Pomperaug River Watershed Based Plan

prepared by FUSS & O'NEILL

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Table of Contents

Pomperaug River Watershed Based Plan

Table of Contents

Pomperaug River Watershed Based Plan

Table of Contents

Pomperaug River Watershed Based Plan

Tables Page

Figures Page

Table of Contents

Pomperaug River Watershed Based Plan

Figures | Page

Appendices

List of Acronyms

APA	Aquifer Protection Area
BMP	Best Management Practice
CFU	Colony Forming Units
CLEAR	Center for Land Use Education and Research
COGCNV	Council of Governments Central Naugatuck Valley (merged with Valley COG 2016 to form Naugatuck Valley COG)
CTDPH	Connecticut Department of Public Health
CT ECO	Connecticut Environmental Conditions Online
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTDOT	Connecticut Department of Transportation
DCIA	Directly Connected Impervious Area
EQIP	Environmental Quality Incentives Program
EPA	U.S. Environmental Protection Agency
FLRP	Farmland Restoration Program
GI	Green Infrastructure
GIS	Geographic Information Systems
GPD	Gallons per Day
HVA	Housatonic Valley Association
IC	Impervious Cover
IDDE	Illicit Discharge Detection and Elimination
IWQR	Integrated Water Quality Report
LID	Low Impact Development
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
NEMO	Nonpoint Education for Municipal Officials
NFWF	National Fish and Wildlife Foundation
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
NRCS	USDA Natural Resource Conservation Service
NVCOG	Naugatuck Valley Council of Governments
NWQA	National Water Quality Assessment
NWQI	National Water Quality Inventory (EPA)
NWQI	National Water Quality Initiative (NRCS)
PDDH	Pomperaug District Department of Health
PRWC	Pomperaug River Watershed Coalition
QAPP	Quality Assurance Project Plan
ROW	Right-of-Way
TMDL	Total Maximum Daily Load
UCONN	University of Connecticut
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
WTM	Watershed Treatment Model

1 Introduction

1.1 Background

The Pomperaug River and Its Watershed

The Pomperaug River watershed (also referred to as the Pomperaug River Regional Basin) (*Figure 1-1*) covers a 90-square mile area within the eight Connecticut towns of Bethlehem, Woodbury, Southbury, Washington, Roxbury, Watertown, Middlebury, and Morris in western Connecticut.

The Pomperaug River flows for approximately 13 miles from the confluence of the Weekeepeemee and Nonnewaug Rivers in Woodbury, south to the Housatonic River along the Southbury/Newtown border. Other major tributaries to the Pomperaug River include Transylvania Brook and Hesseky Brook, while Sprain Brook drains to the Weekeepeemee River and East Spring Brook feeds the Nonnewaug River (*Figure 1-2*).

Figure 1-1. Municipalities located within the Pomperaug River watershed (PRWC)

Land use in the southern part of the Pomperaug River watershed is dominated by suburban residential and commercial development, while the northern portion of the watershed is rural in character with primarily low-density residential land use and agricultural lands. Forested areas account for a third of the watershed, and approximately 16% of the watershed is protected open space. Major roads located in the watershed include Interstate 84, U.S. Route 6, and State Routes 61, 63, 64, 67, 172, 317, 47, and 132.

The waters of the Pomperaug River and its tributaries are connected to the groundwater aquifers within the watershed. The aquifers seasonally sustain streamflow and supply millions of gallons of drinking water daily to towns both in and outside of the Pomperaug watershed.

The existing physical, land use, and water quality characteristics of the Pomperaug River watershed are summarized in *Section 2* of this watershed based plan.

What is a Watershed?

A watershed is the area of land that contributes runoff to a lake, river, stream, wetland, estuary, or bay. Land use activities within a watershed affect the water quality of the receiving waters.

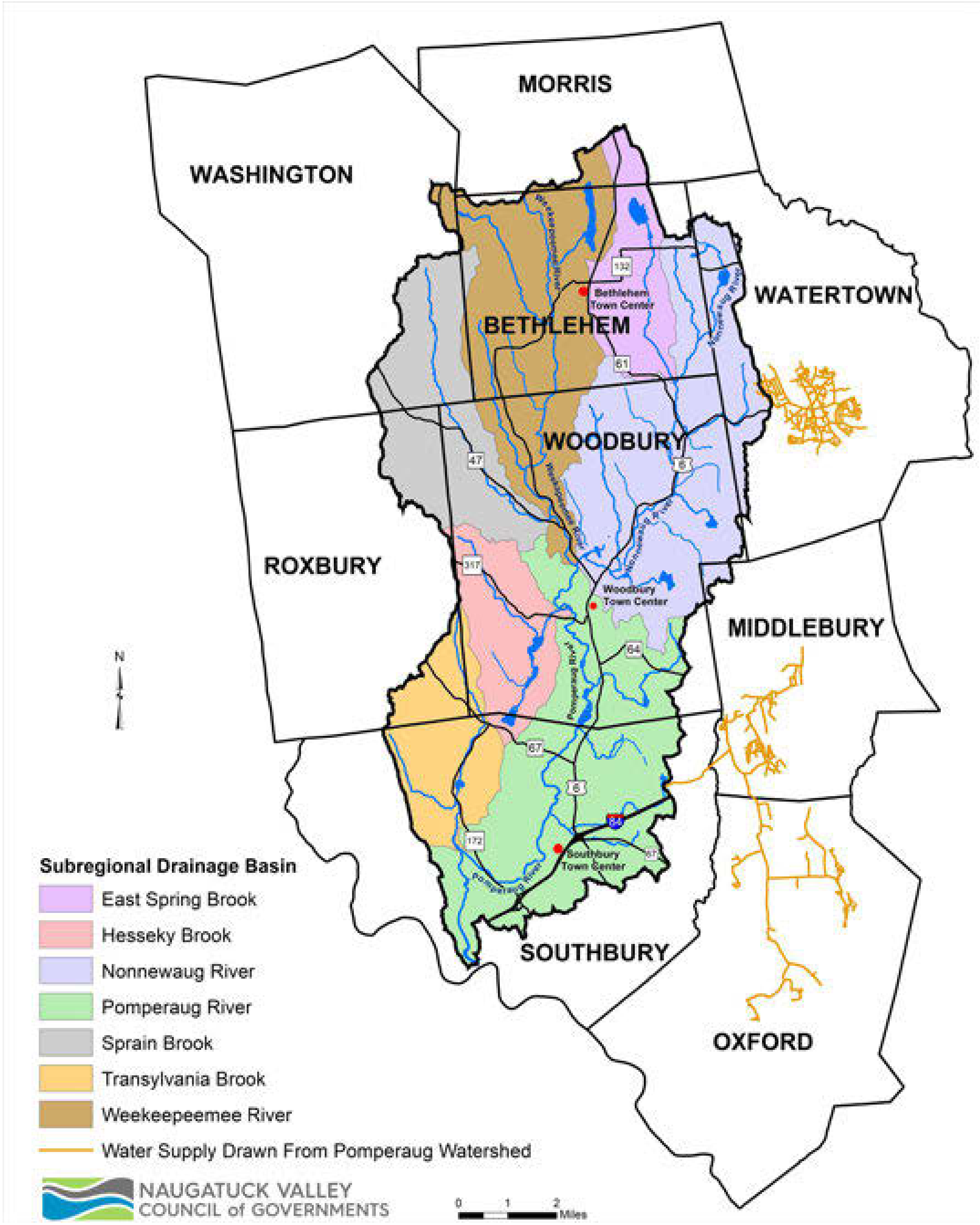


Figure 1-2. Watershed overview

Issues Facing the Pomperaug River Watershed

Impaired Recreational Use – Degraded Surface Water Quality

The Pomperaug River has been impacted by development and land use activities in its watershed. There are segments of the Pomperaug River, Weekeepeemee River, and Transylvania Brook where in-stream fecal indicator bacteria levels have been measured in excess of the State water quality standard for recreation.

Potential sources of bacteria in the watershed include "non-point sources" such as diffuse stormwater runoff, failing or malfunctioning septic systems, agricultural activities including but not limited to numerous farms in the northern part of the watershed, and waste from wildlife and pets. "Point sources" of bacteria include permitted discharges from Municipal Separate Storm Sewer Systems (MS4s), potential illicit discharges, and runoff from industrial and commercial facilities.

The Connecticut Department of Energy and Environmental Protection (CTDEEP) completed a "Statewide Bacteria Total Maximum Daily Load" (TMDL) for 176 impaired waterbody segments (CTDEEP, 2012) based on the 2010 Impaired Waters List. The TMDL sets target pollution levels and establishes a framework for restoring water quality of the impaired segments. Three of the bacteria-impaired segments in the Pomperaug River watershed are included in the TMDL (Pomperaug River-01 and -03 and Weekeepeemee River) based on past monitoring data. The pollution reduction goals specified in the Statewide Bacteria TMDL can be achieved by implementing actions that will reduce bacterial loads using a watershed framework. This watershed based plan therefore provides a framework for implementing the TMDL. Ultimately, the goal of both the watershed plan and the TMDL is to improve water quality in the Pomperaug River watershed, which will contribute to improved water quality in downstream receiving waters including Long Island Sound.

It is important to note that the data supporting the identified recreational impairments in the Pomperaug River watershed are extremely limited and based on data collected between 2006 and 2010, which underscores the need for additional water quality monitoring and analysis to support future plan implementation.

Physical Alterations

Physical alterations to stream channels (historic channelization), floodplains, and riparian corridors in the watershed have impacted water quality and the flow regime of the Pomperaug. Historically, gravel removal in the watershed has affected streamflow and altered the river floodplain. Potential future flow alterations, including permitted water withdrawals, have the potential to further impact habitat and limit other uses of the river.

Aquatic life has been impacted in some rivers and streams as a result of man-made impoundments such as dams, groundwater withdrawals for public water supply, and land development. These and other factors have contributed to reduced streamflow, causing some streams to run dry during periods of the year. A 0.25-mile long segment of Stiles Brook near its confluence with the Pomperaug River (Stiles Brook-01) is listed in the 2016 Connecticut Integrated Water Quality Report (IWQR) as impaired for aquatic life due to flow regime alterations.

The CTDEEP is working with the State Department of Public Health and stakeholders to refine proposed Stream Flow Classifications for the Housatonic, Hudson and Southwest Coastal River Basins, which includes the Pomperaug River watershed. Adoption of the Stream Flow Classifications is a key component in the effort to update standards for maintaining minimum flows in rivers and streams to balance river and stream ecology, wildlife, and recreation while providing for public health, flood control, industry, water supply, public safety, agriculture and other uses of water.

Threats to Groundwater Resources

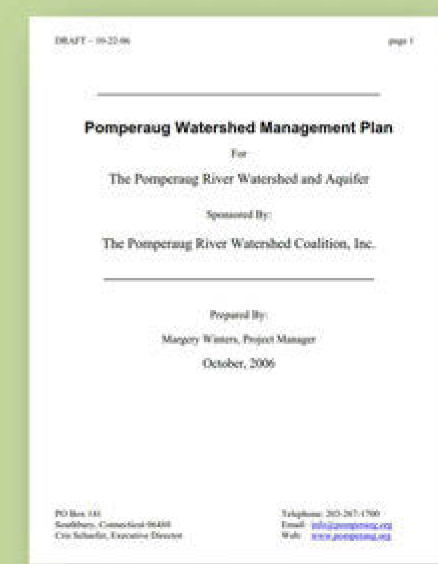
There is an especially strong connection between groundwater and surface waters in the Pomperaug River watershed given the high percentage of stratified drift deposits in the basin (Markstrom et al., 2012). The groundwater in these stratified drift deposits is associated with high-yield sand and gravel aquifers, which formed in the typical New England glacial valley setting of the watershed. Groundwater in these aquifers provides drinking water both within the watershed and to surrounding communities. Water from the aquifer system also feeds the Pomperaug River and its tributaries, supplementing stream flows especially during periods of little precipitation, in which case it may be the only natural source of stream flow.

Given this close link between groundwater and surface water in the watershed and the coarse sand and gravel allowing for quick infiltration, the Pomperaug Aquifer is highly susceptible to contamination. The aquifers can also be depleted through overuse and disconnected from replenishing rainfall and snowmelt due to intensive land use development. Such development can also increase surface runoff and reduce the amount of precipitation that infiltrates into the ground and recharges groundwater levels. As development and the demand for water increases, so does the potential for groundwater contamination, depleted wells, lower river flows, and increased stress on fish and wildlife species that rely on aquatic habitat.

Preserving and protecting groundwater resources in the watershed – both groundwater quality and availability for various uses – continues to be a major focus of the watershed communities, the Pomperaug River Watershed Coalition (PRWC), resource agencies, and other stakeholders.

1.2 Prior Watershed Planning

2006 Pomperaug River Watershed Management Plan


Pomperaug Watershed Management Plan
For
The Pomperaug River Watershed and Aquifer
Sponsored By:
The Pomperaug River Watershed Coalition, Inc.
Prepared By:
Margery Winters, Project Manager
October, 2006

The Pomperaug River watershed is one of the most studied watersheds in the country, with research dating back to 1898. The watershed has been the focus of grass-roots watershed management and water resource protection efforts over the years, led by the PRWC and its partners including university research groups, state and federal resource protection agencies, the watershed municipalities, land owners, and other local and regional groups. This work in the Pomperaug watershed has served as a model for other organizations and watersheds in the region and beyond. *Table 1-1* summarizes the existing plans and studies on water quality and related water resource issues within the Pomperaug River watershed. Many of these reports are available on the PRWC website: http://www.pomperaug.org/scientific-reports

In 2001, the Council of Governments of Central Naugatuck Valley and PRWC developed the "State of the Watershed Report," which was the first comprehensive overview of conditions in the Pomperaug River watershed. The report integrated the findings of numerous prior studies and research projects in the watershed as of 2001. In 2006, PRWC developed the first watershed management plan for the Pomperaug River watershed, called the "Pomperaug River Watershed Management Plan."

The 2006 Watershed Management Plan was developed prior to the establishment of the U.S. Environmental Protection Agency (EPA) Nine Elements criteria for watershed based plans for addressing impaired waters. The 2006 plan outlines data/information that was available at the time as well as data gaps and proposed actions for obtaining such data. Other action items within the plan are broad "programmatic" recommendations for efforts PRWC could undertake to further protect local rivers and streams. However, the 2006 plan does not identify site-specific recommendations or actions to improve or protect water quality.

Table 1-1. Existing plans and studies on the Pomperaug River watershed

Document/ Information Source	Author/Date	Notes
Connecticut Integrated Water Quality Report to Congress	CTDEEP (2014 and 2016)	In relation to the Pomperaug Watershed, this report identifies local stream segments that are classified as "impaired" relative to aquatic life support and/or recreational use based on water quality assessments conducted under CTDEEP's leadership. Report does not contain water quality data, just determinations made based on such data which can be obtained by contacting CTDEEP staff.
Restoring the Pomperaug River with Woody Debris – PowerPoint Presentation	Audubon Center at Bent of the River (2014)	Successful in-stream habitat restoration project constructed along a half-mile stretch of the lower Pomperaug River that flows through the Audubon at the Bent of the River (BOTR). Need for restoration initially identified in the 2007 UMASS Amherst study by the Instream Habitat Program
Water Allocation and Use Ordinance, Presentation to Town of Southbury Board of Selectmen	PRWC (2014)	Proposed model water use ordinance
CTDEEP River Bioassessment by Volunteers (RBV) Program, 2014 Annual Program Summary (Report #16)	CTDEEP (2014)	Annual macroinvertebrate survey report
CTDEEP River Bioassessment by Volunteers (RBV) Program, 2013 Annual Program Summary (Report #15)	CTDEEP (2013)	Annual macroinvertebrate survey report
Mapping Bedrock Surface Contours Using the Horizontal-to-Vertical Spectral Ratio (HVSR) Method Near the Middle Quarter Area, Woodbury, Connecticut	USGS (2013)	Bedrock mapping using novel non-invasive method. Relevance is to groundwater contamination in Woodbury
Impaired Stream Segments of the Pomperaug River	PRWC (2016)	PRWC summary of water quality impairments from CTDEEP's 2012 Integrated Water Quality Report. Superseded by the 2014 and 2016 IWQR information.

Table 1-1. Existing plans and studies on the Pomperaug River watershed

Document/ Information Source	Author/Date	Notes
Statewide Bacteria TMDL Core Document	CTDEEP (2012)	The purpose of a TMDL is to calculate the amount of a pollutant a waterbody can assimilate without exceeding water quality standards or impairing designated uses. This document provides (1) documentation for the impaired waters listing status and the need for a TMDL, (2) the water quality target that needs to be attained to restore the health of the waterbody, (3) details regarding sources of bacteria in the impaired waterbodies, and (4) estimated percent reductions, calculated from existing data, needed to meet the concentration-based water quality target.
Statewide Bacteria TMDL – Appendix A: Watershed Specific Bacteria Impairment Appendices for: Pomperaug River CT6800	CTDEEP (2012)	Sections of the statewide bacteria TMDL relevant to the Pomperaug River watershed. Includes general load reduction estimates and water quality data related to cause of impairment
Statewide Bacteria TMDL – Appendix A: Watershed Specific Bacteria Impairment Appendices for: Weekeepeemee River CT6804	CTDEEP (2012)	Sections of the statewide bacteria TMDL relevant to the Weekeepeemee River watershed. Includes general load reduction estimates and water quality data related to cause of impairment
Watershed Scale Response to Climate Change- Pomperaug River Watershed, Connecticut	USGS (2012)	Modeling to evaluate the climate change effects of various combinations of precipitation, temperature, and land use on streamflow and general basin hydrology.
Integrated Watershed-Scale Response to Climate Change for Selected Basins Across the United States	USGS (2011)	Modeling to evaluate the climate change effects of various combinations of precipitation, temperature, and land use on streamflow and general basin hydrology. Pomperaug Watershed is 1 of 14 basins included in the study, representing New England watersheds and regional climate characteristics.
Three Rivers Park and the Pomperaug River, A Management Analysis of River Stability and Riparian Buffers	Prepared for the River Processes and Restoration Course at the Yale School of Forestry and Environmental Studies (2010)	Riparian buffer and floodplain restoration recommendations for Three Rivers Park. Establishes baseline on the extent (length and width) and composition of the buffer. Provides stream profile/cross section data showing channel incision and bank steepness along the floodplain to the east of the river channel and potential flood storage area on the opposite bank
Assessing the Vulnerability of Public-Supply Wells to Contamination: Glacial Aquifer System in Woodbury, Connecticut	USGS (2010)	USGS National Water Quality Assessment

