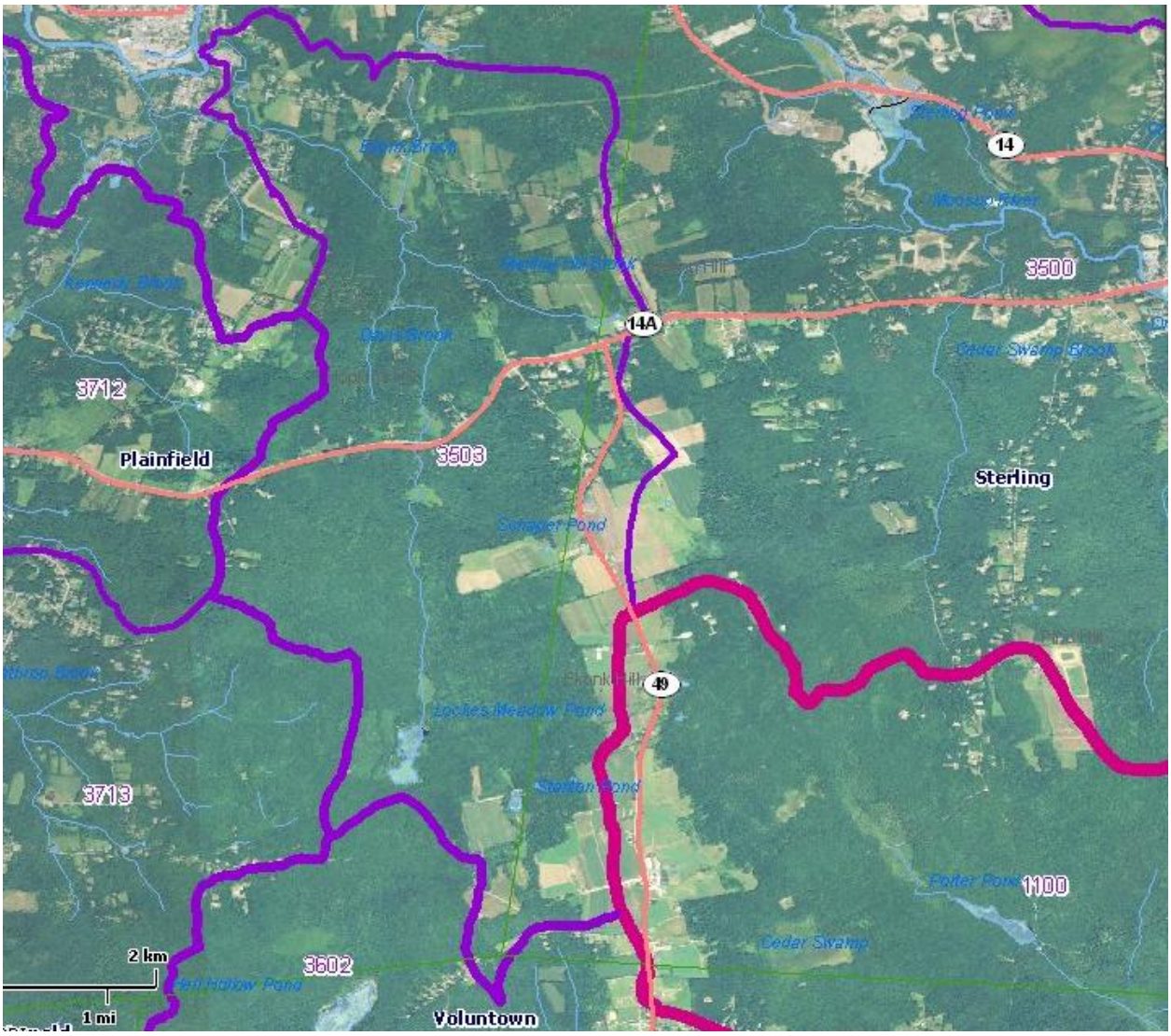


Figure 2: Aerial photo of the Ekonk Sub-Regional Basin (3503) from 2008, available from DEEP. Although the majority of this basin is forested land, this photo shows the patchwork of farms in this basin.

Appendix C. Municipal Stormwater alternative monitoring guidance

Guidance for Implementing Bacteria-based TMDLs within DEEP Stormwater Permitting Program

DEEP investigates impaired waterbodies to determine the major causes of impairment. This information is expressed as Total Maximum Daily Load (TMDL). TMDLs provide the framework for restoring impaired waters by establishing the maximum amount of a pollutant that a waterbody can take in without adverse impact to fish, wildlife, recreation, or other public uses. If a TMDL includes requirements for control of stormwater discharges it is the responsibility of the municipalities within the watershed to implement the recommendations of the TMDL (typically bacteria reduction). Management of stormwater quality within the municipality is governed by the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 General Permit).

The MS4 General Permit is required for any municipality with urbanized areas that initiates, creates, originates or maintains any discharge of stormwater from a storm sewer system to waters of the state. The MS4 permit requires towns to design a Stormwater Management Plan (SMP) to reduce the discharge of pollutants in stormwater to improve water quality. The plan must address the following 6 minimum measures.

1. Public Education and Outreach.
2. Public Involvement/Participation.
3. Illicit discharge detection and elimination.
4. Construction site stormwater runoff control.
5. Post-construction stormwater management in the new development and redevelopment.
6. Pollution prevention/good housekeeping for municipal operations.

Section 6(k) of the MS4 General Permit requires a municipality to modify their Stormwater Management Plan to implement the TMDL within 4 months of TMDL approval by EPA if stormwater within the municipality contributes pollutant(s) in excess of the allocation established within the TMDL. For the discharges to the TMDL waterbody(ies), the municipality must assess the six minimum measures of its plan and modify the plan to implement additional, necessary controls for each appropriate measure. Particular focus should be placed on the following plan components: public education program, illicit discharge detection and elimination, stormwater structures cleaning, priority for the repair, upgrade, or retrofit of storm sewer structures. The goal of the modifications is to establish a program to improve water quality consistent with the requirements of the TMDL. Modifications to the Stormwater Management Plan in response to TMDL development should be submitted to the Stormwater Program of DEEP for review and approval.

Also required under the MS4 General Permit is annual stormwater monitoring. The permit provides a general framework for monitoring stormwater quality within a municipality. At minimum, stormwater from six sample locations are to be collected annually: two outfalls from commercial areas, two from industrial areas, and two from residential areas. These six sample locations are point source discharges that drain areas with distinct characteristics. Each

stormwater sample is tested for 12 parameters using methods prescribed in Title 40, CFR, Part 136.

pH (SU)	Total Suspended Solids (mg/l)
Hardness (mg/l)	Total Phosphorous (mg/l)
Conductivity (umos)	Ammonia (mg/l)
Oil and grease (mg/l)	Total Kjeldahl Nitrogen (mg/l)
Chemical Oxygen Demand (mg/l)	Nitrate plus Nitrite Nitrogen (mg/l)
Turbidity (NTU)	E. coli (col/100ml)

However, DEEP encourages municipalities affected by the establishment of a TMDL to develop an alternative stormwater monitoring plan to assess progress in meeting the goals of the TMDL. Alternate monitoring programs are established in accordance with Section 6(h)(1)(B) of the MS4 permit which allows towns to submit written requests to the Commissioner for the review and approval of alternate stormwater monitoring plans of equivalent or greater scope. This gives towns freedom to develop a plan that better assesses the stormwater quality in their watershed. The monitoring program should be designed to accomplish two objectives; source detection to identify specific sources of bacterial loading and direct BMP implementation efforts with fixed station monitoring to quantify progress in achieving TMDL established goals. Monitoring may be performed by municipal staff, citizen volunteers, or contracted to an environmental consulting firm. In order to secure DEEP approval, the program must include sampling to address both objectives (source detection and progress quantification). Source detection monitoring may include such activities as visual inspection of storm sewer outfalls under dry weather conditions, event sampling of individual storm sewer outfalls, and monitoring of ambient (in-stream) conditions at closely spaced intervals to identify "hot spots" for more detailed investigations leading to specific sources of high bacteria loads.

DEEP strongly recommends that stream monitoring be performed at the same locations DEEP sampled during TMDL development. Samples should also be collected at other key locations within the watershed, such as above and below potential contributing sources or areas slated for BMP implementation. Since watershed borders and TMDLs do not follow town borders there is a possibility DEEP did not sample locations in your town. If this is the case collecting a sample where the waterbody enters your town and another where the waterbody leaves your town maybe helpful to determine how stormwater from your town influences water quality. In all cases, sampling should be scheduled at regularly spaced intervals during the recreational season. In this way, the data set at the end of each season will include ambient values for both "wet" and "dry" conditions.

Appendix D. Cumulative Frequency Distribution Function Method

DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR INDICATOR BACTERIA IN CONTACT RECREATION AREAS USING THE CUMULATIVE FREQUENCY DISTRIBUTION FUNCTION METHOD

Lee E. Dunbar, Assistant Director
Mary E. Becker, Environmental Analyst
CT Department of Environmental Protection
Total Maximum Daily Load Program

Last revised: November 8, 2005

OVERVIEW OF APPROACH

The analytical methodology presented in this document provides a defensible scientific and technical basis for establishing TMDLs to address recreational use impairments in surface waters. Representative ambient water quality monitoring data for a minimum of 21 sampling dates during the recreational season (May 1 – September 30) is required for the analysis. The reduction in bacteria density from current levels needed to achieve consistency with the criteria is quantified by calculating the difference between the cumulative relative frequency of the sample data set and the criteria adopted by Connecticut to support recreational use. Connecticut's adopted water quality criteria for indicator bacteria (*Escherichia coli*) are represented by a statistical distribution of the geometric mean 126 and log standard deviation 0.4 for purposes of the TMDL calculations.

TMDLs developed using this approach are expressed as the average percentage reduction from current conditions required to achieve consistency with criteria. The procedure partitions the TMDL into wet weather allocation and dry weather allocation components by quantifying the contribution of ambient monitoring data collected during periods of high stormwater influence and minimal stormwater influence to the current condition. The partition is used to determine the effect of high stormwater influence on the contribution of sources to the waterbody. TMDLs developed using this analytical approach provide an ambient monitoring benchmark ideally suited for quantifying progress in achieving water quality goals as a result of TMDL implementation.

APPLICABILITY

The methodology is intended solely for use in developing TMDLs for waters that are identified as impaired on the *List of Connecticut Water Bodies Not Meeting Water Quality Standards* [1]. It is expected that implementation of these TMDLs will be accomplished through implementing the provisions of the Small Municipal Separate Storm Sewer System general permit (MS4 permit) [2] in designated urban areas, as well as through measures that address non-point sources. The method as described here is not intended for use as an assessment tool for purposes of identifying use attainment status relative to listing or delisting of waterbody segments pursuant to Section 303(d) of the federal Clean Water Act. Assessment of use support is performed in accordance with the Department's guidance document, *Connecticut Consolidated Assessment and Listing Methodology (CT-CALM)* [3].

BACKGROUND

TMDLs are established by the State in accordance with the requirements established in the federal Clean Water Act. Section 303(d) of the Act requires the State to perform an assessment of waters within the State relative to their ability to support designated uses including recreational use. The procedure used by the Department to assess use attainment is described in the guidance document, *CT-CALM* [3]. The list of waterbody segments in Connecticut that do not currently support recreational use is updated to incorporate the most recent monitoring information by the Department every two years. As a result of this process, waterbodies may be added to or deleted from the list of impaired waters in accordance with the *CT-CALM* guidance. Once complete, the list is submitted to the Regional office of the federal EPA for approval. Section 303(d) of the Act requires the State to establish TMDLs for each pollutant contributing to the impairment of each waterbody segment identified on the list.

WATER QUALITY CRITERIA FOR INDICATOR BACTERIA

Connecticut's adopted water quality criteria for the indicator bacteria *Escherichia coli (E.coli)* in the CT Water Quality Standards [4] include a geometric mean and upper confidence limit (i.e. single sample maximum), which are based on three recreational use categories. The categories include designated swimming, non-designated swimming, and all other recreational uses. 'Designated swimming' includes areas that have been designated by State or Local authorities. 'Non-designated swimming' includes waters suitable for swimming but have not been designated by State or Local authorities, as well as water that support recreational activities where full body contact is likely, such as tubing or water skiing. 'All other recreational uses' include waters that support recreational activities where full body contact is infrequent, such as fishing, boating, kayaking, and wading. The recreational uses and applicable criteria are provided in the following table.

Recreational Use Category	Indicator Bacteria	Geometric Mean	Single Sample Maximum Upper Confidence Limit
Designated Swimming	*E.coli*	126col/100mls	235col/100mls 75th Percentile
Non-designated Swimming			410col/100mls 90th Percentile
All Other Recreational Uses			576col/100mls 95th Percentile

Table 1. Applicable indicator bacteria (*E.coli*) water quality criteria for recreational uses

The indicator bacteria, *E. coli*, is not pathogenic, rather its presence in water is an indicator of contamination with fecal material that may also contribute pathogenic organisms. Connecticut's criteria are based on federal guidance [5]. In this guidance, the basis for the criteria and the relationship between the geometric mean criterion and the single sample maximum criterion is explained in detail.

The geometric mean criterion was derived by EPA scientists from epidemiological studies at beaches where the incidence of swimming related health effects (gastrointestinal illness rate) could be correlated with indicator bacteria densities. EPA's recommended criteria reflect an average illness rate of 8 illnesses per 1000 swimmers exposed. This condition was predicted to exist based on studies cited in the federal guidance when the steady-state geometric mean density of *E. coli* was 126 col/100ml. The distribution of individual sample results around the geometric mean is such that approximately half of all individual samples are expected to exceed the geometric mean and half will be below the geometric mean.