Table 1-1. Existing plans and studies on the Pomperaug River watershed

Document/ Information Source	Author/Date	Notes
Estimation of the Effects of Land Use and Groundwater Withdrawals on Streamflow for the Pomperaug River, Connecticut	USGS (2010)	USGS National Water Quality Assessment. Also known as "Precipitation-Runoff Model." Contains potentially useful water withdrawal and precipitation data. This model utilized precipitation, slope, soil, land cover, and other data to estimate the ratio of rainfall that runs off the landscape vs. soaks into the ground to recharge the aquifer. Different scenarios were run with increasing impervious cover and groundwater withdrawals to evaluate impact to in-stream flow.
Pomperaug River Watershed Streamwalk Summary Report	PRWC (2010)	Findings of PRWC volunteer streamwalk program. Includes findings from surveys conducted between 2005 and 2010. Survey areas are scattered spatially and temporally. Data is qualitative and subjective, and was not collected following a formalized QAPP.
Recharge Mapping: A GIS-based tool for identifying areas of land with significant groundwater recharge	PRWC, COGCNV, HVA (2009)	A simplified GIS tool to identify areas of land with significant groundwater recharge. Includes recharge estimates at the local basin scale. Simplified model based on USGS's Estimation of the Effects of Land Use and Groundwater Withdrawals on Streamflow for the Pomperaug River, Connecticut (when final report had not yet been released).
Pomperaug Water Allocation Planning Study (PWAPs) White Paper	PRWC (2009)	Identifies consensus actions to be taken by the major stakeholders in the Pomperaug Watershed about the allocation of water resources.
Aquifer Chemistry and Transport Processes in the Zone of Contribution to a Public-Supply Well in Woodbury, Connecticut, 2002–06	USGS (2009)	USGS National Water Quality Assessment
Draft After-Action Report Pomperaug River Watershed Extreme Drought Tabletop Exercise	Gradient Planning (2009)	Tabletop simulation exercise of response actions (by utilities; municipal offices, state agencies; local public health, safety and emergency response teams; and the public) to severe drought in the Pomperaug River watershed
Transylvania Pond Environmental Review Team Report	Eastern Connecticut Resource Conservation and Development Area, Inc. (2008)	Report examining the feasibility of options for addressing eutrophication problems in Transylvania Pond. Report also examines the increasing invasive aquatic plant infestation and degrading condition of the dams associated with the pond.
Hydrogeologic Setting and Ground-Water Flow Simulations of the Pomperaug River Basin Regional Study Area, Connecticut	USGS (2007)	USGS National Water Quality Assessment

Table 1-1. Existing plans and studies on the Pomperaug River watershed

Document/ Information Source	Author/Date	Notes
Simulations of Ground-Water Flow and Residence Time near Woodbury, Connecticut	USGS (2007)	USGS National Water Quality Assessment
Anthropogenic Organic Compounds in Source and Finished Water from Community Water System Wells in Western and Central Connecticut, 2002–2004	USGS (2007)	Study area includes water supply wells in Southbury and Woodbury. Particular interest was evaluating removal success for known contaminants in the Woodbury public water supply well area.
First Annual Water Quality Report Long Meadow Lake, Bethlehem, Connecticut	HydroEnvironmental Solutions, Inc. Environmental Consultants (2007)	Volunteer water quality monitoring report. Long Meadow Lake (also known as Long Meadow Pond) is one of the key headwaters to the Weekeepeemee River.
A Manual for Assessing Hydrologic Value of Land Parcels based on Physical Attributes	PWRC and Southbury Land Trust in cooperation with COGCNV and USGS (2007)	Modeling study to identify specific parcels in the Town of Southbury with significant hydrologic function (precursor to the GIS-tool for Recharge Mapping)
Assessment and Restoration of Instream Habitat for the Pomperaug, Nonnewaug, and Weekeepeemee Rivers of Connecticut	Northeast Instream Habitat Program, University of Massachusetts (2007)	Study to evaluate the low-flow related stresses to physical habitat and fish community and to determine ecologically viable objectives for a management plan for the Pomperaug River watershed. Study mapped existing instream habitat characteristics at varying levels of flow. Stresses determined by availability of certain habitat characteristics needed to support indicator fish species during different bioperiods (ex. spawning, overwintering, rearing and growth) under different flow scenarios. Report also known as the "MesoHABSIM" study.
Drugging the Waters (article)	Natural Resources Defense Council magazine OnEarth (2006)	Impacts of pharmaceutical products on water quality in the Pomperaug River. Only one waste water treatment plant discharges directly to the Pomperaug River, a plant that serves a community of residents all 55+ years old (high concentration of medication use). Article discusses research efforts of UCONN to understand the fate and transport of pharmaceuticals once they enter the river system.

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Table 1-1. Existing plans and studies on the Pomperaug River watershed

Document/ Information Source	Author/Date	Notes
Pomperaug Watershed Management Plan	PRWC (2006)	Original watershed management plan developed prior to the establishment of the EPA 9-elements criteria for watershed-based plans for addressing impaired waters. This Plan outlines data/information that was available at the time as well as data gaps and proposed actions for obtaining such data. Other action items within the plan are broad "programmatic" recommendations for efforts PRWC could/should undertake to further protect local rivers and streams, but not specific remediation or on-the-ground pollution prevention actions to improve or protect water quality.
Volunteer Streamwalk Program – Summary Report and Proposed Action Plan	PRWC (2005)	Findings of ongoing PRWC volunteer streamwalk program. Includes findings from surveys conducted between 2000 and 2005. Survey areas are scattered spatially and temporally (i.e. not contiguously surveyed). Data is qualitative and subjective, and was not collected following a formalized QAPP.
Assessment of Bank Stabilization Options for a Streambank Erosion Site in Woodbury, Connecticut	Prepared for the River Processes and Restoration Course at the Yale School of Forestry and Environmental Studies (2002)	Study to address severe streambank erosion at a site along the Pomperaug River in Woodbury, CT (near Judson Avenue and Orton Lane)
Pomperaug River State of the Watershed Report	COGCNV and PRWC (2001)	Overview of conditions in the Pomperaug River watershed as of 2001. Points of interest include census / projected population, precipitation record, pumping rates for water supply wells, median August streamflow, land use maps, surface water quality classifications
Delineation and Analysis of Uncertainty of Contributing Areas to Wells at the Southbury Training School, Southbury, Connecticut	USGS (2000)	Contributing areas to public-supply wells at the Southbury Training School in Southbury, Connecticut, were mapped by simulating ground-water flow in stratified glacial deposits in the lower Transylvania Brook watershed
The Role of Agriculture In the Preservation of Open Space and the Protection of Water Resources: A Case Study of the Pomperaug River Watershed	COGCNV and PWRC Land Use Committee (undated)	Study to prioritize preservation of agricultural land in the watershed for water quality protection. Notes the hydrologic characteristics of farmland soils and general capacity for groundwater recharge in open farm fields with mid-level vegetative cover

1.3 Why Update the Watershed Plan?

EPA Nine Elements Watershed Plan Framework

1. Impairment
2. Load Reduction
3. Management Measures
4. Technical & Financial Assistance
5. Public Information & Education
6. Schedule
7. Milestones
8. Performance Criteria
9. Monitoring

Since the original Pomperaug River Watershed Management Plan was developed in 2006, EPA and CTDEEP have issued watershed planning guidance for impaired water bodies, placing greater emphasis on achieving quantifiable pollutant load reductions and water quality improvements through specific, measurable actions. The guidance outlines nine key elements (see the adjacent text box) that establish the structure of the plan, including specific goals, objectives, and strategies to protect and restore water quality; methods to build and strengthen working partnerships; a dual focus on addressing existing problems and preventing new ones; a strategy for implementing the plan; and a feedback loop to evaluate progress and revise the plan as necessary.

Updating the watershed management plan is a critical first step to be eligible for future Federal funding for corrective-action projects to improve sections of river that do not fully support recreation or aquatic life because of water-quality or habitat limitations. Following the EPA Nine Elements framework will enable implementation projects under this plan to be considered for funding under the Section 319 nonpoint source program of the Clean Water Act and improve the chances for funding through other State and Federal sources. *Table 1-2* summarizes the nine elements and where they are addressed in this watershed based plan. This updated EPA and CTDEEP watershed planning process is also the recommended approach for achieving the pollutant load reductions for the Pomperaug watershed outlined in the Statewide Bacteria TMDL.

The PRWC, CTDEEP, and other partners recognize the need for an updated watershed management plan for the Pomperaug River to address the water quality issues within the Pomperaug. The updated plan will serve as a road map to return impaired waters to swimmable and fishable conditions and will be used to evaluate changes through time.

Specifically, the objectives of this plan update are to:

- Establish an up-to-date baseline of water quality and land use conditions in the watershed
- Evaluate contributing factors in areas of known impairments
- Identify water quality monitoring needs to support plan implementation
- Establish community buy-in through public engagement in the planning process
- Identify and prioritize actions to reduce pollutant inputs to impaired rivers and streams
- Incorporate proactive measures to protect/maintain high quality streams.

This Plan is a *guidance* document that seeks to resolve surface water quality impairments and related water resource issues within the Pomperaug watershed. This document is not intended to "point fingers" but is to help make all aware of how individual and collective actions are interconnected and can impact the Pomperaug's water resources. Unless identified as a required action under an existing local, State or federal regulation or permit, the recommendations in this Plan for specific projects/actions are intended to be *voluntary* undertakings, carried out with willing, cooperative partners, working together to protect and improve water quality. Towards this end, this Plan identifies potential partners and funding sources to assist with achieving the recommendations presented herein.

Table 1-2. How this watershed based plan addresses the EPA nine key elements

EPA Nine Elements	Description	Location in Watershed Based Plan
1. Impairment	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and other goals identified in the watershed plan	• Section 2 (Watershed Characteristics) • Appendix B (Technical Memorandum – Visual Field Assessments)
2. Load Reduction	An estimate of the load reductions expected from management measures	• Section 5 (Management Measures and Pollutant Load Reductions) • Appendix C (Technical Memorandum – Pollutant Loading Model)
3. Management Measures	A description of the nonpoint source management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan	• Section 3 (Management Recommendations) • Section 4 (Site-Specific BMP Concepts)
4. Technical and Financial Assistance	An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan	• Section 3 (Management Recommendations) recommendations tables • Section 4 (Site-Specific BMP Concepts) • Appendix E (Site-Specific BMP Concept Cost Estimates)
5. Public Information and Education	An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented	• Section 3.3 (Education and Outreach)
6. Schedule	A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious	• Section 3 (Management Recommendations) recommendations tables
7. Milestones	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented	• Section 3 (Management Recommendations) recommendations tables
8. Performance Criteria	A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards	• Section 3 (Management Recommendations) recommendations tables
9. Monitoring	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the performance criteria established	• Section 3 (Management Recommendations) recommendations tables • Section 3.2 (Monitoring and Assessment)

1.4 Plan Development Process

PRWC and its partners, including the watershed municipalities, land owners, and regional, state, and federal agencies, worked collaboratively to develop an updated watershed based plan for the Pomperaug River watershed. Funding for this project was provided in part by CTDEEP through an EPA Clean Water Act Section 319 Nonpoint Source Grant as well as by the Connecticut Community Foundation. Fuss & O'Neill, Inc. was retained by PRWC to lead the development of the watershed based plan.

Development of the watershed based plan consisted of the following tasks.

Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPP) was developed for this project to address data quality objectives associated with the field assessments (collection of direct measurements), manipulation of existing data (secondary data), and pollutant load modeling. The QAPP was approved by CTDEEP and EPA in May 2017. A copy of the approved QAPP is provided in *Appendix A*.

Project Steering Committee

PRWC's Land Use Committee provided guidance and oversight during the plan development process. The Land Use Committee consists of, but is not limited to, representatives from local conservation organizations, town land use departments, as well as regional, state, and federal agencies. Members of the Land Use Committee and other individuals involved in the plan development process are listed in the Acknowledgments section at the beginning of this document. A series of meetings were held with the Land Use Committee to discuss issues of concern in the watershed and provide critical input on planning recommendations. The Land Use Committee also provided review comments on draft deliverables. *Appendix F* contains meeting agenda, presentation materials, and notes from the Land Use Committee meetings held during the project.

Update of Existing Watershed Conditions

Water quality, land use, and other relevant characteristics of the Pomperaug River watershed were updated since the initial watershed management plan was developed in 2006. Updates incorporated information from CTDEEP water quality monitoring data that was collected in support of the Statewide Bacteria TMDL; information contained in the latest Connecticut Integrated Water Quality Report; updated land use, land cover, and impervious cover data; other GIS layers including open space, soils, ecological resources, riparian areas, wastewater, and water supply; and information from PRWC and local, state, and federal agencies regarding pollution sources in the watershed. *Section 2* of this plan summarizes existing water quality and land use conditions in the watershed.

Visual Field Assessments

Visual field assessments were performed by Fuss & O'Neill in September 2017 to further assess potential sources of water quality impairments in the Pomperaug River watershed and to identify possible restoration opportunities. The assessments focused on projects that would reduce bacteria loads in areas of the watershed with documented recreational impairments. Concepts for site-specific Best Management Practices (BMPs) were developed at priority sites throughout the watershed based on the results of the visual assessments and input from the PRWC Land Use Committee. The findings of the visual field assessments are documented in a technical memorandum, which is provided in *Appendix B*.

Watershed Pollutant Loading Model

A pollutant loading model was developed for the Pomperaug River watershed to estimate the quantity of pollutants that are delivered to rivers and streams in the watershed from various land uses and land use activities. The model is used to refine an understanding of relative sources of fecal indicator bacteria and other pollutants and to support the development of planning recommendations for the watershed. The results of the watershed pollutant loading model are described in a technical memorandum, which is provided as *Appendix C* to this plan. Estimated reductions in pollutant loads associated with the plan recommendations are addressed in *Section 5*.

Development of BMP Concepts

Potential site-specific restoration projects or actions to address elevated bacteria levels and flow regime alterations (referred to as Best Management Practices or BMPs) were initially identified based on the updated watershed conditions, results of the visual field assessments and pollutant load modeling, and input from the PRWC Land Use Committee. A matrix of potential BMPs was developed to help prioritize and select up to 15 site-specific project concepts based on consideration of bacteria removal, relative cost, maintenance requirements, and other factors. A copy of the BMP Prioritization matrix is included in *Appendix D*. Project concepts were then developed for 10 small BMP projects and 5 large BMP projects to serve as potential on-the-ground projects for future implementation. They also provide examples of the types of projects that could be implemented at similar sites throughout the watershed. The BMP project concepts are included in *Section 4* of this plan.

Management Plan Recommendations

In addition to site-specific BMP concepts, recommendations are also provided for other watershed-wide and non-structural BMPs with the goal of addressing elevated bacteria levels and alterations to the flow regime. *Section 3* of this plan outlines the management recommendations for the watershed, including responsible parties, timeframes, products and evaluation criteria, and estimated costs. *Section 6* of the plan identifies potential funding sources for implementation of the plan recommendations.

1.5 Public Participation and Outreach

Public participation and outreach was conducted as part of the watershed planning process to increase public understanding of issues affecting the watershed, to encourage participation in the development of the watershed plan, and to build support for implementation of the plan.

Early in the planning process, PRWC met with local elected officials and land use agencies to discuss the known impairments within the Pomperaug Watershed and the need to update the watershed management plan to a watershed based plan. This outreach includes a January 17, 2017 meeting with the First Selectman of Bethlehem; a January 18, 2017 presentation at the Joint Land Use Commission Meeting in the Town of Woodbury; a February 14, 2017 presentation during a joint meeting of the Inland Wetlands Agency and Conservation Commission in the Town of Bethlehem; an April 4, 2017 presentation at a Joint Land Use Commission Meeting in the Town of Southbury; and a progress report at the Joint Land Use Commission Meeting in the Town of Woodbury on January 17, 2018. Meeting presentations and notes are provided in *Appendix G*.

Three public information meetings were held on July 17 and 18, 2018 to present information on the Pomperaug River watershed, the watershed planning process, results of technical analyses, general recommendations for reducing pollutant loads to local rivers and streams, and to provide an opportunity for public feedback and input. The July 17 meeting was held in the evening at the Woodbury Municipal Complex. Two meetings were held on July 18, one in the afternoon at Southbury Town Hall and another in the evening at the Bethlehem Public Library. Meeting announcements, presentation materials, and notes are provided in *Appendix G*.

The draft watershed based plan was presented to the public on the evening of August 22, 2018 at the Woodbury Senior Center. Questions and comments were received during and following the meeting. Public comments have been incorporated into the final watershed management plan. The meeting announcement, presentation materials, and notes are also provided in *Appendix G*.

Throughout the planning process, outreach methods included press releases to area newspapers, news and blog posts on the PRWC website www.pomperaug.org, and articles featured in PRWC's semi-annual newsletter. These outreach materials are also provided in *Appendix G*.

2 Watershed Characteristics

2.1 Watershed Description

The Pomperaug River watershed (also referred to as the Pomperaug River Regional Basin) covers an area of approximately 90 square miles within the eight Connecticut towns of Bethlehem, Woodbury, Southbury, Washington, Roxbury, Watertown, Middlebury, and Morris in western Connecticut (*Table 2-1*). The Pomperaug River Regional Basin (#68)[1] consists of six Subregional Basins: Pomperaug River Subregional Basin (#6800), East Spring Brook Subregional Basin (#6801), Nonnewaug River Subregional Basin (#6802), Sprain Brook Subregional Basin (#6803), Weekeepeemee River Subregional Basin (#6804), Hesseky Brook Subregional Basin (#6805), and Transylvania Brook Subregional Basin (#6806) (*Figure 2-1*).

Table 2-1. Watershed composition by municipality

Municipality	Acres	Square Miles	Percent of Watershed
Woodbury	22,536	35.2	39.6
Southbury	12,624	19.7	22.2
Bethlehem	11,975	18.7	21.0
Washington	3,273	5.1	5.7
Roxbury	2,982	4.7	5.2
Watertown	2,492	3.9	4.4
Morris	895	1.4	1.6
Middlebury	185	0.3	0.3
Total	**56,960**	**89.0**	**100.0**

The main stem of the Pomperaug River is approximately 13.4 miles long, winding from the confluence of the Weekeepeemee and Nonnewaug Rivers in Woodbury, south to the Housatonic River between Southbury and Newtown where it flows into Lake Zoar. The Weekeepeemee and Nonnewaug Rivers are the largest tributaries to the Pomperaug River. Transylvania Brook and Hesseky Brook drain to the Pomperaug, while Sprain Brook drains to the Weekeepeemee River and East Spring Brook feeds the Nonnewaug River. Numerous smaller streams complete the network of waterbodies draining the Pomperaug River watershed. Major surface waterbodies in the watershed include Long Meadow Pond, Cat Swamp Pond, Judd Pond Reservoir, and Lockwood Reservoir.

The northern portion of the Pomperaug River watershed is rural in character with primarily low-density residential land use and agricultural lands, while land use in the southern part of the watershed is dominated by suburban residential and commercial development. Population density is 185 people per square mile in Bethlehem, 267 people per square mile in Woodbury, and 500 people per square mile in Southbury. Together, these three towns make up 83% of the watershed area. Major roads located in the watershed include Interstate 84, U.S. Route 6, and State Routes 61, 63, 64, 67, 172, 317, 47, and 132. Other landmarks in the watershed include Heritage Village, Audubon Center at Bent of the River, Southbury Training School, and Orenaug Park.

[1] CTDEEP has established a statewide mapping system of natural drainage basins in Connecticut which classifies watersheds in a hierarchical order based on drainage size. Major basins are subdivided into smaller nested basins described, in turn, as regional, subregional and local drainage basins. Each basin has a unique code which reflects its relationship to the major basin in which it is nested.

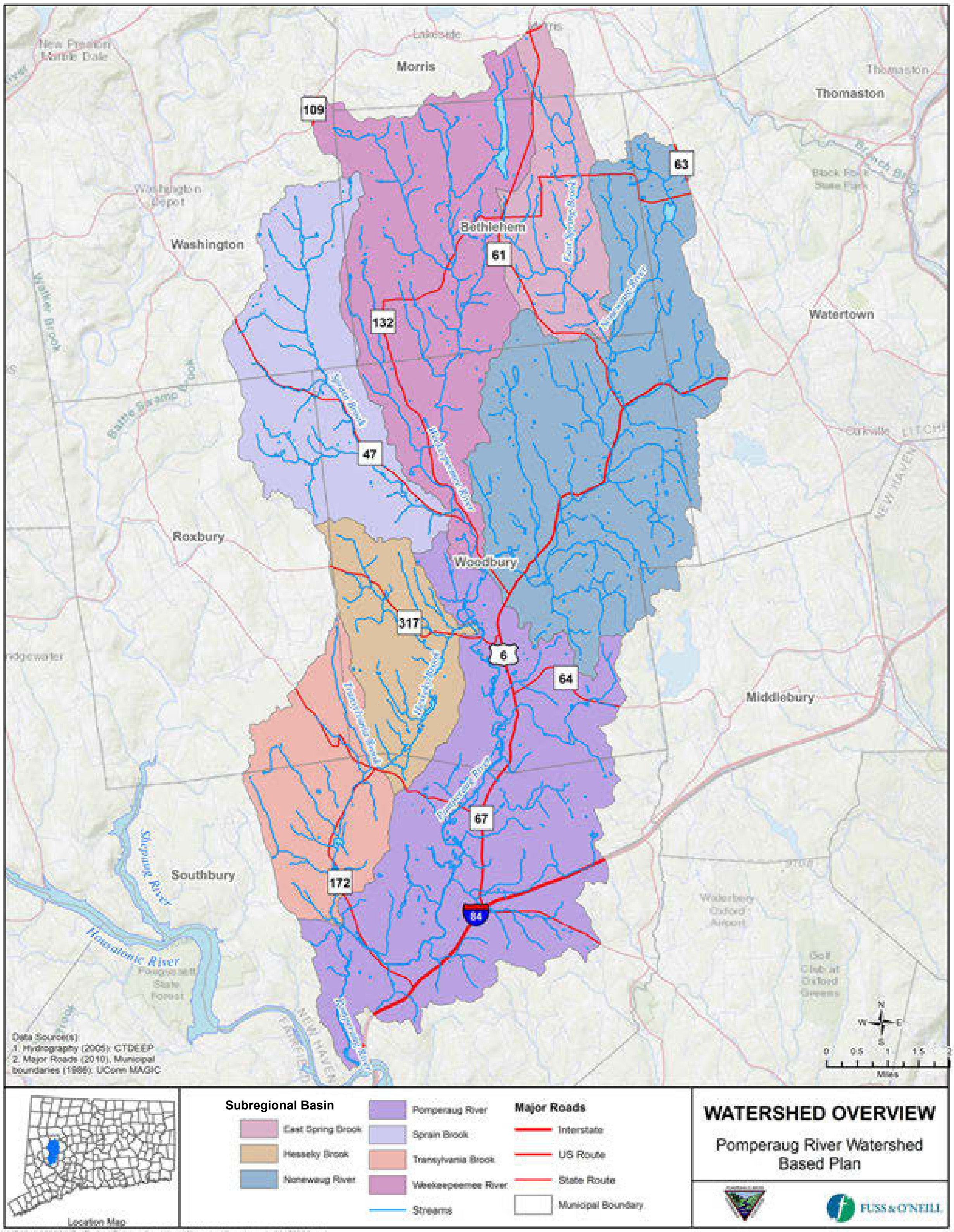

Figure 2-1. Pomperaug River Regional Basin and Subregional Basins

2.2 Water Quality

Water quality in the Pomperaug River and its tributaries is mixed. Some segments of the Pomperaug River have good water quality and support recreational activities (fishing, swimming, and boating) and healthy populations of resident fish species and benthic macroinvertebrates. Other segments of the Pomperaug and its tributaries have been impacted by historical development and land use activities, including portions of the Pomperaug River, Weekeepeemee River, and Transylvania Brook where in-stream fecal indicator bacteria (*Escherichia coli* or *E. coli*) levels have been measured in excess of the State water quality standard for recreation in non-designated swimming areas (410 colonies/100mL maximum for a single sample, and less than 126 colonies/100 mL for the geometric mean). Aquatic life has also been impacted in some rivers and streams as a result of man-made impoundments, groundwater withdrawals for public water supply, and land development, which has contributed to reduced streamflow, causing some streams to run dry in extreme drought conditions.

Nineteen river segments within the Pomperaug River Watershed were assessed in the 2016 Integrated Water Quality Report (IWQR). Of these, five river segments are impaired (i.e., do not meet water quality standards) for at least one designated use category (*Figure 2-2* and *Table 2-2*).

- **Pomperaug River.** Pomperaug River segment CT6800-00_01 ("Pomperaug River-01") is 2.74 miles long and extends from its mouth at the confluence with the Housatonic River, upstream to the confluence with Transylvania Brook in Southbury. Pomperaug River Segment CT6800-00_03 ("Pomperaug River-03") is 1.31 miles long and extends from Flood Bridge Road, upstream to the confluence with Bullet Hill Brook downstream of Heritage Road in Southbury. Both segments are fully supporting of aquatic life, but impaired for recreation. Two other Pomperaug River segments have been identified as fully supporting for aquatic life but not assessed for recreation.

- **Weekeepeemee River.** Weekeepeemee River segment CT6804-00_01 ("Weekeepeemee River-01") is 9.61 miles long and extends from its mouth at the confluence with the Nonnewaug River downstream of the Jacks Bridge Road crossing in Woodbury to its headwaters in a marsh just upstream of Bergman Hill Road crossing, east of the intersection with Todd Hill Road in Morris. The segment is fully supporting for aquatic life but is impaired for recreation.

- **Transylvania Brook.** Transylvania Brook segment CT6806-00_01 ("Transylvania Brook-01") is 1.6 miles long and extends from its mouth at the confluence with the Pomperaug River (just downstream of the East Flat Hill Road crossing), upstream to its confluence with Spruce Brook (just on the upstream side of the former Southbury Training School wastewater treatment facility) in Southbury, and is impaired for both aquatic life and recreation uses.

- **Stiles Brook.** Stiles Brook segment CT6800-03_01 ("Stiles Brook-01") is 0.25 miles long and extends from its mouth at the confluence with the Pomperaug River upstream to the Anna Stiles Pond outlet Dam adjacent to Route 6 in the northern portion of Southbury. This segment is listed in the 2016 IWQR as not assessed for recreation but impaired for aquatic life, due to flow regime alterations.

Potential sources of bacteria in the watershed include "non-point sources" such as diffuse stormwater runoff, failing or malfunctioning septic systems, agricultural activities including but not limited to numerous farms in the northern part of the watershed, and waste from wildlife and pets. "Point sources" of bacteria include discharges from Municipal Separate Storm Sewer Systems (MS4s), potential illicit discharges, and runoff from industrial and commercial facilities.

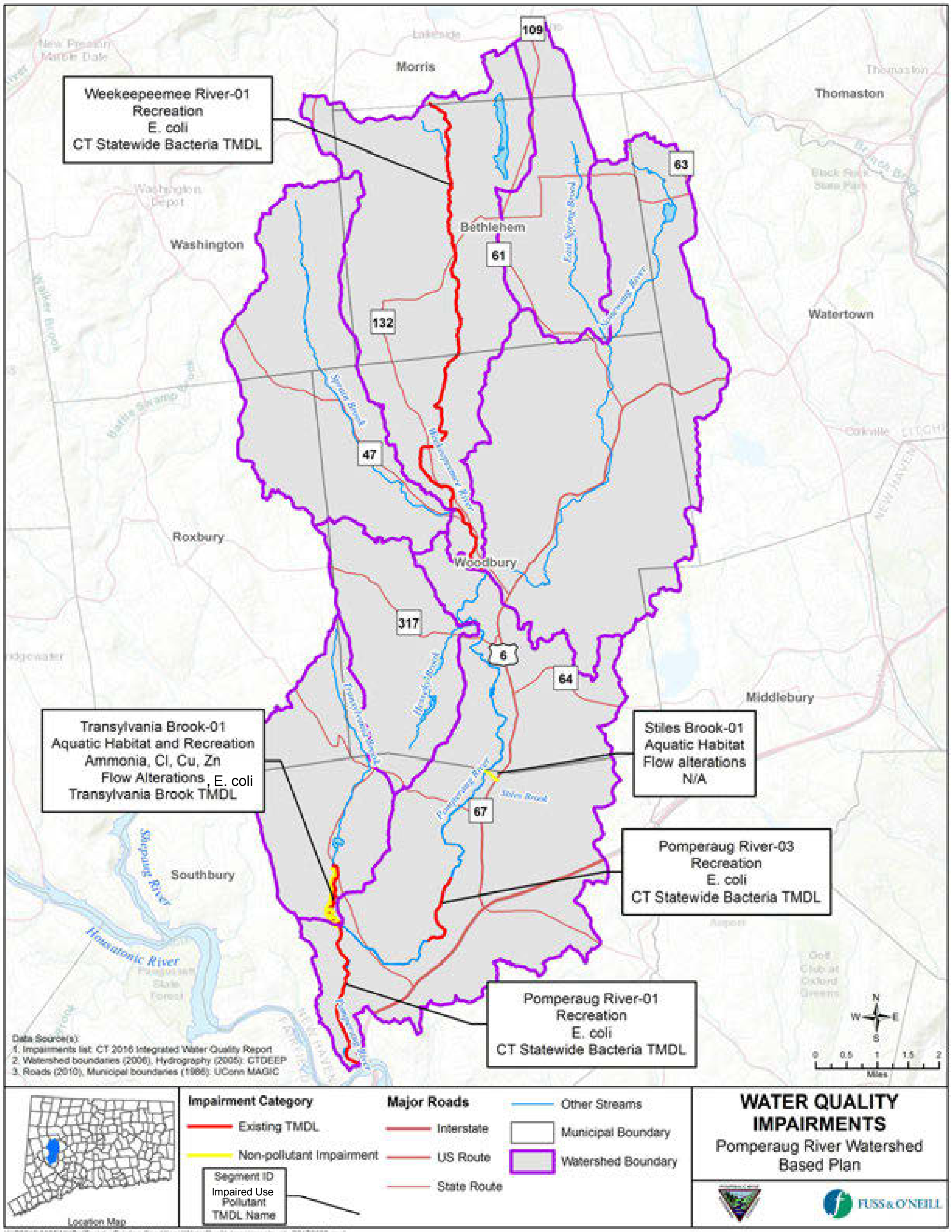

Figure 2-2. Water quality impairments in the Pomperaug River watershed

It is important to note that the data supporting the identified recreational impairments in the Pomperaug River watershed are extremely limited and based on data collected between 2006 and 2010.

Table 2-2. Impaired waterbody segments in the Pomperaug River watershed

Impaired Segment	Impaired Designated Use	Cause	TMDL Status
CT6800-00_01 Pomperaug River-01 Southbury	Recreation	*E. coli*	Included in Statewide Bacteria TMDL approved 2012
CT6800-00_03 Pomperaug River-03 Southbury, Woodbury	Recreation	*E. coli*	Included in Statewide Bacteria TMDL approved 2012
CT6804-00_01 Weekeepeemee River-01 Morris, Bethlehem, Woodbury	Recreation	*E. coli*	Included in Statewide Bacteria TMDL approved 2012
CT6806-00_01 Transylvania Brook-01 Southbury	Recreation Aquatic Life	*E. coli* Flow alterations, Ammonia, Chlorine, Copper, and Zinc	Proposed for bacteria reduction action plan development in 2018. Aquatic life impairment TMDL approved in 2001.
CT6800-03_01 Stiles Brook-01 Southbury	Aquatic Life	Flow alterations	Listed as category 4C: Non-pollutant impairment. No TMDL required

TMDL Analysis and Target Load Reductions

The Connecticut Department of Energy and Environmental Protection (CTDEEP) completed a "Statewide Bacteria Total Maximum Daily Load" (TMDL) for 176 impaired waterbody segments based on the 2010 Impaired Waters List (CTDEEP, 2012). The TMDL sets target pollution levels and establishes a framework for restoring water quality of the impaired segments. Three of the bacteria-impaired segments in the Pomperaug River watershed are included in the approved TMDL (Pomperaug River-01 and -03 and Weekeepeemee River-01) based on past monitoring data. The TMDL identifies percent reductions in geometric mean and single sample fecal indicator bacteria (*E. coli*) concentrations required to meet recreational water quality criteria.

Based on the 2010 data included in the TMDL, the Pomperaug River-01 segment requires a 65% reduction in geometric mean *E. coli* levels and a 90% single sample *E. coli* reduction to meet the TMDL targets. For the Pomperaug River-03 segment, the required percent reductions, based on data from 2006-2009, are 75% and 92%, respectively. The Weekeepeemee River-01 TMDL reduction targets are also derived from 2010 data, including 48% reduction in geometric mean and a 98% reduction in single sample bacteria levels. It is also important to note that these impairments and percent reductions are based on a very limited data set consisting of approximately 10 samples (wet and dry weather) collected at a single station in each river segment in 2010.

Potential sources of indicator bacteria identified in the TMDL include discharges from MS4s and industrial and commercial facilities. Additional non-point sources include stormwater runoff, failing septic systems, agricultural activities, and wastes from wildlife and pets. Stormwater discharges to MS4s and illicit discharges are two of the primary targets identified in the Statewide Bacteria TMDL for pollution reduction in freshwater segments. These items will be addressed through the regulatory requirements of the MS4 Permit program.

CTDEEP also completed a TMDL analysis in 2001 for the impaired segment of Transylvania Brook downstream of the Southbury Training School. This TMDL for copper, zinc, chlorine, and summer ammonia was developed for aquatic life habitat during low-flow conditions in the brook. As of June 2013, the discharge from the Southbury Training School to Transylvania Brook was eliminated and all flows are now conveyed to the

Heritage Village Water Pollution Control Facility for treatment and discharge. An action plan to address the recreation impairment is scheduled for development by CTDEEP in 2018.

Water Quality Monitoring

CTDEEP routinely monitors ambient water quality, macroinvertebrate diversity, and fisheries at three locations within the watershed (*Table 2-3*). These data are incorporated into the biannual IWQRs and TMDLs. Due to constrained resources, CTDEEP has a limited number of fixed stations across the state that are monitored on an annual basis. Additional assessments are conducted annually on a five-year rotating basis by major watershed throughout the state (i.e., one year the focus will be the Housatonic River Major Basin, and another it will be the Connecticut River Major Basin). As such, the TMDLs in the Pomperaug River watershed are based on limited water quality monitoring data. No water quality sampling for bacteria has occurred since 2010, as the State's priority for bacteria monitoring is focused on State-owned public swimming areas.

Table 2-3. CTDEEP Water Quality Monitoring Stations

Ambient Water Quality Station ID	TMDL Station ID	Waterbody	Location
15388	1313	Pomperaug-01	Off Flagg Swamp Road
15025	934	Pomperaug-03	Upstream of Poverty Road crossing
18874	6122	Weekeepeemee-01	Route 47 bridge across from Ruffin Road

2.3 Land Use and Land Cover

Land Cover

The distribution of land cover (physical land type) and land use (how people make use of land) within the watershed plays an important role in shaping spatial patterns and sources of nonpoint source pollution and surface water quality. *Figure 2-3* shows the distribution of land cover across the Pomperaug River watershed. Based on the National Land Cover Database (NLCD) land cover data[2], approximately 14% of the watershed falls into one of the four developed land cover categories (*Table 2-4*), while 16% is agricultural land cover and 60% is deciduous forest land. The Pomperaug River subregional basin is substantially more developed than the other subregional basins in the watershed, which have a greater proportion of agricultural and forested land. The southern part of the Pomperaug watershed is more developed, while the northern portion of the watershed is generally less developed and more agricultural.

Land Use

Where land cover characterizes the physical landscape, land use refers to the way that humans utilize the land. Land use data for the Pomperaug River watershed were obtained from the Naugatuck Valley Council of Governments (NVCOG) for the municipalities within their region. NVCOG last revised their land use data in 2017. Morris, Washington, and Roxbury are not within NVCOG's region and did not have digitized land use data. For this project, land use in these towns was manually assigned to the NVCOG land use categories,

[2] The National Land Cover Database (NLCD) provides Landsat-based, 30-meter resolution land cover data for the entire nation. The most recent national data, presented here, are from 2011. The University of Connecticut Center for Land Use Education and Research (UCONN CLEAR) provides a more recent dataset (2015). However, the NLCD data are preferred as they disaggregate developed land into more precise categories based on density of development, and provide more detailed divisions for agricultural land and other habitat types.