EPA also derived a single sample maximum criterion from this same database to support decisions by public health officials regarding the closure of beaches when an elevated risk of illness exists. Because approximately half of all individual sample results for a beach where the risk of illness is considered "acceptable" are expected to exceed the geometric mean criteria of 126 col/100ml, an upper boundary to the range of individual sample results was statistically derived that will be exceeded at frequencies less than 50% based on the variability of sample data. The mean log standard deviation for *E. coli* densities at the freshwater beach sites studied by EPA was 0.4. The single sample maximum criterion of 235 col/100mls, 410 col/100mls, and 576 col/100mls adopted by Connecticut represents the 75^{th}, 90^{th}, and 95^{th} percentile upper confidence limit, respectively, for a statistical distribution of data with a geometric mean of 126 and a log standard deviation of 0.4 as recommended by EPA [5].

Consistent with the State's disinfection policy (Water Quality Standard #23), the critical period for application of the indicator bacteria criteria is the recreational season, defined as May 1 through September 30. For waters that do not receive point discharges of treated sewage subject to the disinfection policy, a review of ambient monitoring data contained in the State's Ambient Monitoring Database [6] confirms that bacteria densities are typically highest during the summer months. Consistency with criteria during the summer is indicative of consistency at all times of the year. Lower densities reported during other portions of the year are most likely a result of several environmental factors including more rapid die-off of enteric bacteria in colder temperatures and reduced loadings from wildlife and domestic animal populations. Further, human exposure to potentially contaminated water is greatly reduced during the colder months, particularly exposure that results from immersion in the water since cold temperatures discourage participation in recreational activities that typically involve immersion.

Connecticut's adopted criteria are based on federal guidance and reflect an idealized distribution of bacteria monitoring data for sites studied by EPA that can be represented by statistical distribution with a geometric mean of 126 col/100ml and a log standard deviation of 0.4. The criteria can therefore be expressed as a cumulative frequency distribution or "criteria curve" as shown in figures 1a through1c for each of the specified recreational uses in Connecticut's bacteria criteria.

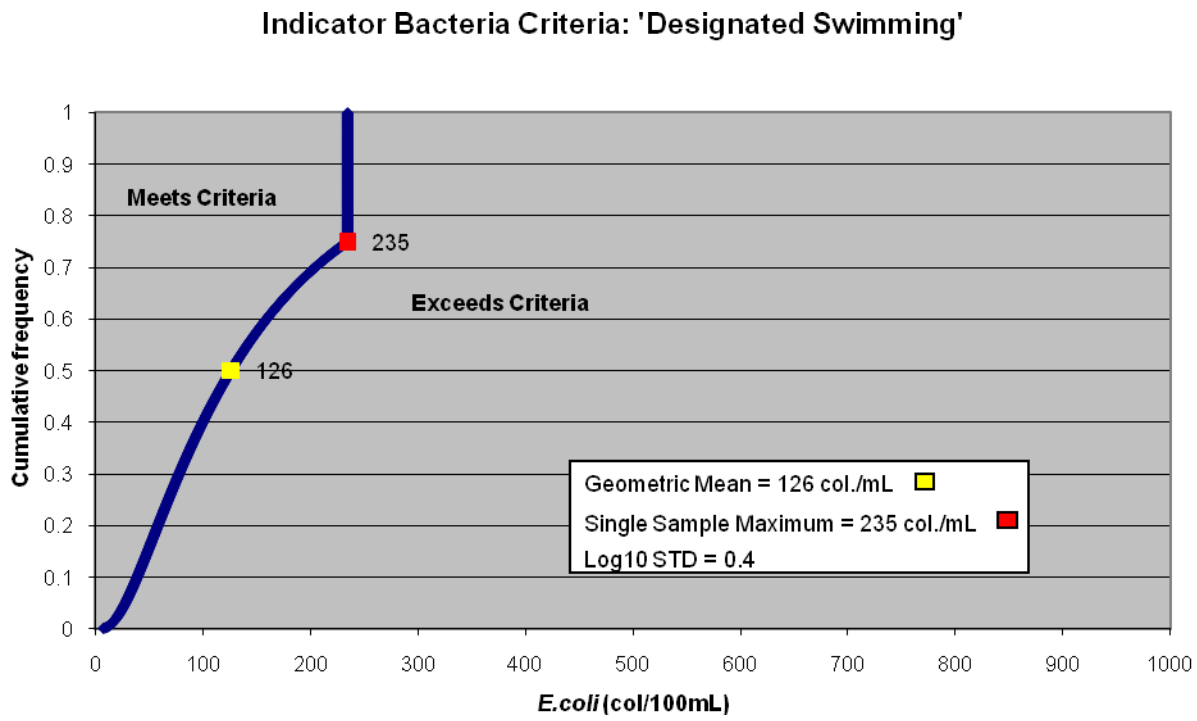


Figure 1a. Cumulative Relative Frequency Distribution representing water quality to support designated swimming use.

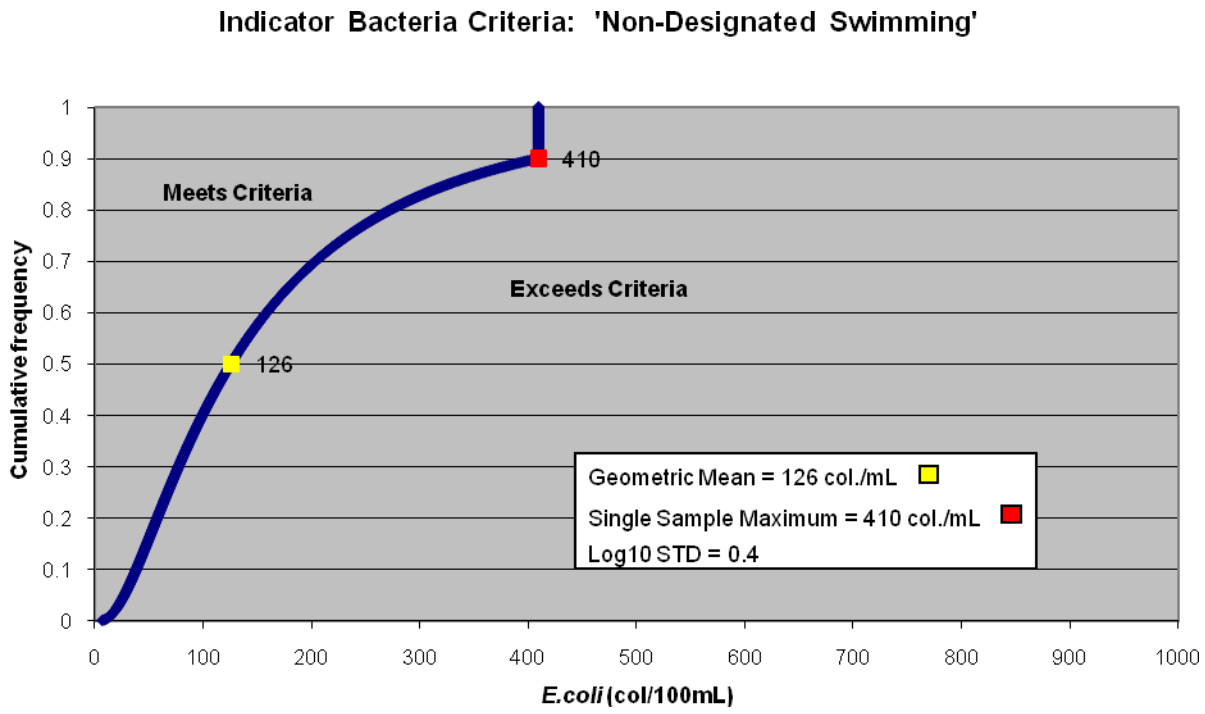


Figure 1b. Cumulative Relative Frequency Distribution representing water quality to support non-designated swimming use.

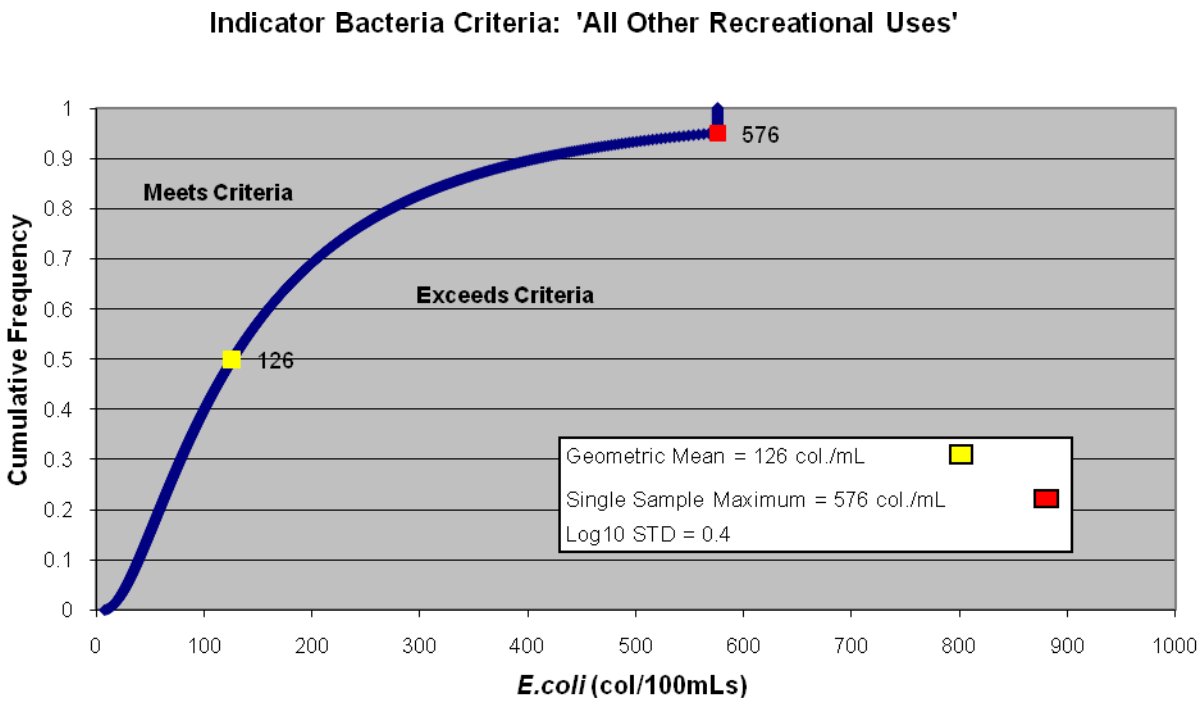


Figure 1c. Cumulative Relative Frequency Distribution representing water quality criteria to support all other recreational uses.

TMDL

As with the cumulative relative frequency curves representing the criteria shown in Figure 1a through 1c, a cumulative relative frequency curve can be prepared using site-specific sample data to represent current conditions at the TMDL monitoring site. The TMDL for the monitored segment is derived by quantifying the difference between these two distributions as shown conceptually in Figures 2a through 2c. This is accomplished by calculating the reduction required at representative points on the sample data cumulative frequency distribution curve and then averaging the reduction needed across the entire range of sampling data. This procedure allows the contribution of each individual sampling result to be considered when estimating the percent reduction needed to meet a criterion that is expressed as a geometric mean.

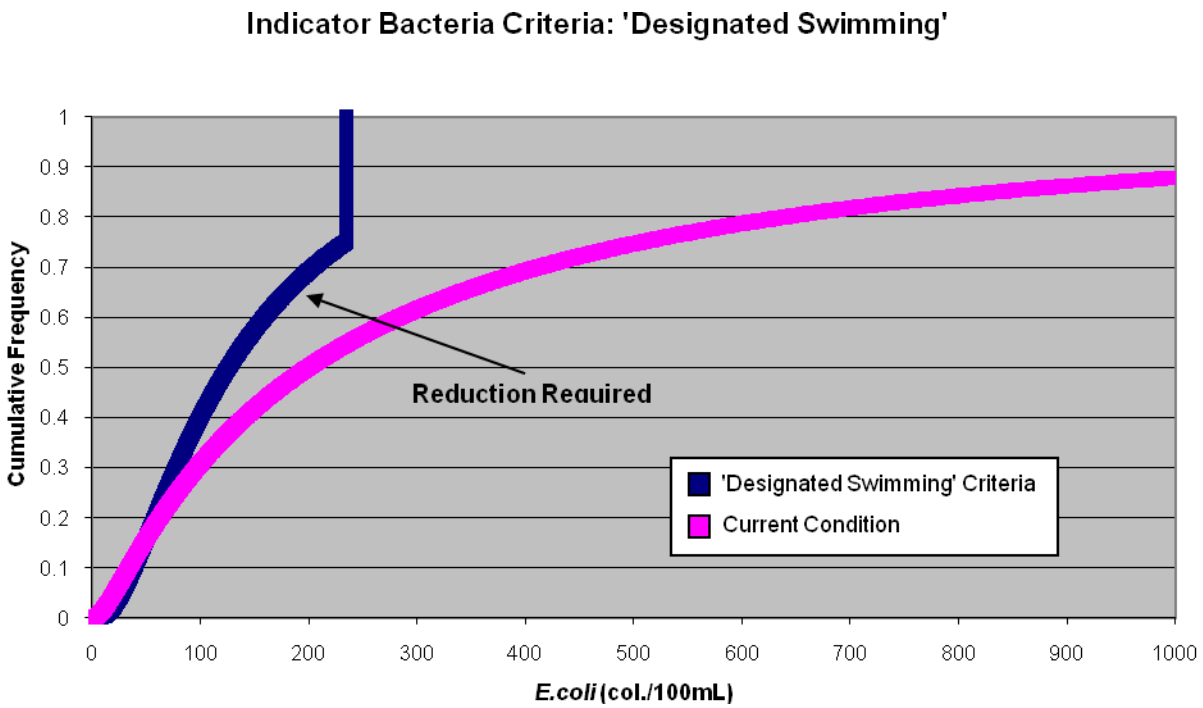


Figure 2a. Reduction indicator bacteria density needed from current condition to meet 'designated swimming' criteria based on cumulative relative frequency distribution.