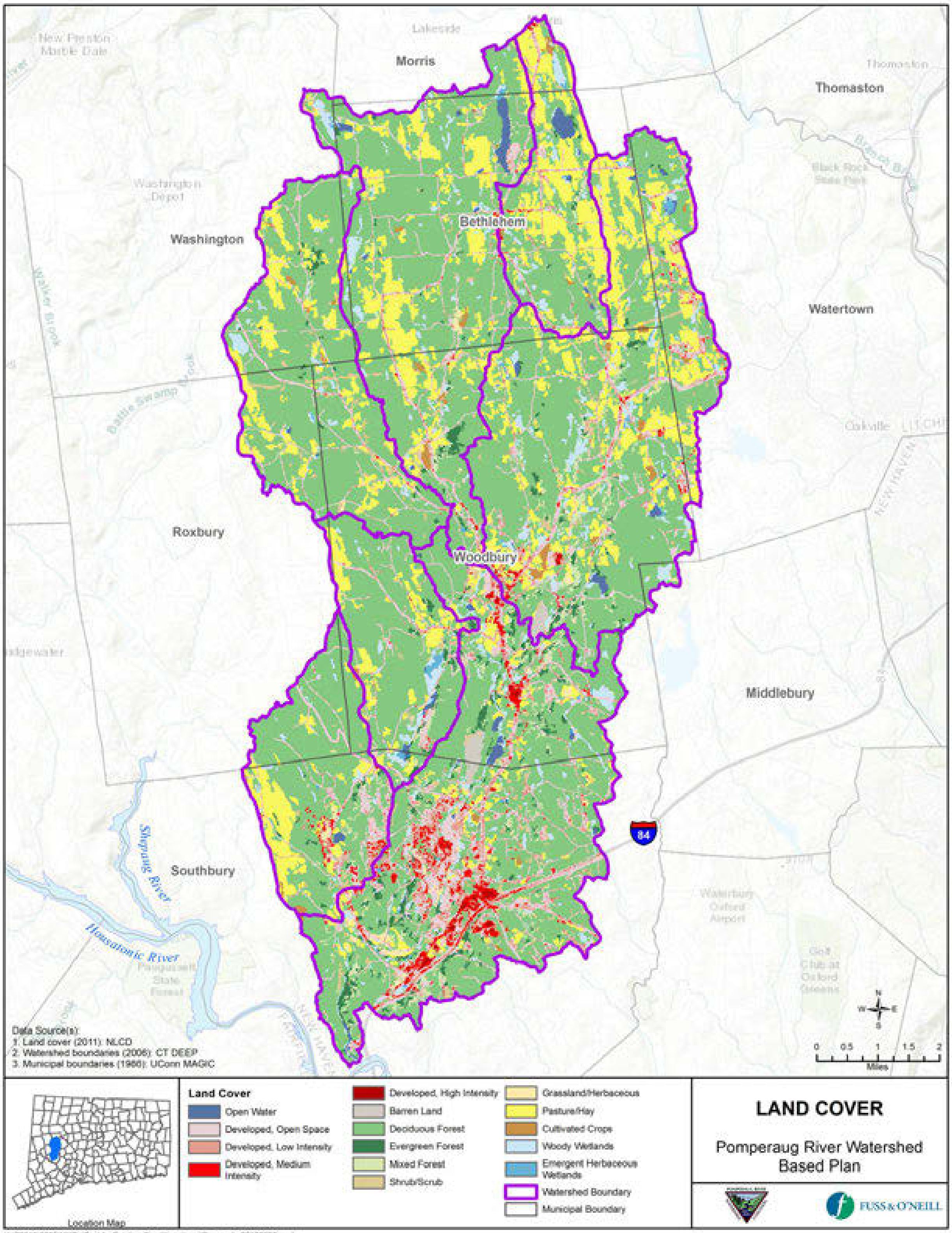

Figure 2-3. Land cover in the Pomperaug River watershed (NLCD, 2011)

Table 2-4. Distribution of land cover types by acres (and percent) in the Pomperaug River watershed (NLCD, 2011)

Land Cover	East Spring Brook		Weekeepeemee River		Nonnewaug River		Sprain Brook		Hesseky Brook		Pomperaug River		Transylvania Brook	
Open Water	90.3	(2.4)	142.3	(1.4)	84.3	(0.6)	9.1	(0.1)	31.1	(0.8)	95.4	(0.7)	15.8	(0.3)
Developed, Open Space	**223.9**	**(6.0)**	**655.7**	**(6.4)**	**946.1**	**(7.0)**	**375.5**	**(5.4)**	**257.5**	**(6.5)**	**1,724.2**	**(12.6)**	**415.1**	**(9.0)**
Developed, Low Intensity	**131.0**	**(3.5)**	**171.9**	**(1.7)**	**456.2**	**(3.4)**	**59.6**	**(0.8)**	**83.6**	**(2.1)**	**1,155.7**	**(8.4)**	**174.3**	**(3.8)**
Developed, Medium Intensity	22.5	(0.6)	21.8	(0.2)	88.7	(0.7)	4.7	(0.1)	5.6	(0.1)	506.5	(3.7)	57.8	(1.3)
Developed, High Intensity	2.0	(0.1)	2.0	(0.0)	9.1	(0.1)	0.0	(0.0)	0.0	(0.0)	94.3	(0.7)	2.9	(0.1)
Barren Land	1.8	(0.0)	2.2	(0.0)	75.4	(0.6)	3.1	(0.0)	2.9	(0.1)	118.7	(0.9)	2.2	(0.0)
Deciduous Forest	**1,559.7**	**(41.7)**	**6,794.0**	**(65.9)**	**7,643.6**	**(56.2)**	**5,094.0**	**(72.7)**	**2,675.4**	**(67.2)**	**7,535.5**	**(55.1)**	**3,012.9**	**(65.2)**
Evergreen Forest	24.2	(0.6)	107.2	(1.0)	166.8	(1.2)	56.5	(0.8)	84.7	(2.1)	505.6	(3.7)	40.5	(0.9)
Mixed Forest	27.8	(0.7)	67.1	(0.7)	315.3	(2.3)	21.3	(0.3)	34.2	(0.9)	352.4	(2.6)	42.7	(0.9)
Shrub/Scrub	38.2	(1.0)	126.7	(1.2)	290.4	(2.1)	179.4	(2.6)	61.1	(1.5)	301.7	(2.2)	40.0	(0.9)
Grassland-Herbaceous	9.3	(0.2)	45.1	(0.4)	46.5	(0.3)	13.3	(0.2)	13.8	(0.3)	147.6	(1.1)	41.4	(0.9)
Pasture/Hay	**1,404.3**	**(37.6)**	**1,746.0**	**(16.9)**	**2,739.2**	**(20.1)**	**1,027.4**	**(14.7)**	**522.3**	**(13.1)**	**598.5**	**(4.4)**	**685.0**	**(14.8)**
Cultivated Crops	35.4	(0.9)	71.1	(0.7)	118.3	(0.9)	29.1	(0.4)	8.9	(0.2)	28.7	(0.2)	30.0	(0.6)
Woody Wetlands	155.6	(4.2)	332.4	(3.2)	563.2	(4.1)	135.2	(1.9)	155.2	(3.9)	496.7	(3.6)	56.7	(1.2)
Emergent Herbaceous Wetlands	12.9	(0.3)	26.5	(0.3)	54.3	(0.4)	2.2	(0.0)	44.9	(1.1)	24.7	(0.2)	2.0	(0.0)
Total	**3,738.9**		**10,312.1**		**13,597.1**		**7,010.6**		**3,981.2**		**13,686.3**		**4,619.3**	

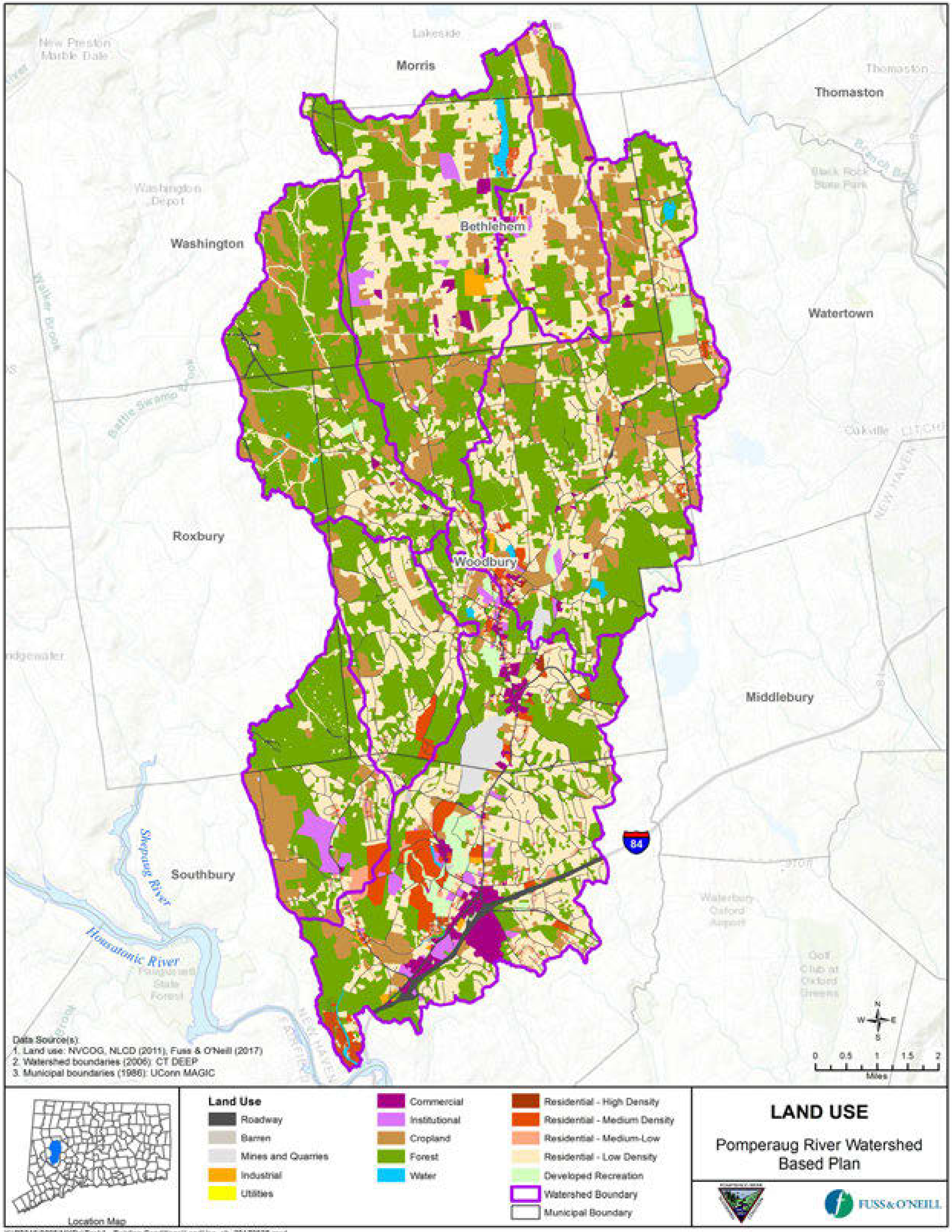

Figure 2-4. Land use in the Pomperaug River watershed (NVCOG, 2017)

Table 2-5. Land use composition by percent* in the Pomperaug River watershed (NVCOG, 2017)

Land Use	East Spring Brook	Hesseky Brook	Nonnewaug River	Pomperaug River	Sprain Brook	Transylvania Brook	Weekeepeemee River	Total Land Use Acres
Barren	0.0	0.0	0.0	0.2	0.3	0.1	0.0	**54.8**
Commercial	1.4	0.0	0.6	4.8	0.2	0.1	1.4	**699.0**
Cropland	**29.3**	**7.2**	**18.7**	5.1	**15.2**	**16.7**	**17.2**	**8,996.4**
Developed Recreation	0.0	0.0	1.5	3.3	0.4	0.1	0.1	**449.9**
Forest	**26.0**	**45.8**	**39.9**	**30.1**	**63.8**	**53.4**	**43.2**	**24,835.1**
Industrial	0.2	0.0	0.2	0.4	0.0	0.0	0.9	**137.4**
Institutional	1.2	0.1	0.4	2.2	0.0	5.1	2.0	**904.0**
Mines and Quarries	0.0	0.0	0.6	3.0	0.0	0.0	0.0	**297.9**
Residential - High Density	0.0	0.0	0.1	0.1	0.0	0.0	0.0	**19.8**
Residential - Low Density	**37.0**	**39.2**	**30.0**	**34.1**	**17.4**	**16.8**	**30.0**	**16,795.8**
Residential - Medium Density	0.4	2.9	0.9	6.4	0.0	1.7	0.5	**1,059.7**
Residential - Medium-Low	1.0	1.1	1.3	2.8	0.2	3.1	0.6	**826.8**
Roadway	0.3	3.9	3.3	**7.1**	2.0	2.8	1.0	**1,677.1**
Utilities	0.3	0.0	0.0	0.0	0.0	0.0	0.0	**25.3**
Water	0.0	0.0	0.5	0.4	0.2	0.0	1.1	**181.2**
Total (Acres)	**3,742**	**3,982**	**13,605**	**13,691**	**7,011**	**4,616**	**10,313**	**59,960**

*The top three most prevalent land uses within a subregional basin are shown in bold.

based on land cover data and aerial photography. Residential and agricultural uses are the dominant developed land uses across the entire watershed, comprising roughly half of the watershed land area (*Table 2-5*; *Figure 2-4*). Commercial and institutional uses make up a small proportion of land use in the subregional basins, but are more concentrated in the Pomperaug Subregional Basin and tend to cluster at the southern-most end of the watershed, in Southbury, near the I-84 corridor. Forest is the largest undeveloped category, making up 25-65% of the land area within each subregional basin.

2.4 Impervious Cover

Impervious cover (IC) refers to any surface that prevents natural infiltration of stormwater into the soil, most notably buildings and pavement. Urban stormwater runoff generated in developed areas from buildings, pavement, and other impervious surfaces is a significant source of pollutants to the Pomperaug River and its tributaries. Stormwater flowing off of impervious surfaces typically contains pollutants associated with atmospheric deposition, vehicles, industrial and commercial operations, lawns, construction sites, and human and animal activities. Without treatment, these pollutants may be conveyed during storm events from an impervious surface directly to a nearby waterbody or to a storm drainage system that eventually discharges to a waterbody. Impervious surfaces also prevent infiltration of rainfall and runoff into the ground which helps to filter out pollutants. In addition, impervious surfaces, especially those connected to traditional, piped storm drainage systems, increase the volume, peak flow rates, and velocity of stormwater runoff to receiving waters. This can contribute to higher flood risk, channel erosion, sedimentation, and reduced groundwater recharge and baseflow to streams, particularly during dry periods.

Research has documented the effects of urbanization on stream and watershed health. More specifically, studies by CTDEEP that have found a negative relationship between upstream impervious land cover and aquatic habitat in downstream, adjacent waters, with predictable, detrimental impacts to aquatic life when impervious cover exceeds 12% (CTDEEP, 2015a). However, impacts to streams can also occur before impervious cover reaches that level, particularly where sources other than piped stormwater discharges contribute to water quality impairments.

Figure 2-5 and *Table 2-6* summarize IC in the Pomperaug River watershed based on the 2012 high-resolution impervious cover data layer released by UCONN CLEAR in 2016. The map in *Figure 2-5* also includes estimates of IC for each local stream basin (smallest CTDEEP watershed unit) in the Pomperaug watershed. As a whole, the Pomperaug River watershed has an estimated 5.6% impervious cover. At 9.8%, impervious cover in the Pomperaug River subregional basin is below the 12% impacts threshold. However, at the local basin scale, 9 of the 57 local basins across the entire watershed exceed the 12% threshold. The highest impervious cover in the watershed is found in the local basins associated with the Pomperaug-03 river segment, where overall IC is estimated at 20-30%. IC in this basin is driven by the development along Main Street South and Heritage Village. Local basins that are predominantly rural and/or are less-developed tend to have impervious cover below 5%.

Table 2-6. Impervious Cover statistics (2012) for the Pomperaug River watershed (CTECO, 2017)

	Impervious Cover	
Subregional Basin	**Percent**	**Acres**
Pomperaug River	9.8	1,343.7
Transylvania Brook	5.5	255.0
East Spring Brook	5.3	199.3
Hesseky Brook	5.0	200.2
Nonnewaug River	4.6	619.8
Weekeepeemee River	3.6	372.4
Sprain Brook	2.9	204.4

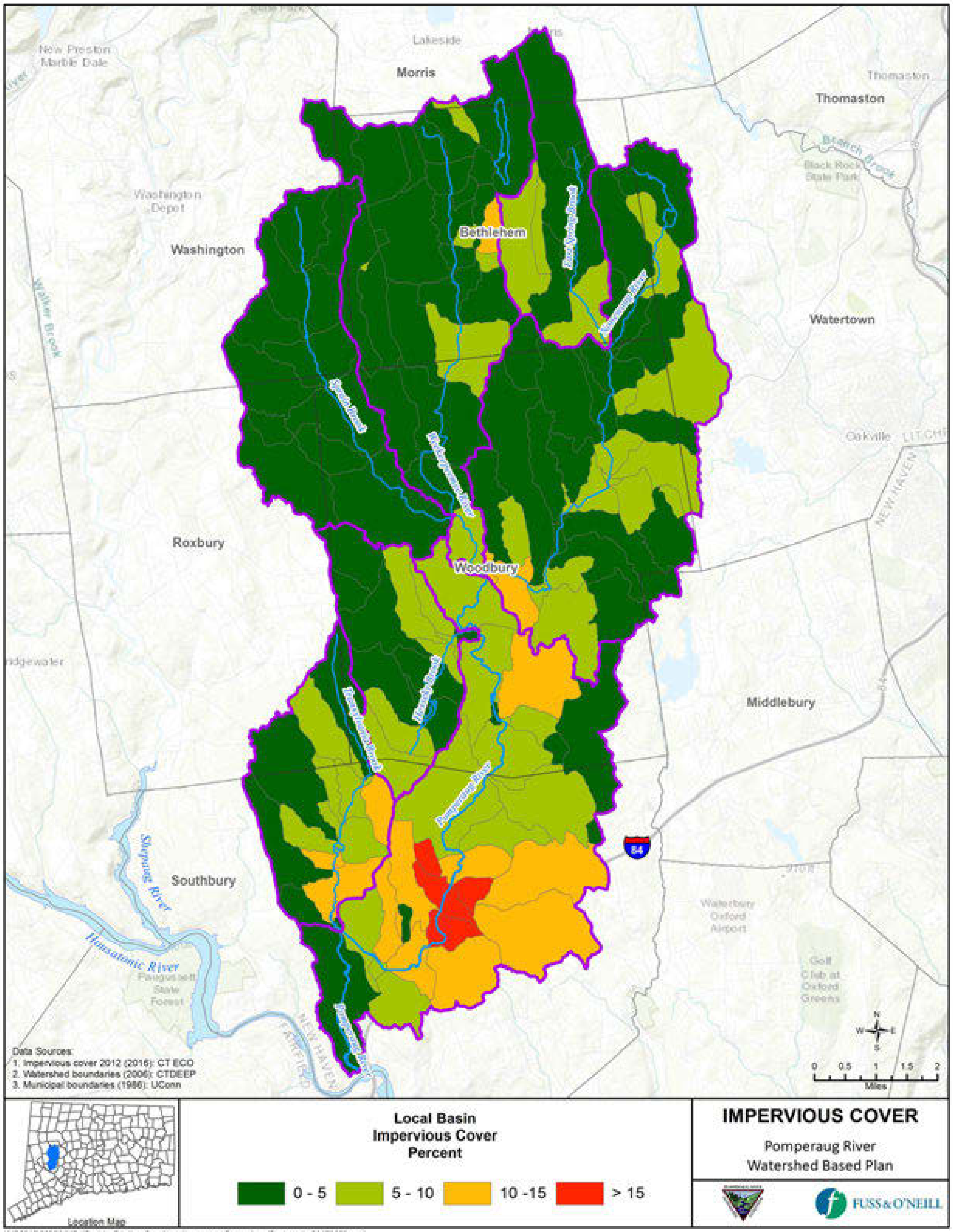

Figure 2-5. Impervious cover by local stream basin (2012) in the Pomperaug River watershed (CTECO, 2017)

2.5 Open Space

Open space plays a critical role in protecting and preserving the health of a watershed by limiting development and impervious cover, preserving natural pollutant attenuation characteristics, and supporting other planning objectives such as farmland preservation, community preservation, passive recreation, habitat, and water supply. Open space includes public open space, which is land owned by the local, state, or federal government. Public open spaces are lands which may be used for recreation or other purposes and which may currently be lightly developed and potentially subject to future, more intensive development, if not protected. Permanently protected open space is land that has been set aside specifically to prevent future development through conservation easements, purchase, or other methods. Protecting open space from development, through these methods, is also an effective strategy for protecting the quantity and quality of local water resources.

Approximately 16 percent of the land area in the Pomperaug River watershed consists of protected open space (*Figure 2-6*). The permanently protected open space parcels in the Pomperaug watershed include Town-owned parks, recreation areas, and preserves; land trust properties; State of Connecticut properties that are undeveloped; farms where the development rights have been acquired (excluding Public Act 490 land); and Class A water company land. Major protected open space parcels in the Pomperaug River watershed include:

- Southbury Training School, Southbury (800 acres)
- Whittemore Sanctuary, Flanders Nature Center and Land Trust, Woodbury (700 acres)
- Audubon Center at Bent of the River, Southbury (450 acres)
- Bronson Lockwood Reservoir, Bethlehem (205 acres)
- Orenaug Park, Woodbury (182 acres)
- Baldridge Farm Preserve, Woodbury (145 acres)
- Aldo Leopold Wildlife Management Area, Southbury (135 acres)
- Swendsen Farm Preserve, Bethlehem (130 acres)
- Good Hill Farm Preserve, Roxbury Land Trust, Woodbury (127 acres)
- Young Farm, Watertown (118 acres)
- Van Vleck Sanctuary, Woodbury (111 acres)
- Platt Farm Preserve, Southbury (129 acres)
- Janie Pierce Park, Southbury/Woodbury (145 acres).