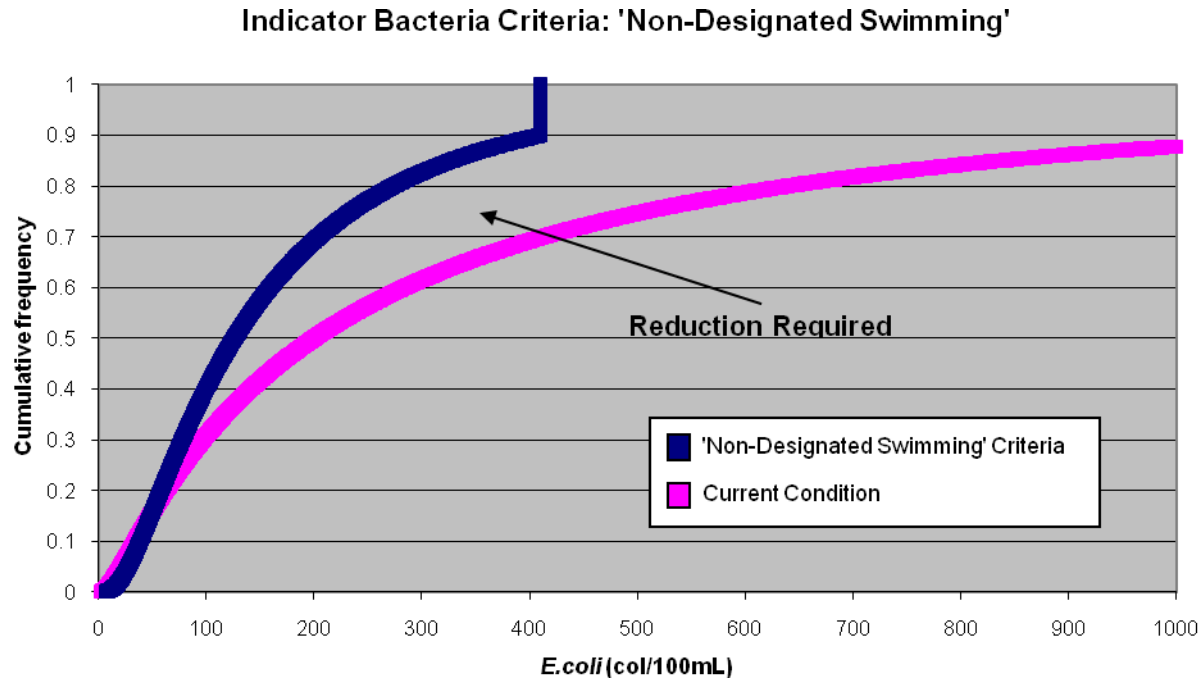


Figure 2b. Reduction indicator bacteria density needed from current condition to meet 'non-designated swimming' criteria based on cumulative relative frequency distribution.

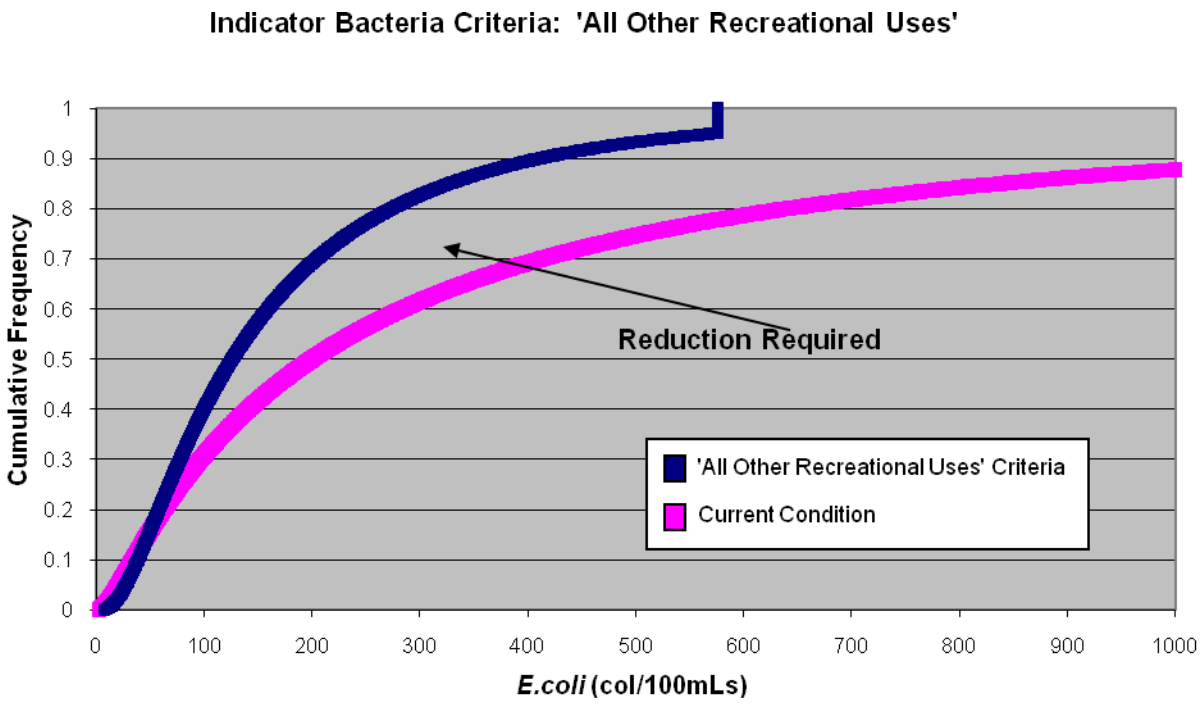


Figure 2c. Reduction indicator bacteria density needed from current condition to meet 'all other recreational uses' criteria based on cumulative relative frequency distribution.

TMDL ALLOCATIONS

Federal regulations require that the TMDL analysis identify the portion of the total loading which is allocated to point source discharges and the portion attributed to non-point sources, which contribute that pollutant to the waterbody. Stormwater runoff is considered a point source subject to regulation under the NPDES permitting program in designated urbanized areas. Designated urban areas, as defined by the US Census Bureau [7], are required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 permit). The general permit is applicable to municipalities that contain designated urban areas (or MS4 communities) and discharge stormwater via a separate storm sewer system to surface waters of the State. TMDLs for indicator bacteria in waters draining urbanized areas must therefore be partitioned into a WLA to accommodate point source stormwater loadings of indicator bacteria and a LA to accommodate non-point loadings from unregulated sources. One common characteristic of urbanized areas is the high percentage of impervious surface. Much of the impervious surface is directly connected to nearby surface waters through stormwater drainage systems. As a result, runoff is rapid following rain events and flow in urban streams is typically dominated by stormwater runoff during these periods. Monitoring results for samples collected under these conditions are strongly influenced by stormwater quality. During dry conditions, urban streams contain little stormwater since urban watersheds drain quickly and baseflows are reduced due to lower infiltration rates and reduced recharge of groundwater. At baseflow, urban stream water quality is dominated by non-point sources of indicator bacteria since stormwater outfalls are inactive.

A WLA for stormwater discharges is not warranted in non-designated urbanized areas and in waterbody segments where there are no stormwater outfalls. As such, sources of bacteria in these waterbodies segments are attributed solely to nonpoint sources. However, wet weather and dry weather percent reductions are partitioned in the LA analysis to demonstrate the effect of stormwater events on the contribution of nonpoint sources of bacteria to the waterbody.

The relative contribution of indicator bacteria loadings occurring during periods of high or low stormwater influence to the geometric mean indicator density is estimated by calculating separate averages of the reduction needed to achieve consistency with criteria under "wet" and "dry" conditions. In urbanized areas, the reduction needed under "wet" conditions is assigned to the WLA and the reduction needed under "dry" conditions is assigned to the LA. In non-designated urbanized areas, the LA is comprised of "wet" and "dry" conditions, which are partitioned into separate reduction goals. Separate reduction goals are established for baseflow and stormwater dominated periods that can assist local communities in selection of best management practices to improve water quality. The technique also facilitates the use of ambient stream monitoring data to track future progress in meeting water quality goals.

The sources contributing to the WLA and LA can be further subdivided depending on knowledge of sources present in the watershed (Table 2). Some existing sources such as dry weather flows from stormwater collections systems, illicit discharges to stormwater systems, and combined sewer overflows are allocated "100 percent reduction" since the management goal for these sources is elimination. Permitted discharges of treated and disinfected domestic wastewater (sewage treatment plants) are allocated "zero percent reduction" since disinfection required by the NPDES permit is sufficient to reduce indicator bacteria levels to below levels of concern. Natural sources such as wildlife are also allocated a "zero percent reduction" since the management goal is to foster a sustainable natural habitat and stream corridor to the extent practicable. Management measures to control nuisance populations of some wildlife species that can result in elevated indicator bacteria densities such as Canadian geese however should be considered in developing an overall watershed management plan. The management goal for point sources in designated swimming areas is elimination when the source is determined to be the main contributor of bacteria to the swimming area. This is consistent with the United States Environmental Protection Agency's (EPA) advisory for swimmers to avoid areas with discharge pipes [8] and a recent study indicating an increased potential for health risk to people swimming in areas near storm drains [9].

Source	Critical Conditions	Assigned To
On-Site Septic	Baseflow (DRY)	LA
Domestic Animal	Baseflow (DRY)	LA
Natural (Wildlife)	Baseflow (DRY)	LA
Wastewater Treatment Plants	Baseflow (DRY)	WLA
Regulated Urban Runoff/Storm Sewers	Wet Weather Flow (WET)	WLA
Dry Weather Overflow	Baseflow (DRY)	None
Illicit Discharges	Baseflow (DRY)	None
Combined Sewer Overflow	Wet Weather Flow (WET)	None

Table 2: Establishing WLA and LA Pollutant Sources

MARGIN OF SAFETY

Federal regulations require that all TMDL analyses include either an implicit or explicit margin of safety (MOS). The analytical approach described here incorporates an implicit MOS. Factors contributing to the MOS include assigning a percent reduction of "zero" to sampling results that indicate quality better than necessary to achieve consistency with the criteria. The increase in loadings on those dates that could be assimilated by the stream without exceeding criteria is not quantified (as a negative percent reduction) and averaged with the load reductions needed on other sampling dates. Rather, this excess capacity is averaged as a zero value thereby contributing to the implicit MOS.

The means of implementing the TMDL also contributes to the MOS. The loading reductions specified in the TMDL for regulated stormwater discharges and nonpoint sources must be sufficient to achieve water quality standards since confirmation that these reductions have been achieved will be based on ambient monitoring data documenting that water quality standards are met. Further, achieving compliance with the requirements of the MS4 permit includes elimination of high loading sources such as illicit discharges and dry weather overflows from storm sewer systems. Eliminating loads from these sources, as opposed to allocating a percent reduction equal to that given other sources, contributes to the implicit MOS. Further assurance that implementing the TMDL will meet water quality standards is provided by the iterative implementation required for compliance with the MS4 permit. This approach mandates that additional management efforts must be implemented until ambient monitoring data confirms that standards are met.

Many of the best management practices that are implemented to address either wet or dry weather sources will have some degree of effectiveness in reducing loads under all conditions. For example, the TMDL allocates all the percent reduction needed to meet standards under wet weather conditions to the WLA. However, reductions resulting from best management practices implemented to reduce dry weather loads (LA) will provide some benefit during wet weather conditions as well. These reductions also contribute to the implicit MOS.

DATA REQUIREMENTS

Ambient monitoring data for a minimum of 21 sampling dates during the recreational season (May 1 – September 30) is required. Data collected at other times during the year are excluded from the analysis. In addition to data on indicator bacteria density, precipitation data for each sampling date and the week prior to the sampling is necessary. Sampling dates should be selected to insure that representative data is available for both wet and dry conditions. This may be accomplished most easily by selecting sampling dates without prior knowledge of the meteorological conditions likely to be encountered on that date.

Data must reflect current conditions in the TMDL segment. The monitoring location where data is collected must therefore be sited in an area that can be considered representative of water quality throughout the TMDL segment. Data obtained under unusual circumstances may be excluded from the analysis provided the reason for excluding that data is provided in the TMDL. Potential reasons for excluding data may include such things as evidence that a spill, upset in

wastewater treatment, or sewer line breakage occurred that resulted in a short-term excursion from normal conditions. Data that represent conditions during an extreme storm event that resulted in widespread failure of wastewater treatment or stormwater best management practices may also be excluded. However, data for periods following typical rainfall events must be retained. Reasons for excluding any data must be provided in the TMDL Analysis.

All data must be less than five years old. If circumstances in any watershed suggest that conditions have changed during the most recent five-year period, the analysis may be restricted to more recent data in order to be representative of the current status provided the minimum data requirements are met.

Assurance of acceptable data quality must be provided. Typically, all data should be collected and results analyzed and reported pursuant to an EPA approved Quality Assurance Project Plan (QAPP). Data collected in the absence of a QAPP may be acceptable provided there is evidence that confirms acceptable data quality.

ANALYTICAL PROCEDURE – TMDL

1.

The *E. coli* monitoring data is ranked from lowest to highest. In the event of ties, monitoring results are assigned consecutive ranks in chronological order of sampling date. The sample proportion (*p*) is calculated for each monitoring result by dividing the assigned rank (*r*) for each sample by the total number of sample results (*n*):

$$p = r / n$$

2.

Next, a single sample criteria reference value is calculated for each monitoring result according to the specified recreational use (designated swimming, non-designated swimming, or all other) in a waterbody segment from the statistical distribution used to represent the criteria following the procedure described in steps **3 - 6** below:

3.