2.6 Geology and Soils

The Pomperaug River watershed has a unique geology, comparable to the Connecticut River Basin. Typical of watersheds in Connecticut, the topography of the Pomperaug watershed is quite variable, encompassing flat plains along the streams, with a mixture of rolling hills and steep slopes that run roughly north-to-south. The surficial geology of the watershed has been shaped by glaciation and is a major factor shaping topography, soils, and drainage characteristics within the watershed (USGS, 1929). Glacial advance and retreat carved rock ledges and removed existing soil, and deposited two types of glacial drift: unstratified drift, or till (e.g., hard-packed and jumbled mixture of unsorted glacial sediment smeared onto the bedrock by the glacier, often referred to colloquially as "hard pan"), and stratified drift, or glacial outwash (e.g., sorted layers of sand or gravel deposited by glacial meltwaters). Till was deposited directly by the ice, forming a till mantle of variable thickness, frequently interrupted by bedrock in the higher elevations of the watershed (Lyford et al., 2007). Stratified drift was deposited by glacial meltwater in the Pomperaug, Transylvania, and Hesseky Subregional Basins. The resulting alluvial plains formed terraces along the sides of valleys. These terraces are largely

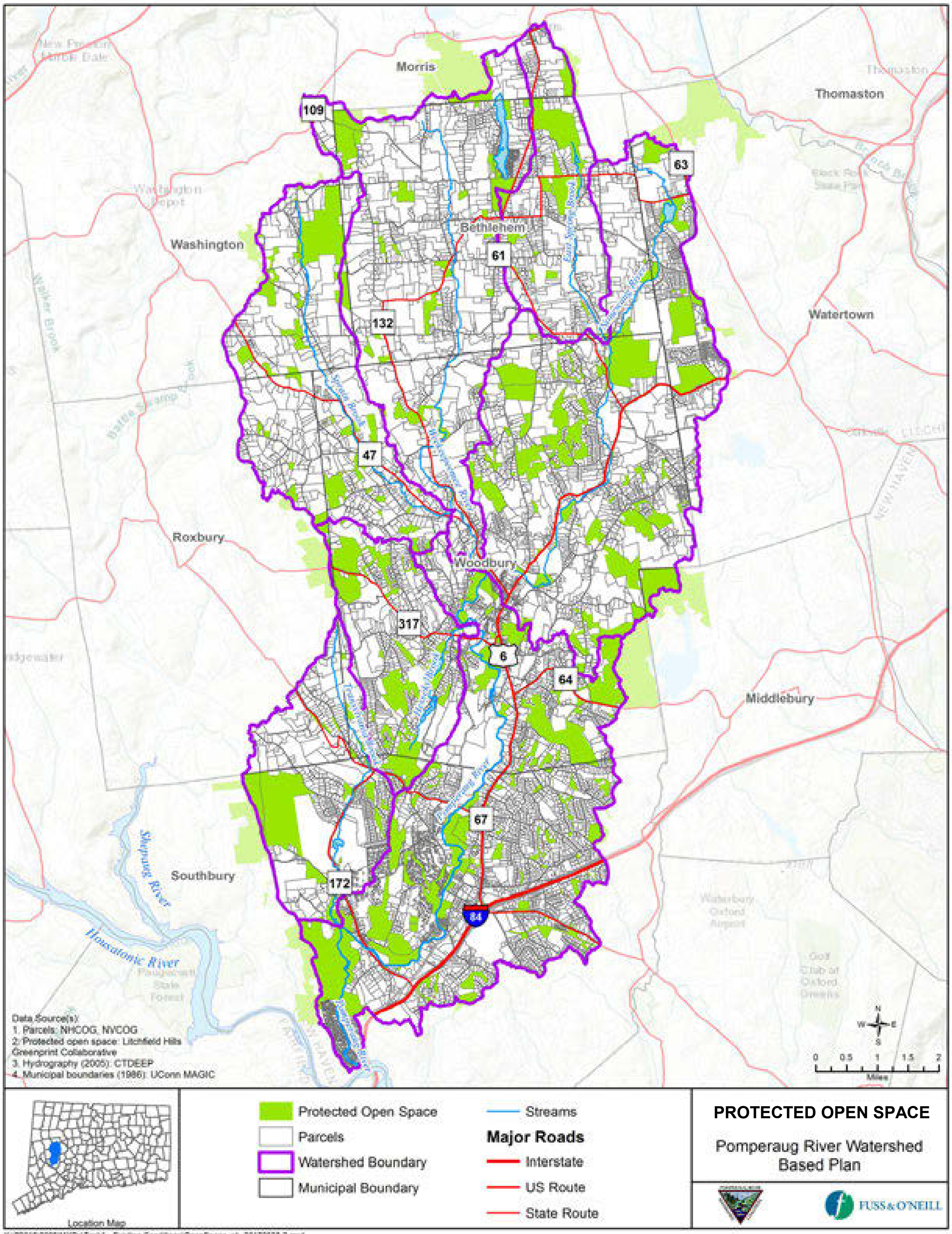

Figure 2-6. Protected open space parcels in the Pomperaug River watershed

smooth, with some kames and kettle holes[3]. At the northern reaches of the Pomperaug River watershed, the landscape rises to a maximum elevation of 1,150 feet above sea level in Morris, falling to just 100 feet above sea level at the confluence with the Housatonic River.

The U.S. Department of Agriculture - Natural Resources Conservation Service (NRCS) classifies soils into Hydrologic Soil Groups that characterize a soil's runoff versus infiltration potential after prolonged wetting. Group A soils are the most well drained, meaning that they have low runoff potential and high infiltration potential. At the other extreme, Group D soils are the most poorly drained. Water movement through Group D soils is restricted, causing them to have high runoff potential and low infiltration potential. Group D soils are frequently either high in clay content or shallow soils over an impermeable layer (such as shallow bedrock or a dense glacial till) or a shallow water table. Group B and C soils complete the continuum between these extremes. Group B soils have moderately low runoff potential and unimpeded water transmission through the soil, while group C soils have moderately high runoff potential and are somewhat restrictive of water movement.

Figure 2-7 shows the distribution of Hydrologic Soil Groups in the Pomperaug watershed. Areas of the watershed at higher elevation and with a thin layer of till are generally classified as Group C or D soils, which are characterized by poor infiltration potential. Approximately 47% of the watershed is classified as either Group C or Group D soils. Conversely, approximately 52% of the watershed consists of areas with Group A or B soils, which have greater infiltration potential and are generally more conducive to infiltration-based Low Impact Development and green stormwater infrastructure. The Pomperaug, Weekeepeemee, Nonnewaug and Sprain Brook subregional basins have the largest percentage of Group A and B soils and are therefore expected to have better infiltration potential (*Table 2-7*). Additionally, some of the areas of Group A and B soils in the Pomperaug River subregional basin coincide with areas of denser development, making these areas potential targets for infiltration-based stormwater retrofits.

Table 2-7. Distribution of Hydrologic Soil Groups by Subregional Basin

Subregional Basin	Hydrologic Soil Group (Acres)				
	A	B	C	D	Water
Pomperaug River	1,392	7,108	1,987	3,023	181
Weekeepeemee River	426	5,382	2,671	1,689	146
Sprain Brook	193	4,185	1,282	1,336	15
Hesseky Brook	171	1,641	1,299	788	82
Nonnewaug River	1,416	4,611	3,642	3,820	117
East Spring Brook	97	889	2,155	516	86
Transylvania Brook	85	2,035	1,549	933	13
% of Watershed	6.6	45.4	25.6	21.3	1.1

*Soils labeled B/D or C/D are included in Group D
**Open water is not characterized into a HSG

[3] A kame is an irregularly shaped hill or mound composed of sand, gravel and till that accumulates in a depression on a retreating glacier, and is then deposited on the land surface with further melting of the glacier. A kettle hole is a shallow, sediment-filled body of water formed when a block of ice from a retreating glacier becomes buried in sediment and melts slowly, leaving a basin that is usually shallow and may fill with water to create a pond or lake.

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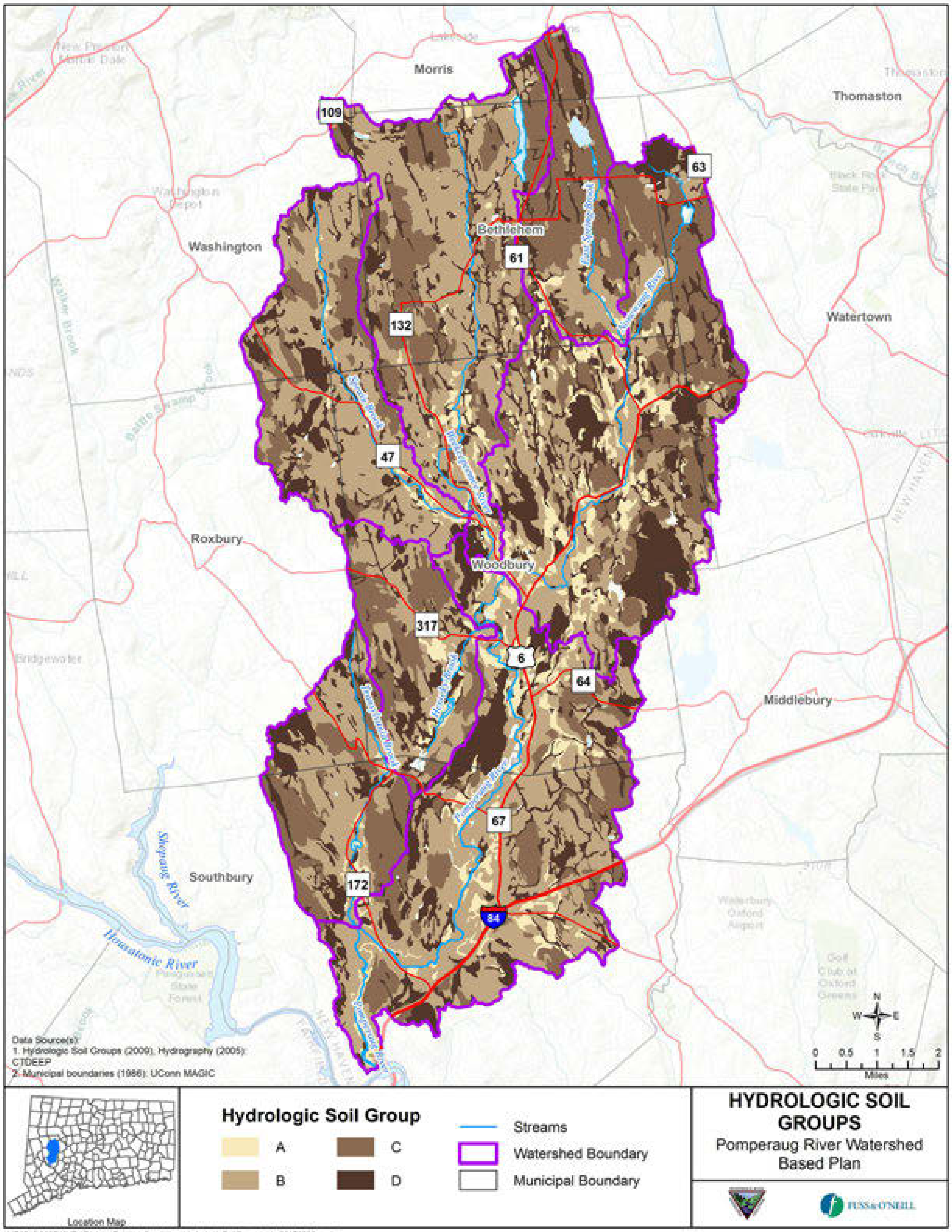


Figure 2-7. Distribution of Hydrologic Soil Groups in the Pomperaug River watershed

2.7 Wetlands, Riparian Areas, and Forested Areas

Wetlands

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and plant and animal communities living in the soil and on its surface. Wetlands can vary widely in type and characteristics, but are an important feature of a watershed, providing water quality benefits by removing pollutants and mitigating flooding. The extent and distribution of wetlands in the Pomperaug River watershed are shown in *Figure 2-8*. Wetlands make up approximately 12.5% of the watershed overall; 9.0% of the area consists of poorly drained and very poorly drained soils, with an additional 3.5% alluvial and floodplain soils. Wetlands comprise between 9% and 15% of the land area within the subregional basins making up the Pomperaug River watershed.

Riparian Areas

Riparian area refers to the interface between land and water. Healthy riparian areas are characterized by a vegetated area along a river or stream that provides habitat to a diverse array of plants and animals. Such areas, also referred to as vegetated or stream "buffers," can also slow stormwater runoff, trap sediment and other pollutants, provide shade to the stream, and a food source for wildlife. Conversely, riparian areas that are developed or that lack a dense stand of vegetation (e.g., paved or landscaped lawn areas or pasture and cropland right up to the water's edge) can be limited in their ability to filter stormwater and pollutants, leaving rivers and streams vulnerable to water quality issues. Slopes, soils, vegetation type and width all influence the effectiveness of buffers to protect water quality. Further, studies have found that minimum buffer widths required to accomplish different management goals and across jurisdictions are not uniform (Hawes and Smith 2005, Lee et al. 2004).

In 2006, UCONN CLEAR analyzed land cover within riparian areas in the Pomperaug River watershed, defined as 300 feet on both sides of mapped rivers and streams, including the areas of rivers and streams, which can be mapped as open water depending on their width. For this analysis, land cover types were grouped by their effectiveness as riparian buffer. Overall, approximately two-thirds of the riparian areas in the watershed are undeveloped (forest, wetland, and open water), with the percentage of undeveloped riparian land cover ranging from 60% to 75% across the subregional basins (*Table 2-8*). Agriculture, turf, and grass account for approximately 20% of the riparian land cover overall, while roughly 13% of the riparian areas in the watershed consist of developed land cover types. The Pomperaug River and Transylvania Brook subregional basins have the highest amounts of developed riparian land cover, while other subregional basins have higher amounts of agricultural land cover in the riparian area (*Figure 2-9*).

Table 2-8. Land cover composition (by percent) of riparian areas within the Pomperaug River watershed

	Land Cover Category		
Subregional Basin	**Developed, Other Grasses, Barren**	**Agriculture, Turf & Grass**	**Forest, Wetland, Water**
East Spring Brook	10.3	30.4	59.3
Hesseky Brook	10.3	14.9	74.8
Nonnewaug River	12.0	26.8	61.2
Pomperaug River	22.0	14.5	63.4
Sprain Brook	11.7	16.0	72.3
Transylvania Brook	17.6	20.1	62.2
Weekeepeemee River	9.9	19.4	70.7
Average	**13.4**	**20.3**	**66.3**

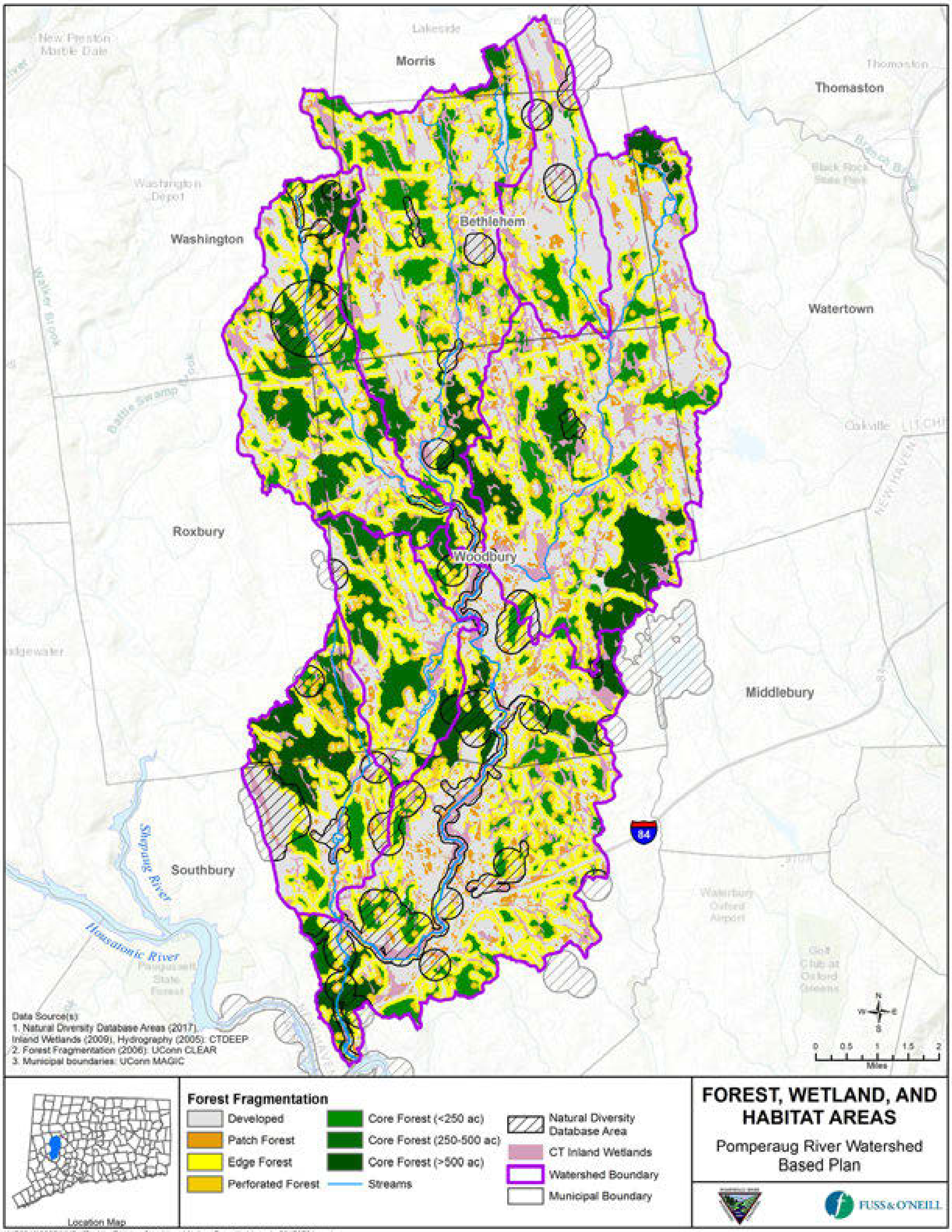


Figure 2-8. Forest, wetlands, and habitat areas in the Pomperaug River watershed

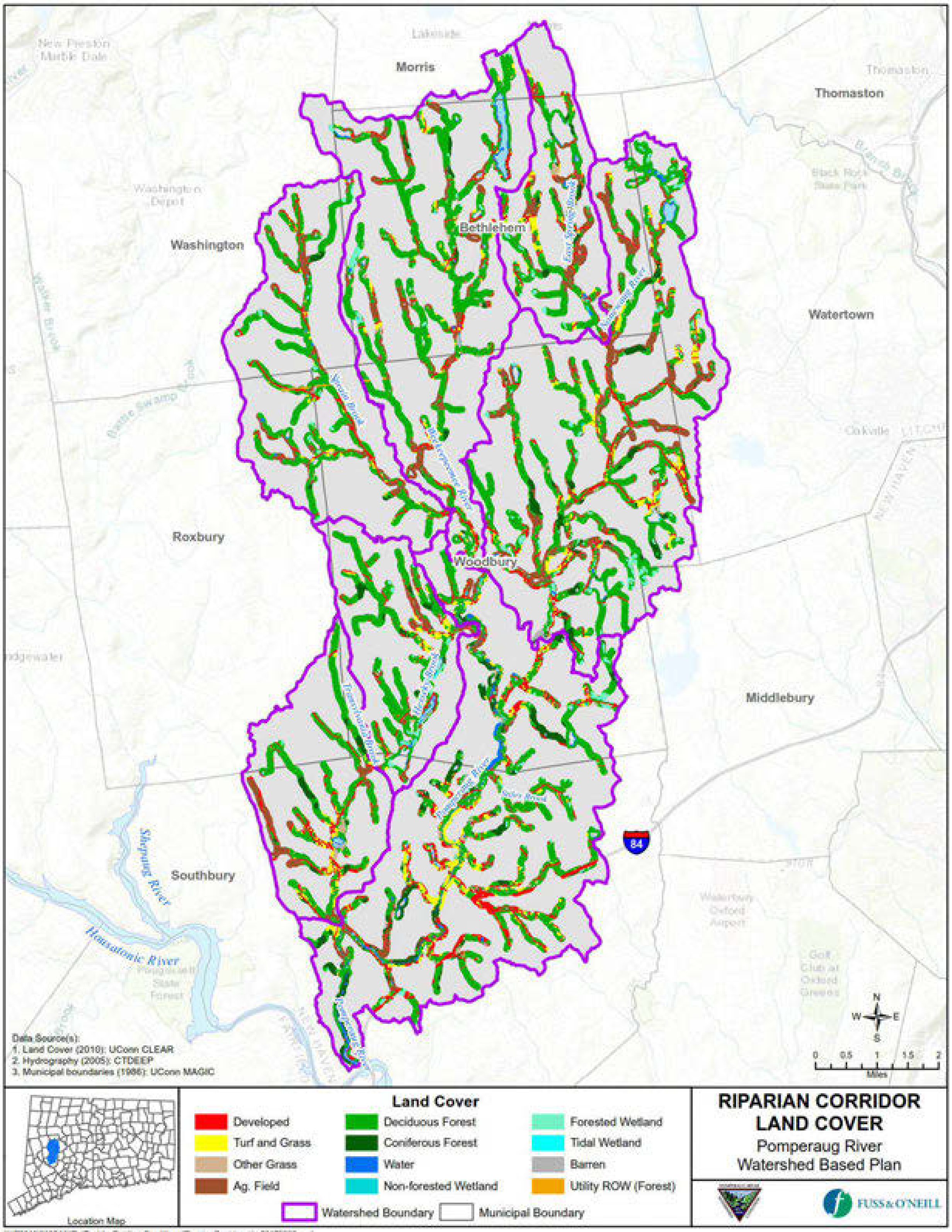


Figure 2-9. Riparian corridor land cover in the Pomperaug River watershed (UCONN CLEAR, 2015)

Forested Areas

Watershed forest cover provides numerous benefits including habitat for terrestrial and aquatic wildlife, improved soil and water quality, improved regional air quality, reduction in stormwater runoff, flooding, and stream channel erosion. Large, unfragmented forested areas play a critical role with regard to watershed integrity and the protection of water resources. Urbanization and fragmentation of forestland associated with land development have been shown to adversely affect stream water quality and ecological health.

Forested land cover varies between 43% and 74% across the subregional basins within the Pomperaug River watershed. Much of the larger tracts of unfragmented forestland within the Pomperaug River watershed (*Figure 2-8*) are protected (e.g., Audubon Center at Bent of the River and Whittemore Sanctuary). Others, such as the forested area west of O&G Industries' Southbury Quarry, are not protected from development. Across the watershed, core forest, defined as intact forest located over 300 feet from non-forested areas, typically comprises one-quarter to one-third of the total forest area. Edge forest, which make up the exterior periphery of core forest tracts where they meet with non-forested areas, also account for approximately one-third of the forest area in the watershed. Patch and perforated forest areas, which are highly fragmented and often associated with residential development and subdivisions, account for 7-11% of forest area (*Table 2-9*).

Table 2-9. Distribution of forest types in the Pomperaug River watershed

Subregional Basin	Forest Type (%)				Total Acres Core Forest
	Patch Forest	Perforated Forest	Edge Forest	Core Forest	
East Spring Brook	4.5	3.0	23.3	9.5	**353**
Weekeepeemee River	3.1	5.6	28.9	25.9	**2,669**
Nonnewaug River	5.0	3.9	25.0	24.0	**3,266**
Sprain Brook	1.5	6.5	31.3	32.5	**2,277**
Hesseky Brook	2.0	7.9	30.0	31.6	**1,259**
Pomperaug River	6.0	5.2	29.7	21.6	**2,952**
Transylvania Brook	2.5	7.4	25.7	31.4	**1,451**

2.8 Water Supply, Wastewater, and Stormwater

Water Supply

Groundwater serves as the sole water supply source for the Pomperaug River watershed. Water drawn from private and public wells supplies residents of all 8 municipalities in the watershed, as well as nearby Middlebury and Oxford. Depending on the location within the watershed, many homes rely on private wells drilled into bedrock aquifers for their water supply. Five large public wellfields in the watershed are located in and around areas of stratified drift (*Figure 2-10*). The Pomperaug Aquifer, made up of coarse sand and gravel materials, is highly susceptible to contamination. The aquifers can also be depleted through overuse and disconnected from replenishing rainfall and snowmelt due to intensive land use development which can increase surface runoff and reduce the amount of precipitation that infiltrates into the ground and recharges groundwater levels. As development and the demand for water increases, so does the potential for groundwater contamination, depleted wells, lower river flows, and increased stress on fish and wildlife species that rely on aquatic habitat.

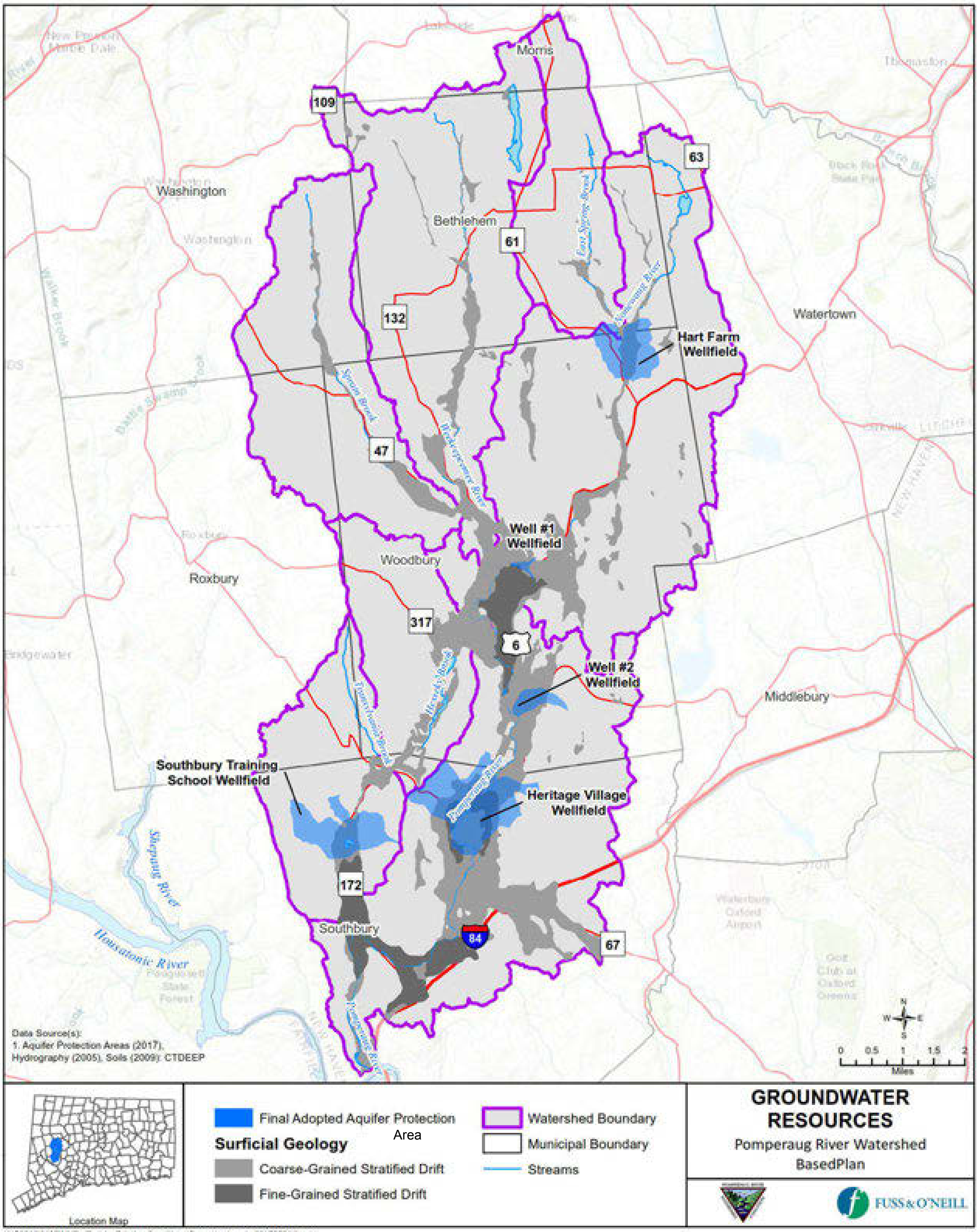


Figure 2-10. Groundwater resources in the Pomperaug River watershed

To protect major public water supply wells in stratified drift deposits that serve more than 1,000 people, CTDEEP requires water companies to map the boundaries for the area contributing groundwater to their well fields. These areas are called Aquifer Protection Areas (APAs). Municipalities are required, in turn, to delineate APA boundaries on local zoning (or inland wetland) maps and adopt aquifer protection regulations consistent with State regulations which restrict development of certain new land use activities involving hazardous materials and require existing regulated land uses to register and follow best management practices. Preserving and protecting groundwater resources in the watershed – both groundwater quality and availability for various uses – continues to be a major focus of the watershed communities, PRWC, resource agencies, and other stakeholders.

Regulated Wastewater Discharges

Only a small portion of the watershed is served by sanitary sewers (*Figure 2-11*). Wastewater treatment facilities in the watershed include those that serve Heritage Village (and Southbury Training School), Woodlake Condominium complexes, and the IBM Complex. The rest of the watershed is served by private subsurface sewage disposal systems, most of which are conventional septic systems. Larger subsurface disposal systems typically serve apartments, condominiums, restaurants, and other commercial buildings.

Subsurface disposal systems that are properly designed, installed, and maintained provide a safe and efficient way of disposing domestic sewage. Failing or older, sub-standard systems can impact surface water and groundwater quality and can expose the public to untreated sewage and be a source of bacteria, pathogens, and nutrients to the Pomperaug River and other surface waterbodies.

Septic systems on sites with design flows of 7,500 gallons per day (GPD) and less are under the jurisdiction of the Connecticut Department of Public Health (CTDPH) and the Local Director of Health. In general, systems of this size are permitted by local health directors and health districts, a process which includes: permit issuance, site investigation, plan review, approval to construct, system inspection, approval to discharge and enforcement of all newly constructed, repaired, altered or extended systems. However, plans for large septic systems serving buildings with design flows of 2,000 to 7,500 GPD must be approved by CTDPH. The Towns of Southbury and Woodbury are part of the Pomperaug District Department of Health (PDDH), the Town of Roxbury falls under the jurisdiction of Newtown Health District, and the remaining Towns (with the exception of Washington) form the southern part of the Torrington Area Health District. The Town of Washington has an independent part-time municipal health department. Disposal systems on sites with design flows exceeding 7,500 GPD, alternative sewage disposal systems, and community sewage systems are under the jurisdiction of CTDEEP.

According to discussions with the Pomperaug and Torrington Area Health Districts, failing or older, sub-standard residential septic systems are relatively isolated problems in the watershed, with annual failure rates of 1 percent or less in residential areas. Older residential neighborhoods with poor soils are most likely to experience failure or have substandard performance, and such systems in close proximity to rivers and streams can potentially impact surface water quality. Subsurface systems that serve apartment complexes, condos, and commercial businesses in the watershed are a potentially more significant source of water quality impacts. Facilities with new or existing subsurface systems (>7,500 GPD) are required to obtain a CTDEEP permit, which requires oversite/maintenance of the system by the facility owner. If the facility owner does not operate or maintain the system in accordance with their permit, it may take a while for CTDEEP to take action due to limited State resources for inspection and enforcement.

The accompanying map (*Figure 2-11*) identifies the locations of regulated wastewater and water discharges within the watershed that could potentially contribute bacteria and other pollutants. These include

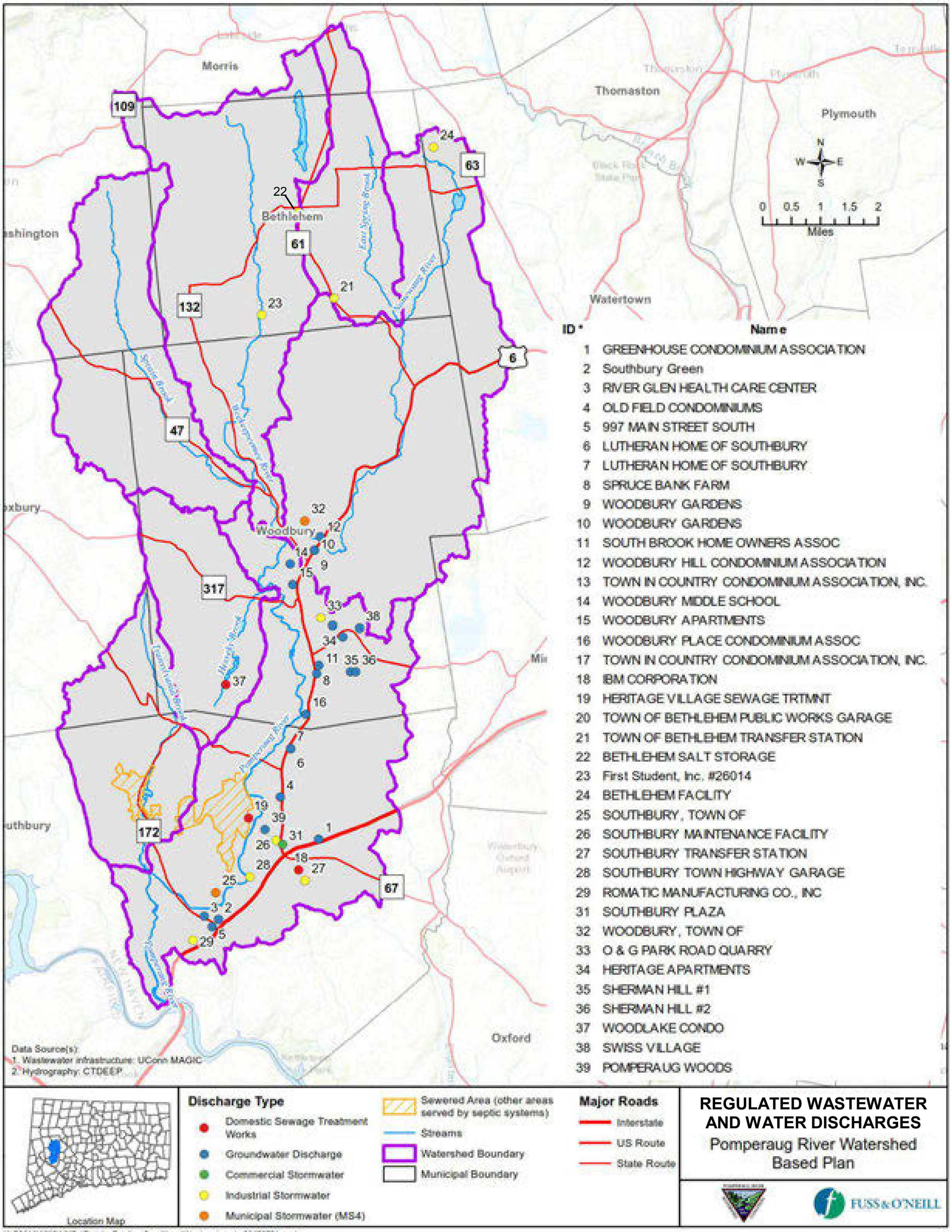


Figure 2-11. Regulated wastewater and water discharges in the Pomperaug River watershed

discharges from industrial and commercial facilities in the watershed, subsurface sewage disposal systems permitted by CTDEEP, and regulated stormwater discharges, described in more detail below.

Regulated Stormwater Discharges

Two of the municipalities within the watershed, Southbury and Woodbury, are regulated under the CTDEEP General Permit for the Discharge of Small Municipal Separate Storm Sewer Systems (MS4 Permit). Although the regulated MS4 communities in the watershed (Woodbury and Southbury) are shown as discrete points (orange dots) on the map in *Figure 2-11*, the regulated stormwater discharges in both communities include numerous discrete outfall pipes and similar conveyances.

Communities subject to the MS4 Permit are required to develop, implement and enforce stormwater management plans centered around 6 minimum control measures, including: public education and outreach, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management in new development or redevelopment, and good housekeeping and pollution prevention. The last two measures include requirements to consider and utilize low impact development measures to reduce or disconnect impervious cover to infiltrate more runoff on site. The MS4 Permit also requires municipalities to address the source(s) of stormwater pollutants contributing to impaired water issues. For example, in this case, it means that both Southbury and Woodbury need to implement Best Management Practices (BMPs) that focus on reducing bacteria loads to waterbodies in the Pomperaug River watershed that are impaired for recreation. The Connecticut Department of Transportation is also required to address the quality of stormwater discharges from the state transportation system in the watershed through compliance with its own MS4 Permit, which becomes effective in July 2019.

Other regulated stormwater discharges in the watershed include industrial facilities that are registered under the CTDEEP General Permit for the Discharge of Stormwater Associated with Industrial Activity ("Industrial General Permit") and commercial facilities registered under the CTDEEP General Permit for the Discharge of Stormwater Associated with Commercial Activity ("Commercial General Permit"). The Industrial General Permit regulates industrial facilities with point source stormwater discharges that are engaged in specific activities according to their Standard Industrial Classification code, while the Commercial General Permit 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 waterbodies. Construction activities in the watershed are also potentially subject to the CTDEEP 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 waterbodies and to address the impacts of stormwater discharges from a project after construction is complete.

2.9 Pollutant Sources and Loads

The major anthropogenic sources of fecal indicator bacteria in the Pomperaug River watershed are summarized below. Individual sites and source areas are based on: 1) the findings of visual field assessments and pollutant load modeling conducted in support of this watershed plan update; 2) information from previous study reports and planning documents including the 2001 Pomperaug River State of the Watershed Report, the 2006 Pomperaug Watershed Management Plan, and the 2010 Pomperaug River Watershed Streamwalk Summary Report; and 3) input from the PRWC Land Use Committee on known or suspected pollutant sources in the watershed.