Designated Swimming	**Non-Designated Swimming**	**All Other Recreational Uses**
If the sample proportion is ≥ 0.75, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (235 col/100ml)	If the sample proportion is ≥ 0.90, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (410 col/100ml)	If the sample proportion is ≥ 0.95, the single sample criteria reference value is equivalent to the single sample criterion adopted into the Water Quality Standards (576 col/100ml)

4.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is less than 0.75, and greater than 0.50, the single sample criteria reference value is calculated as:	If the sample proportion is less than 0.90, and greater than 0.50, the single sample criteria reference value is calculated as:	If the sample proportion is less than 0.95, and greater than 0.50, the single sample criteria reference value is calculated as:

$$\textit{criteria reference value} = \text{antilog}_{10}\,[\log_{10} 126 \text{ col/100ml} + (F * 0.4)]$$

N.B. 126 col/100ml is the geometric mean indicator bacteria criterion adopted into Connecticut's Water Quality Standards, *F* is a factor determined from areas under the normal probability curve for a probability level equivalent to the sample proportion, 0.4 is the $\log_{10}$ standard deviation used by EPA in deriving the national guidance criteria recommendations (Table 4).

5.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is equal to 0.50, the single sample reference criteria value is equal to the geometric mean criterion adopted into the Water Quality Standards (126 col/100 ml)		

6.

Designated Swimming	Non-Designated Swimming	All Other Recreational Uses
If the sample proportion is less than 0.50, the single sample reference criteria value is calculated as:		

$$\textit{criteria reference value} = \text{antilog}_{10}\,[\log_{10} 126 \text{ col/100ml} - (F * 0.4)]$$

7. The percent reduction necessary to achieve consistency with the criteria is then calculated following the procedure described in steps **8 - 9** below:

8. If the monitoring result is less than the single sample reference criteria value, the percent reduction is zero.

9. If the monitoring result exceeds the single sample criteria reference value, the percent reduction necessary to meet criteria on that sampling date is calculated as:

$$\textit{percent reduction} = [(\textit{monitoring result} - \textit{criteria reference value})/\textit{monitoring result}]*100$$

10. The TMDL, expressed as the average percent reduction to meet criteria, is then calculated as the arithmetic average of the percent reduction calculated for each sampling date.

ANALYTICAL PROCEDURE – WET AND DRY WEATHER EVENTS

Precipitation data is reviewed and each sampling date is designated as a "dry" or "wet" sampling event. Although a site-specific protocol may be specified in an individual TMDL analysis, "wet" conditions are typically defined as greater than 0.1 inches precipitation in 24 hours or 0.25 inches precipitation in 48 hours, or 2.0 inches precipitation in 96 hours.

In designated urbanized areas the average percent reduction for all sampling events used to derive the TMDL that are designated as "wet" is computed and established as the WLA. The average percent reduction for all sampling events used to derive the TMDL that are designated as "dry" is computed and established as the LA.

In areas that do not have point sources, the average percent reduction for all sampling events used to derive the TMDL that are designated "wet" is computed as the wet weather LA, and the average percent reduction for all sampling events used to derive the TMDL that are designated as "dry" is computed as the dry weather LA.

ANALYTICAL PROCEDURE – SPREADSHEET MODEL

An Excel$^{(tm)}$ spreadsheet has been developed that performs all calculations necessary to derive a TMDL using this procedure. Copies of the spreadsheet in electronic form may be obtained from DEEP by contacting Mary Becker at (860) 424-3262 or by email at mary.becker@ct.gov.

REFERENCES

1. 2004 List of Connecticut Water Bodies Not Meeting Water Quality Standards, Connecticut Department of Environmental Protection, Adopted April 28, 2004, approved June 24, 2004.

2. General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems. Connecticut Department of Environmental Protection. Issued January 9, 2004.

3. Connecticut Consolidated Assessment and Listing Methodology for 305(b) and 303(d) Reporting. Connecticut Department of Environmental Protection, April 2004.

4. Water Quality Standards. Connecticut Department of Environmental Protection. Effective December 17, 2002.

5. Ambient Water Quality Criteria for Bacteria – 1986. U.S. Environmental Protection Agency, Office of Water, January 1986. (EPA440/5-84-002).

6. Water Quality Database. Connecticut Department of Environmental Protection, Monitoring and Assessment Program.

7. U.S. Census Bureau, March 2002. www.census.gov/geo/www/ua/ua_2k.html

8. Environmental Protection Agency, 2004. http://www.epa.gov/beaches/.

9. Haile, RW et al, 1999. *The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff***.** Epidemiology. 10 (4) 355-363.

Appendix E. Links to web sites mentioned in this document

Stormwater Program information -MS4, Industrial, Construction and Commercial general permits: www.ct.gov/dep/stormwater

EPA's Stormwater website: http://cfpub.epa.gov/npdes/stormwater/swphases.cfm

Nuisance wildlife www.ct.gov/dep/enconpolice listed under featured links

Pet waste disposal:
http://www.ct.gov/Dep/cwp/view.asp?a=2708&q=457360&depNav_GID=1763

DEEP Water Quality Manual-Source Control & Pollution Prevention including Nuisance Wildlife & Pet waste:
http://www.ct.gov/dep/lib/dep/water_regulating_and_discharges/stormwater/manual/Chapter_5.pdf .

Staff list: Watershed Management Program:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325624&depNav_GID=1654

List of approved stormwater management plans:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=379296&depNav_GID=1654

The nine planning elements in an EPA approved Watershed Based Plan:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=335504&depNav_GID=1654

CWA 319 program:
http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325588&depNav_GID=1654

(This page intentionally left blank)

Appendix B
Watershed Treatment Model Results

Upper Ekonk Brook Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	377	56	8,807	16,382	66	27.4	32.6	20.9	52.3
MDR (1-4 du/acre)	44	6	1,019	1,896	8	3.2	3.5	2.4	6.1
HDR (>4 du/acre)	89	13	2,078	3,865	16	6.5	7.6	4.9	12.3
Roadway	108	12	6,276	4,269	17	7.9	7.0	14.9	13.6
Forest	414	33	16,552	1,986	23	30.1	19.2	39.2	6.3
Pasture	95	14	2,066	806	3	6.9	8.1	4.9	2.6
Cropland	248	38	5,395	2,104	7	18.0	22.1	12.8	6.7
Open Water	0	0	0	0	0	0.0	0.0	0.0	0.0
Land Use Total	**1,375**	**172**	**42,193**	**31,308**	**140**	-	-	-	-
Secondary Source Loads									
Septic Systems	123	20	817	420	0	7.9	7.5	1.5	1.3
Channel Erosion	0	0	13,264	0	0	0.0	0.0	23.6	0.0
Livestock	0	0	0	0	0	0.0	0.0	0.0	0.0
Load Reductions from Existing Practices	-51	-74	0	221	-6	-3.3	-27.8	0.0	0.7
Total Secondary Sources	174	94	14,081	199	6	-	-	-	-
Total Load	**1,549**	**266**	**56,274**	**31,507**	**146**	-	-	-	-