- **Agricultural Practices.** Hobby farms, equestrian facilities, and livestock farming practices are common throughout the watershed, with the greatest concentration of farms and agricultural uses in the central and northern portions of the watershed. While some farms maintain animal exclusion fencing to separate livestock from streams, other farms have livestock grazing or feeding areas that allow direct access to streams. Many sites have little or no vegetated buffers, and manure storage locations are sometimes located in close proximity to waterbodies.

Pollutant Source Assessments

Visual field assessments were performed by Fuss & O'Neill in September 2017 to further assess possible sources of water quality impairments in the Pomperaug River watershed. Sites that were assessed were selected from an initial list of potential areas of concern in conjunction with the PRWC Land Use Committee. These included stream corridors and upland sites known or suspected of contributing to the impairments in the watershed.

A **pollutant loading model** was also developed for the Pomperaug River watershed to estimate the pollutant contribution from various land uses and land use activities. The model is used to refine an understanding of relative sources of fecal indicator bacteria and other pollutants and to support the development of planning recommendations for the watershed.

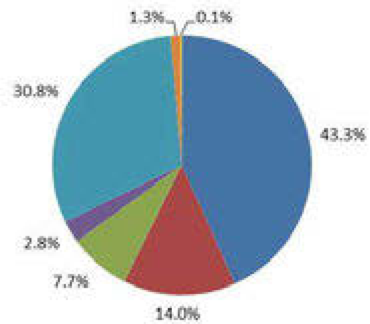
- **Developed Land Use.** Residential, commercial, industrial and other developed land uses in the watershed generate stormwater runoff containing fecal indicator bacteria. Common sources of fecal indicator bacteria in these developed areas include pet waste, waterfowl (such as Canada geese), potential illicit discharges to the storm drainage systems, failing or malfunctioning septic systems, and bacteria growing in sediments and organic materials that collect in the storm drainage system. Stormwater runoff from developed areas includes both point discharges from municipal or privately-owned stormwater outfalls and diffuse nonpoint source runoff from lawns, roofs, driveways, and parking lots.

- **Wastewater Effluent.** Surface wastewater treatment facilities in the watershed discharge treated effluent to the Pomperaug River and its tributaries, including Heritage Village, IBM, and Woodlake Condominiums. Under normal operating conditions, these sources contribute relatively small amounts of fecal indicator bacteria to the receiving waterbodies.

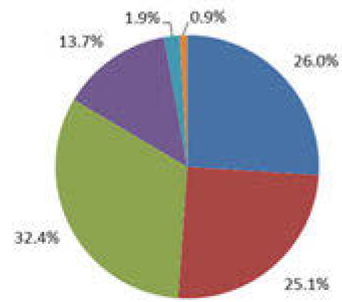
The relative contribution of bacteria from different land uses and activities is well illustrated by a comparison of the modeled loads in the various subregional basins (*Figure 2-12*). In the more-developed Pomperaug River subregional basin, modeled bacteria loads are dominated by stormwater runoff from urban land use (43%) and potential illicit connections associated with residential and commercial land use (31%), with agricultural sources estimated to contribute approximately 10% of the estimated annual load. By contrast, in the more rural Weekeepeemee River subregional basin, agricultural land uses (rural land and livestock) contribute an estimated 45% of the annual bacteria load, with stormwater runoff contributing approximately 25% of the annual load.

This comparison points out some of the opportunities and challenges in watersheds with mixed land use. The modeled bacteria loads in the Pomperaug River subregional basin illustrate the benefits of management measures that focus on sources of fecal indicator bacteria associated with urban stormwater runoff, including source controls, structural stormwater BMPs, education and outreach, and illicit discharge detection and elimination (IDDE). Even though the estimates of illicit connections are modest (0.1% of the population and 5% of the businesses served by sewer), the elimination of these discrete sources of bacteria could substantially reduce bacteria loadings where sanitary-related illicit connections are present (i.e., in areas served by sanitary sewers). Consequently, implementing an IDDE program in the more developed and/or sewered areas of the watershed can be effective at reducing bacteria loads.

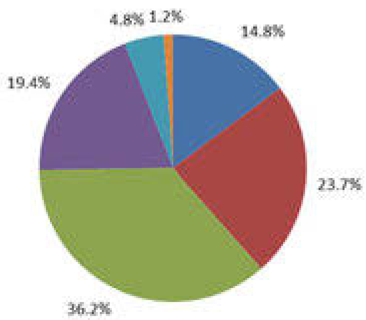
In contrast, in the more rural subregional basins such as the Weekeepeemee, livestock and agricultural practices are key drivers of bacteria loads, though pockets of residential and commercial development in these areas also contribute bacteria loads from urban runoff. Agricultural sources of bacteria typically require a combination of structural and non-structural best management practices (BMPs) to reduce loadings, including identification of "hot spot" bacteria sources and site-specific management strategies to achieve load reductions. Livestock in particular represent a considerable bacteria source in the Weekeepeemee River, Nonnewaug River, and Hesseky Brook subregional basins. Where practicable, load reduction in these basins should focus on agricultural BMPs such as exclusion fencing, vegetated buffers, alternative approaches to manure management, such as moving manure piles further away from streams, and other agricultural BMPs.



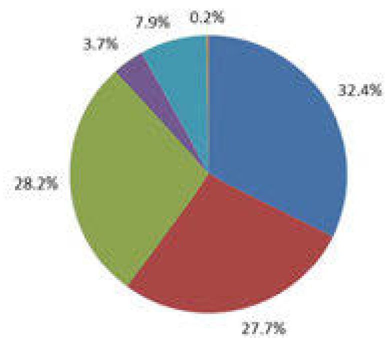
Pomperaug River Subregional Basin
Total annual load: 354,000 billion CFU (29% of watershed load)



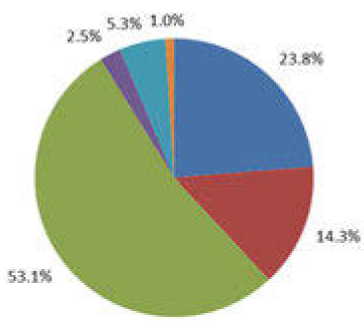
Weekeepeemee River Subregional Basin
Total annual load: 213,000 billion CFU (17%)



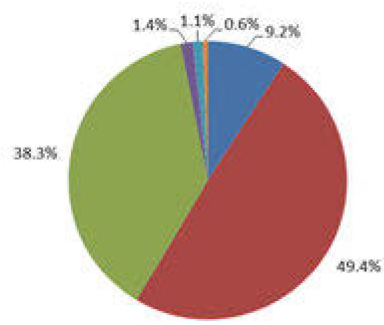
Nonnewaug River Subregional Basin
Total annual load: 275,000 billion CFU (23%)



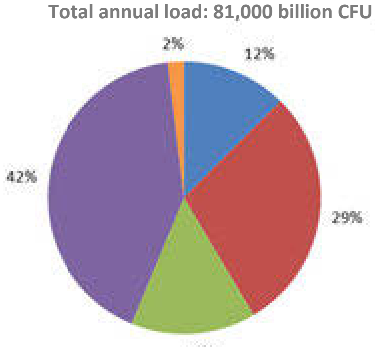
Transylvania Brook Subregional Basin
Total annual load: 107,000 billion CFU (9%)



East Spring Brook Subregional Basin
Total annual load: 81,000 billion CFU (7%)



Sprain Brook Subregional Basin
Total annual load: 109,000 billion CFU (9%)



Hesseky Brook Subregional Basin
Total annual load: 75,000 billion CFU (6%)

LEGEND:
- Urban Land
- Forest
- Rural Land
- Livestock
- Illicit Connections
- Septic Systems
- Point Source Discharges

Figure 2-12. Relative contributions of bacteria sources in the Pomperaug River watershed

3 Management Recommendations

The primary management goals of the Pomperaug River watershed based plan are as follows:

- Strengthen and build local capacity and community support to implement the watershed plan
- Implement ongoing water quality monitoring and other assessments to support plan implementation
- Reduce fecal indicator bacteria and other pollutant inputs to impaired rivers and streams
- Incorporate proactive measures to protect/maintain high quality streams.

This section describes recommended actions to achieve these goals. The recommendations include watershed-wide and targeted actions:

- **Watershed-wide Recommendations** are recommendations that can be implemented throughout the Pomperaug River watershed. These basic measures can be implemented in most areas of the watershed and are intended to address nonpoint source pollution. The water quality benefits of these measures are primarily long-term and cumulative in nature resulting from runoff reduction, source control, pollution prevention, and improved stormwater management.

- **Targeted Recommendations** include site-specific projects and/or actions intended to address issues within specific subregional basins or areas, rather than watershed-wide. Targeted recommendations also include actions to address common types of problems that are identified at representative locations throughout the watershed, but where additional field assessments or evaluations are required to develop site-specific recommendations. Targeted recommendations can have both short and long-term benefits.

Given the large size of the Pomperaug River watershed, compressed timeline, and limited resources available for this initial watershed based planning process, it was challenging to conduct comprehensive field assessments of the entire regional basin. As a result, additional field investigations are recommended to further characterize pollutant sources and develop solutions. Supplementary field assessments, coupled with a strategic water quality monitoring plan, will help to identify and implement more site-specific projects and action plans which will be more effective at improving water quality on a subregional basin scale. This, in turn, will benefit the entire Pomperaug watershed.

The recommendations presented in this section are classified according to their timeframe and implementation priority. Recommendations include ongoing, short-term, mid-term, and long-term actions:

- **Ongoing Actions** are actions that should occur annually or more frequently such as routine water quality monitoring, fundraising, and education and outreach.

- **Short-Term Actions** are initial actions to be accomplished within the first two years of plan implementation. These actions have the potential to demonstrate immediate progress and success and/or help establish the framework for implementing subsequent plan recommendations.

- **Medium-Term Actions** involve continued programmatic and operational measures, delivery of educational and outreach materials, and construction of larger retrofit and/or restoration projects between two and five years after plan adoption.

- **Long-Term Actions** consist of continued implementation of watershed projects, as well as an evaluation of progress, accounting of successes and lessons learned, and an update of the watershed management plan. Long-term actions are intended to be completed between five and ten years or longer after plan adoption. The feasibility of long-term actions, many of which involve significant infrastructure improvements, depends upon the availability of sustainable funding mechanisms.

As discussed in *Section 1*, this Plan is a *guidance* document that seeks to resolve surface water quality impairments and related water resource issues within the Pomperaug watershed. Unless identified as a required action under an existing local, State or federal regulation or permit, the recommendations in this Plan for specific projects/actions are intended to be *voluntary* undertakings, carried out with willing, cooperative partners, working together to protect and improve water quality. This Plan identifies potential partners and funding sources to assist with achieving the recommendations presented herein. While some potential funding sources for specific management measures are suggested in the subsections and associated tables that follow, a more extensive list of potential funding opportunities is provided in *Appendix H*.

3.1 Capacity Building

The success of any watershed based plan depends on effective leadership, active participation by the watershed stakeholders, and local "buy-in" of the plan recommendations by the watershed communities, in addition to funding and technical assistance. Fortunately, significant local support and "capacity" for watershed protection and restoration already exists within the Pomperaug River watershed, through the leadership of the Pomperaug River Watershed Coalition and other stakeholders. Strengthening local capacity for implementing this watershed plan, by building on the existing network of volunteers and programs, is a critical early and ongoing part of the watershed plan implementation process. *Table 3-1* summarizes capacity building recommendations, which are described below in greater detail.

Recommended Actions

- Seek endorsement of the watershed based plan by the watershed municipalities to support the watershed planning effort through funding, staff, or other resources. Endorsement of the watershed management plan by the watershed municipalities is an important first step in implementing the plan recommendations.
- Review and prioritize potential funding sources that have been preliminarily identified in this watershed plan (see *Section 6*). High-priority funding sources that should be considered include:
  - CTDEEP/EPA Section 319 Nonpoint Source Grants
  - National Fish and Wildlife Foundation Long Island Sound Futures Fund
  - Connecticut Clean Water Fund (Green Infrastructure)
  - Private foundations
- Prepare and submit grant applications for projects identified in this plan on an ongoing basis.

3.2 Monitoring and Assessment

Additional monitoring and assessment is recommended to support implementation of the watershed based plan, including water quality monitoring, streamwalk assessments, and track down surveys. These additional assessments will help to establish an improved baseline of water quality conditions, further characterize pollutant sources and problem areas, and develop more detailed action plans and site-specific restoration projects. *Table 3-2* summarizes monitoring and assessment recommendations, which are described in the following sections.

Table 3-1. Capacity building recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Obtain municipal endorsement of the watershed plan • Request letters of support	PRWC	0-2 years	Letter of support from each watershed municipality	$	
2. Identify and pursue funding • Review and prioritize funding sources • Prepare and submit grant applications	PRWC and other stakeholders in coordination with PRWC	0-2 years Ongoing	Funding sources pursued and funding obtained	$$	See *Section 5* and *Appendix H* of this plan for funding sources

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
PRWC = Pomperaug River Watershed Coalition

Table 3-2. Monitoring and assessment recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Establish and implement fixed-station bacteria monitoring program • Identify methodology • Prepare QAPP • Recruit and train volunteers • Conduct monitoring • Analyze samples • Compile and analyze data	PRWC with input from CTDEEP Monitoring & Assessment Program on site selection	Establish within 0-2 years Seasonal sampling (Apr - Oct)	• Approved QAPP • Volunteers trained • Monitoring results/reports	$$ (annually)	Local businesses, Argull Hull Foundation, National Fish and Wildlife Foundation, The Conservation Fund, Earthwatch Institute
2. Prepare a periodic "Water Quality Report Card" • Create and distribute report card	PRWC	2-5 years	• Report card disseminated to stakeholders including the public	$$$	
3. Conduct streamwalk assessments and track down surveys • Identify methodology • Prepare QAPP • Complete streamwalks • Compile and analyze data • Plan and conduct "track down" surveys	PRWC and volunteers	0-2 years (repeat streamwalks every 5 years)	• Approved QAPP • Streamwalks and track down surveys conducted • Streamwalk assessment results • Track down survey results and recommendations	$$$	

Table 3-2. Monitoring and assessment recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
• Analyze results and develop recommendations					
4. Prepare and implement subwatershed action plans • Identify site-specific and/or widespread issues • Develop and implement action plans	PRWC and consultant	2-5 years	• Subwatershed action plans prepared and implemented	$$$	

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
PRWC = Pomperaug River Watershed Coalition   CTDEEP = Connecticut Department of Energy and Environmental Protection

3.2.1 Water Quality Monitoring

The identified recreational impairments in the Pomperaug River watershed are based on extremely limited water quality monitoring data (3 sampling locations) collected between 2006 and 2010. Additional, ongoing water quality monitoring is recommended for the Pomperaug River watershed to refine the understanding of water quality impacts from pollution sources in the watershed, to measure the progress toward meeting watershed management goals and TMDL pollutant load reductions, and ultimately support removal of the impaired segments of the Pomperaug River and its tributaries from the CTDEEP impaired waters list. Water quality monitoring recommendations are summarized in *Table 3-2*.

Recommended Actions

- Establish and implement a routine water quality monitoring program for the Pomperaug River watershed. Consistent with the bacteria TMDL for the Pomperaug and Weekeepeemee Rivers, the monitoring program should be designed to accomplish two objectives: (1) fixed station monitoring to track water quality improvements, and (2) source detection to identify specific sources of bacterial loading.
    - **Fixed Station Bacteria Monitoring.** Conduct routine bacteria (*E. coli*) monitoring at fixed stream locations in the Pomperaug River watershed to measure progress toward achieving the watershed plan and TMDL pollutant load reduction goals. The sampling sites should be located upstream and downstream of potential bacteria sources to bracket and isolate sources of pollution. *Figure 3-1* shows the locations of proposed bacteria monitoring sites. Sampling should be conducted monthly during the recreation season (April – October) under both wet and dry weather conditions.
    - **Bacteria Source Detection Monitoring.** 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. Source detection monitoring should be informed by the findings of streamwalk assessments and follow-up track down surveys. Source detection monitoring should also be implemented by Southbury and Woodbury as part of their "Illicit Discharge Detection and Elimination" efforts as required by the MS4 Permit.