Unnamed Stream 01 Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	305	45	7,122	13,248	54	21	26	16	57
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	69	8	4,032	2,743	11	5	4	9	12
Forest	523	42	20,937	2,512	31	37	24	48	11
Pasture	155	24	3,375	1,316	5	11	13	8	6
Cropland	380	58	8,264	3,223	12	27	33	19	14
Open Water	0	0	0	0	0	0	0	0	0
Land Use Total	**1,433**	**176**	**43,730**	**23,043**	**113**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	13,491	0	0	0	0	24	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	-45	-50	0	0	-6	-3	-22	0	0
Total Secondary Sources	45	50	0	0	6	-	-	-	-
Total Load	**1,478**	**226**	**57,221**	**23,043**	**119**	-	-	-	-

Sterling Hill Brook Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	91	13	2,125	3,953	16	14	17	10	46
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	27	3	1,557	1,059	4	4	4	7	12
Forest	299	24	11,947	1,434	19	45	30	57	17
Pasture	8	1	184	72	0	1	2	1	1
Cropland	242	37	5,270	2,055	8	36	47	25	24
Open Water	3	0	36	0	0	0	0	0	0
Land Use Total	**670**	**79**	**21,119**	**8,573**	**48**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	6,460	0	0	0	0	23	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	-12	-15	0	0	-2	-2	-16	0	0
Total Secondary Sources	12	15	0	0	2	-	-	-	-
Total Load	**682**	**93**	**27,578**	**8,573**	**49**	-	-	-	-

Middle Ekonk Brook Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	219	32	5,104	9,494	38	13	20	9	49
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	75	8	4,372	2,974	12	5	5	7	15
Forest	1,178	94	47,130	5,656	66	72	60	79	29
Pasture	30	5	643	251	1	2	3	1	1
Cropland	122	19	2,663	1,039	4	8	12	4	5
Open Water	6	0	71	0	0	0	0	0	0
Land Use Total	**1,630**	**158**	**59,983**	**19,413**	**121**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	18,313	0	0	0	0	23	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	-36	-37	0	0	-1	-2	-19	0	0
Total Secondary Sources	36	37	0	0	1	-	-	-	-
Total Load	**1,666**	**195**	**78,296**	**19,413**	**122**	-	-	-	-

Unnamed Stream 02 Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	281	42	6,568	12,217	49	21	26	16	55
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	98	11	5,703	3,880	16	7	7	14	18
Forest	510	41	20,386	2,446	32	39	26	49	11
Pasture	33	5	712	278	1	2	3	2	1
Cropland	392	60	8,517	3,322	13	30	38	20	15
Open Water	3	0	36	0	0	0	0	0	0
Land Use Total	**1,316**	**158**	**41,922**	**22,142**	**111**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	12,987	0	0	0	0	24	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	-38	-45	0	0	-1	-3	-22	0	0
Total Secondary Sources	38	45	0	0	1	-	-	-	-
Total Load	**1,355**	**203**	**54,908**	**22,142**	**112**	-	-	-	-

Unnamed Stream 03 Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	160	24	3,736	6,951	28	28	40	18	65
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	50	5	2,928	1,992	8	9	9	14	19
Forest	339	27	13,567	1,628	19	60	46	66	15
Pasture	10	1	207	81	0	2	2	1	1
Cropland	6	1	137	53	0	1	2	1	0
Open Water	3	0	36	0	0	1	0	0	0
Land Use Total	**568**	**59**	**20,611**	**10,704**	**56**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	6,407	0	0	0	0	24	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	-30	-28	0	0	0	-5	-32	0	0
Total Secondary Sources	30	28	0	0	0	-	-	-	-
Total Load	**598**	**87**	**27,017**	**10,704**	**56**	-	-	-	-

Lower Ekonk Brook - West Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	20	3	468	870	4	2	4	1	15
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	2	0	144	98	0	0	0	0	2
Forest	990	79	39,600	4,752	60	98	96	98	83
Pasture	0	0	0	0	0	0	0	0	0
Cropland	0	0	0	0	0	0	0	0	0
Open Water	0	0	0	0	0	0	0	0	0
Land Use Total	**1,013**	**82**	**40,212**	**5,720**	**63**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	12,084	0	0	0	0	23	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	-3	-3	0	0	0	0	-4	0	0
Total Secondary Sources	3	3	0	0	0	-	-	-	-
Total Load	**1,015**	**86**	**52,296**	**5,720**	**63**	-	-	-	-

Lower Ekonk Brook – East Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	36	5	833	1,550	6	2	3	1	12
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	25	3	1,447	984	4	1	1	2	8
Forest	1,148	92	45,937	5,512	75	64	48	75	42
Pasture	18	3	395	154	1	1	1	1	1
Cropland	572	87	12,438	4,851	20	32	46	20	37
Open Water	0	0	0	0	0	0	0	0	0
Land Use Total	**1,799**	**190**	**61,050**	**13,051**	**106**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	18,391	0	0	0	0	0	0
Livestock	137	25	0	771	0	0	0	0	0
Load Reductions from Existing Practices	1	-4	254	342	1	0	0	0	0
Total Secondary Sources	-1	4	-254	-342	-1	-	-	-	-
Total Load	**1,935**	**219**	**79,187**	**13,480**	**105**	-	-	-	-

Stanton Pond Brook Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	68	10	1,576	2,932	12	6	6	5	24
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	36	4	2,079	1,414	6	3	3	6	12
Forest	382	31	15,289	1,835	24	31	20	44	15
Pasture	35	5	758	296	1	3	3	2	2
Cropland	679	103	14,760	5,756	23	55	67	42	47
Open Water	26	1	321	0	0	2	1	1	0
Land Use Total	**1,226**	**154**	**34,783**	**12,233**	**66**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	10,568	0	0	0	0	23	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	-9	-11	0	0	0	-1	-7	0	0
Total Secondary Sources	9	11	0	0	0	-	-	-	-
Total Load	**1,235**	**165**	**45,351**	**12,233**	**66**	-	-	-	-

Lockes Meadow Pond Sub-Watershed Modeled Annual Existing Pollutant Loads by Source

NPS Pollutant Source	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	Runoff Volume (ac-ft/yr)	TN (% of load)	TP (% of load)	TSS (% of load)	Fecal Coliform (% of load)
LDR (<1du/acre)	0	0	0	0	0	0	0	0	0
MDR (1-4 du/acre)	0	0	0	0	0	0	0	0	0
HDR (>4 du/acre)	0	0	0	0	0	0	0	0	0
Roadway	0	0	0	0	0	0	0	0	0
Forest	309	25	12,374	1,485	15	75	82	90	94
Pasture	7	1	161	63	0	2	4	1	4
Cropland	4	1	92	36	0	1	2	1	2
Open Water	91	4	1,104	0	0	22	12	8	0
Land Use Total	**412**	**30**	**13,731**	**1,584**	**16**	-	-	-	-
Secondary Source Loads									
Septic Systems	0	0	0	0	0	0	0	0	0
Channel Erosion	0	0	4,156	0	0	0	0	23	0
Livestock	0	0	0	0	0	0	0	0	0
Load Reductions from Existing Practices	0	0	0	0	0	0	0	0	0
Total Secondary Sources	0	0	0	0	0	-	-	-	-
Total Load	**412**	**30**	**17,887**	**1,584**	**16**	-	-	-	-