Proposed Fixed-Station Bacteria Monitoring Sites in the Pomperaug River Watershed

1. Mill Road - USGS Gauge (Nonnewaug River, Woodbury)
2. Old Town Farm at North Gate Road (Nonnewaug River, Woodbury)
3. Route 47 Bridge (Nonnewaug River, Woodbury)
4. Route 61 Bridge (Nonnewaug River, Bethlehem/Woodbury line)
5. Audubon Center at Bent of the River (Pomperaug River, Southbury)
6. Heritage Road (Pomperaug River, Southbury)
7. Oakdale Manor (Pomperaug River, Southbury)
8. Poverty Road - Ewald Park - USGS Gauge (Pomperaug River, Southbury)
9. Route 67 - Bennett Park (Pomperaug River, Southbury)
10. The Gym - Flood Bridge Road (Pomperaug River, Southbury)
11. Wood Creek Road (Weekeepeemee River, Bethlehem)
12. Brushy Hill Road (Weekeepeemee River, Woodbury)
13. Chohees Trail (Weekeepeemee River, Woodbury/Bethlehem line)
14. Jacks Bridge Road (Weekeepeemee River, Woodbury)

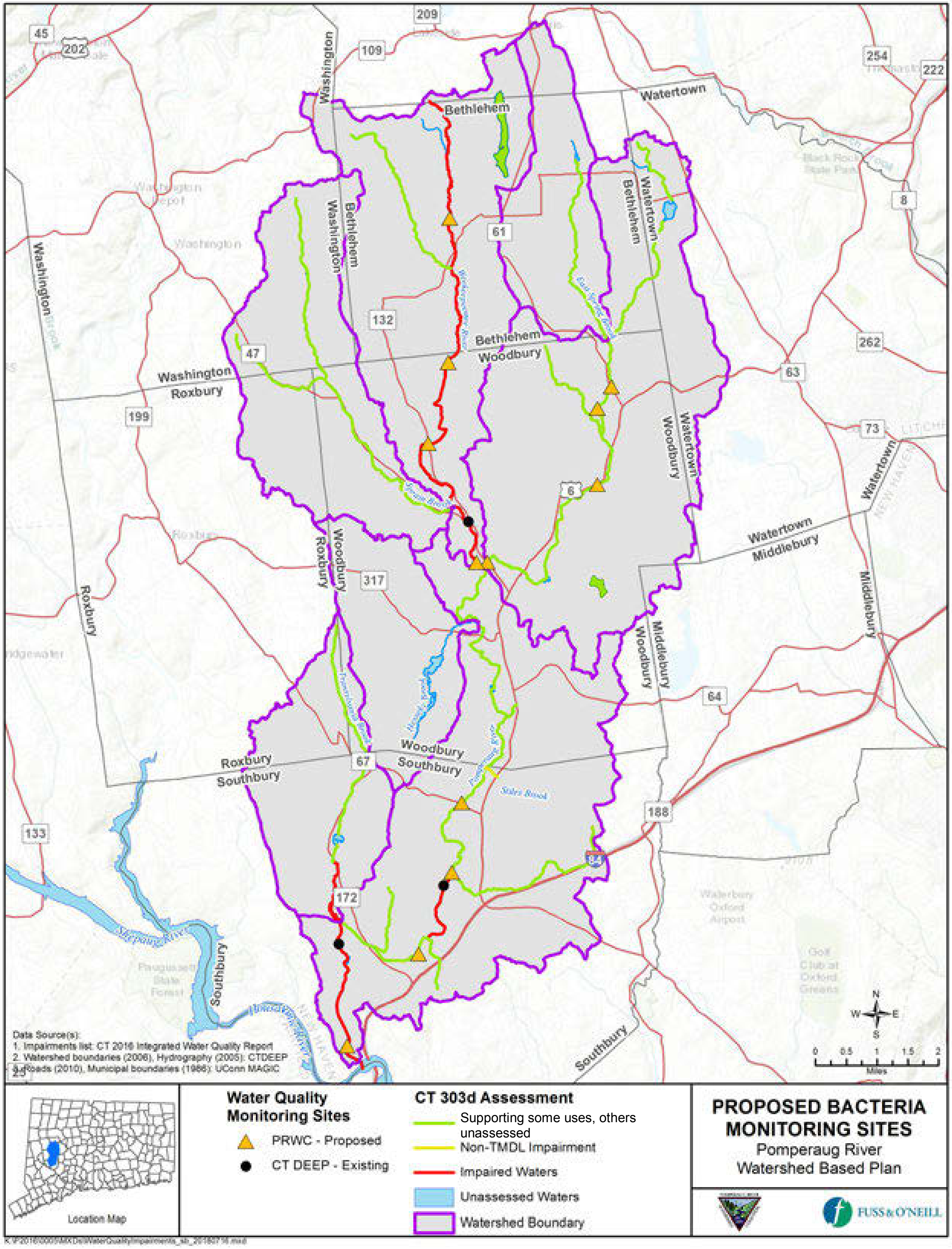
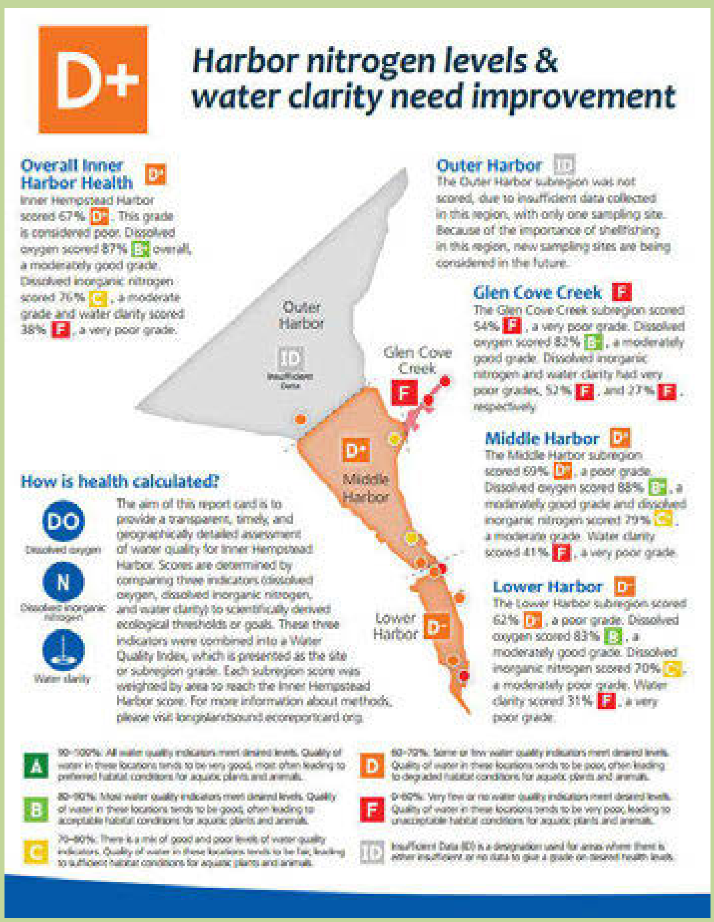


Figure 3-1. Proposed bacteria monitoring sites

- Pursue dedicated funding to finance an ongoing water quality monitoring program.
- Prepare a periodic "Water Quality Report Card" for the Pomperaug River and its tributaries, modeled after similar report cards that have been prepared for other rivers and embayments around Connecticut and elsewhere in the U.S. The report card would provide a transparent, timely, and geographically detailed assessment of water quality to inform the public of water quality conditions as well as actions that are occurring to improve and protect water quality in the river. Report card scores are determined by comparing water quality indicators to scientifically-derived ecological thresholds or goals. The report card for the Pomperaug River watershed would focus on: recreational water quality per the results of the proposed bacteria monitoring program; and aquatic habitat health per the results of continued, existing PRWC benthic macroinvertebrate survey and stream temperature monitoring programs. Results would be compared to Connecticut's Water Quality Standards to help determine watershed report card "grades".

Water Quality Report Card

An example of a water quality report card developed for Hempstead Harbor on the north shore of Long Island.
http://www.nfwf.org/whoweare/mediacenter/pr/Documents/hempstead-harbor-report-card.pdf



3.2.2 Streamwalk Assessments and Track Down Surveys

Streamwalk assessments, which were last performed in the Pomperaug in 2010, are recommended along with visual track down surveys of actual or suspected pollutant sources identified during the streamwalks.

Recommended Actions

- Conduct streamwalk assessments within the Pomperaug River watershed following previously established Connecticut NRCS streamwalk protocols or alternate methodology. PRWC began a Volunteer Streamwalk Program in the summer of 2000 to collect and analyze the data needed to make sound management decisions about the watershed and the future use of its water resources. This program has since become a long-term monitoring and assessment tool, allowing the PRWC to document and track changes in the watershed over time. The program's goals are to document the physical characteristics of the rivers and streams in the Pomperaug River watershed and to involve the community in river conservation stewardship. Future streamwalks should be conducted on a rotating subregional basin basis (i.e., concentrate on Sprain Brook one season and Weekeepeemee another season).

- Following the streamwalks and evaluation of the assessment results, plan and conduct subwatershed visual "track down" surveys of identified or suspected pollution sources, generally located in upland areas that drain to stream. Visual track down surveys are a tool commonly used by the Connecticut Conservation Districts to help identify conditions responsible for water quality impairments in streams. The goals of the track down survey are to collect information on the possible causes of impairment and recommend and implement solutions to address the identified issues of concern. Subregional watershed stream assessments and track down surveys should be updated every five to ten years to monitor changing watershed conditions and the progress of plan implementation.

3.2.3 Subwatershed Action Plans

Development and implementation of site-specific restoration and protection strategies is most effective at the subregional watershed scale for larger, regional watersheds such as the Pomperaug River watershed. Although this watershed plan identifies a number of site-specific recommendations and BMP concepts that are examples of the types of projects that could be implemented elsewhere in the watershed, the limited scope of this watershed planning effort did not allow for comprehensive field assessments of the entire watershed.

Recommended Actions

- Prepare and implement more detailed action plans for priority subregional or local basins based on the findings of water quality monitoring, streamwalk assessments, and track down surveys (see recommendations in previous sections). Higher priority basins include those subregional and local basins associated with impaired segments of the Pomperaug River, Weekeepeemee River, and Transylvania Brook.
- Encourage the watershed municipalities and other stakeholders to participate in development and implementation of the respective subwatershed action plans.

- Subwatershed action plans could be added and maintained as appendices to the overall Pomperaug River Watershed Based Plan, relying on watershed background information, goals, and objectives contained in the larger watershed plan.

3.3 Education and Outreach

The public is often not aware of the critical role they have in protecting water resources. Under current law, municipalities and state agencies do not have statutory authority to mandate nonpoint source pollution reduction projects, other than those that violate land use regulations, on privately owned properties. Thus, inspiring residents and business owners to voluntarily implement practices that improve water quality on their own properties is critical to meeting water quality goals. Public education is vital to the long-term success of watershed management because it raises awareness of both personal responsibilities and the responsibilities of others relative to environmental protection, and teaches people about individual actions they can take to protect and improve water resource conditions in their watershed. Increasing awareness and understanding is the first step in fostering support for watershed management efforts and cultivating a long-term, environmental and watershed stewardship ethic. While there are strong outreach and education programs already in place within the Pomperaug watershed, there is opportunity to expand and refine these activities, as staffing and funding resources allow.

3.3.1 Existing Education and Outreach Programs

Public outreach and education is a core component of PRWC's mission to ensure high quality water for future generations. The organization's existing outreach and education activities include but are not limited to:

- Online platforms including website, blog, and social media accounts which share an online resource center for water resource protection, directory of scientific reports and best practices, volunteer opportunities, and program and event announcements.
- Workshops, presentations, outings, and events such as drinking water and private well forums, *River Ramblers* hiking series, rain barrel workshops, participation in local farmers' markets and community fairs, and organizing Woodbury Earth Day (the largest Earth Day celebration in Connecticut)
- Print communications including a biannual newsletter, brochures, postcards, flyers, direct mailings, and articles in local newspapers
- Youth education programs in local classrooms and at summer camps
- Best management practice (BMP) demonstration sites including a native riparian buffer at Cedarland Park and a rain garden at Community House Park (both in Southbury)
- *Be RiverSmart* campaign focused on BMPs in and around the home related to landscaping, water conservation, septic care, and pet waste
- Volunteer projects including storm drain marking, trash clean-ups, invasive plant removal, and stream monitoring.

PRWC's outreach and education programs are aimed at informing residents, business owners, and municipal leaders about the link between personal property care choices and the health of water resources, and providing easy-to-implement, practical steps to make homes, businesses, and town properties watershed-friendly.

3.3.2 Future Goals and Core Outreach Messages

The overall goal of the recommendations described in this section of the plan is to promote stewardship of the Pomperaug River watershed through education and outreach messages tailored/personalized to diverse audiences, and to promote and offer stewardship opportunities through citizen involvement in science, conservation, and restoration activities.

Future or expanded education and outreach efforts should build upon the extensive programs that already exist in the watershed. Activities should be aimed at increasing awareness of watershed issues, establishing the link between one's personal choices and water resource quality, and encouraging easy-to-implement, low-cost, best management practices that benefit property owners and watershed residents. As such, the following messages were selected as "low-hanging fruit" for outreach based on their relative simplicity to implement, their importance to achieving watershed goals, and their cost effectiveness:

- **Investment in Green Infrastructure/Low Impact Development (GI/LID) practices** can help improve water quality and reduce flooding through improved infiltration in developed areas, pollutant control, and a decrease in erosive flows.
- **Riparian buffer** establishment and maintenance practices improve water quality, provide benefits to streamside property owners, and are simple and inexpensive to implement.
- **Improved landscape management practices** reduce pollutant loads, improve habitat, and reduce property management costs.
- **Proper management and disposal of animal waste** (livestock, pets, and waterfowl) is a relatively simple, inexpensive way to reduce bacterial loadings that can have sizeable impacts on water quality.
- **Rain barrels and rooftop disconnection** on residential properties can prevent roof runoff from discharging directly into the storm drainage system or directly into streams. Homeowners may use the collected rainwater for irrigation, outdoor washing, and other non-potable applications.
- **Inspection, maintenance, upgrade, and repair of residential septic systems** can significantly reduce bacterial and nutrient loading to streams.
- **Open space preservation** provides excellent habitat, recreational, and water quality benefits.

3.3.3 Primary Audiences, Media Formats, and Tailored Messages

Expanded outreach and educational activities should support the goals established in this Plan, and should be focused to reach five primary audience types, which have the greatest potential to affect long-term change and improve water resource conditions in the Pomperaug River watershed, namely:

- Residents and Landowners
- Municipalities
- Businesses
- Agricultural Operations
- Students (K-12)/higher education

Outreach messages and activities should be tailored and delivered in formats appropriate for the intended audience. A variety of media formats to consider include but are not limited to: direct mail, events, websites, social media, radio/television/print news, personal contact (events, presentations, classroom activities, volunteer engagement, etc.), and demonstration of best management practices.

Table 3-3 summarizes education and outreach recommendations for the Pomperaug River watershed.

Resident and Landowner Outreach and Education

An objective of the watershed plan is to build awareness of land stewardship and management practices and reduce water quality impacts associated with residential land use, which comprises approximately 31% of the watershed land area. A successful homeowner outreach program, *Be RiverSmart* has already been established and implemented in the Pomperaug watershed. However, there is still great opportunity for refinement and expansion of this program. Currently, a number of educational brochures for homeowners are available on the *Be RiverSmart* website www.beriversmart.org with topics including LID practices, lawn care practices, in-home water conservation, pet waste disposal, septic care, and more. These brochures can be distributed (more widely) by themselves and/or used in conjunction with the outreach activities described below.

Looking forward, outreach messages to homeowners should focus on:

Encouraging the Use of Residential LID Practices

Homeowners should be encouraged to implement Green Infrastructure or Low Impact Development (LID) practices on their properties.

- Encourage reductions in impervious areas associated with driveways, walkways, and patios through use of permeable pavements/pavers which allow for infiltration of stormwater.

- Promote infiltration of run-off through use of rain gardens, vegetated swales, gravel-filled infiltration trenches, and dry wells in areas appropriate distances from drinking water wells, septic systems, and property boundaries.

- Provide education and outreach to homeowners, neighborhood groups, and roofing contractors on disconnecting roof downspouts and installing and maintaining residential rain gardens and rain barrels. The Connecticut NEMO web site provides a wealth of information about residential rain gardens: http://nemo.uconn.edu/raingardens/

- Provide residential LID incentive programs similar to that led by Save the Sound's *Reduce Runoff* initiative: http://ctenvironment.wixsite.com/reduce-runoff/raingardens-bioswales

Promoting Rooftop Disconnection

Residences in some areas of the watershed contribute significant quantities of rooftop runoff to the storm drainage system. Opportunities exist to disconnect residential rooftop runoff from the storm drainage system and reduce the quantity of runoff by redirecting the runoff to pervious areas, rain gardens, or into rain barrels to store water for watering outdoor plants during dry periods. Downspout disconnection (also referred to as "roof leader disconnection") is a cost-effective, on-site option for reducing the volume and cost of stormwater that requires public management. Downspout disconnection provides a number of economic and environmental benefits to the municipality and the property owner. The major benefits include:

- Reduced volumes of flows and associated pollutant loads conveyed to watercourses
- Reduced volume of flow to the municipal storm drainage system (MS4)
- Increased infiltration and groundwater recharge
- Options to reuse rainwater for non-potable needs such as watering outdoor plants

Individual rooftop retrofits encompass a small area, requiring the participation of many homeowners to make a measurable difference across a watershed. As a result, a coordinated effort is required for widespread participation in such a program which typically includes a combination of targeted education, technical assistance, and financial subsidies to homeowners or the business community. Examples of effective local downspout disconnection programs are presented in Urban Stormwater Retrofit Practices (CWP, 2007). Recommended actions include:

- Encourage disconnection of rooftop runoff from the storm drainage system and impervious areas to reduce the quantity of runoff by redirecting the runoff to pervious areas, through the use of dry wells, compost-amended soils (in areas with poorly-drained soils), or through the use of rain barrels or rain gardens.

- Disseminate educational materials on designing, constructing or installing, and maintaining residential rain gardens and rain barrels. The Connecticut NEMO web site provides a wealth of information about residential rain gardens: http://nemo.uconn.edu/raingardens/.

- Continue to facilitate rain barrel workshops in coordination with River Network's "Project Rain Barrel" program which offers low-cost rain barrel conversion kits and up-cycled 55 gallon plastic drums to residents and other workshop participants.

Promoting Sustainable Lawn Care Practices and Creating Backyard Habitat

Although sustainable lawn care practices will not significantly reduce bacteria loadings, they will reduce nutrient loadings, the use of toxic chemicals, and promote water conservation. Since many homeowners hire landscaping companies to perform landscape care services, outreach to both property owners and landscape companies is important in driving wide-scale changes in practices.

Outreach to property owners and landscape professionals should:

- Emphasize the benefits of watershed-friendly landscaping practices in improving the health and quality of local streams and Long Island Sound
- Underscore responsible disposal of leaves and lawn clippings which includes not dumping them into a nearby waterbody, participating in municipal curbside leaf collection programs if offered and/or composting them on site
- Promote the use of soil testing to calibrate fertilizing requirements and eliminate excessive or unneeded fertilizer
- Encourage the use of slow-release fertilizers
- Highlight responsible application of fertilizers during dry weather periods
- Promote lawn aeration as a means to improve infiltration and improve turf health
- Emphasize the benefits of Integrated Pest Management (IPM) practices as an alternative to pesticide use
- Underscore appropriate mowing heights as a means to conserve water and improve turf health
- Encourage reductions in turf areas by promoting the replacement of lawn with low to no-mow grass, ground cover, or native flowering plant species as these may reduce property management costs by reducing the need for water, fertilizers and pesticides, and mowing.

Disposing of Pet Waste

Pet waste represents a small but manageable source of the overall bacterial load in the Pomperaug watershed. While solutions are simple and inexpensive—cleaning up after pets—the challenge for advocates lies in reaching the multitude of dog owners, and creating a message with enough social incentive to spur a change in behavior.

In public parks and along town sidewalks, availability of free baggies to pick up pet waste and trash receptacles for proper disposal of pet waste are a simple, inexpensive solution that can encourage pet owners to clean up after their pet. In addition, signage and print handouts placed near the baggies can be used to spread the message.

It may be more difficult to influence behavior on private property. In this case, a mass-media campaign using electronic and print media may be the most effective way to reach pet owners. Emphasizing the health and hygiene benefits of cleaning up pet waste within private properties and disposing of it properly can be an effective route to encouraging behavior change.

Establishing and Maintaining Riparian Buffers

Significant attention should be given to streamside property owners, as their land has a direct connection to runoff and water quality. Property owners who take steps to establish and maintain riparian buffers can create a measureable improvement in local in-stream conditions.

Tall grass, shrub, or forested riparian buffers along the stream corridor are a very efficient method of removing or reducing bacteria, nutrients, sediments and other pollutants carried in overland flow. In addition, riparian buffers help stabilize banks, deter geese from taking up permanent residence on nearby grassy areas, and reduce water temperatures by providing shade. Since a third of the land cover in riparian area is comprised of developed, agricultural, and turf or other grasses, outreach to streamside landowners and residents is an important vehicle for implementing riparian buffers on a large scale.

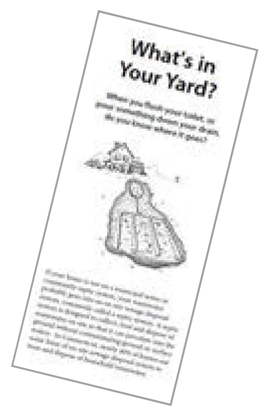
Outreach efforts should:

- Emphasize the relationship between water quality and overall quality of life
- Educate residents about the critical importance of riparian buffers, even relatively narrow buffers, in improving water quality and preventing potentially damaging stream bank erosion
- Highlight design details that can maintain views of and access to the stream
- Provide tips and advice for self-installation of riparian buffers including planting tips, contact information for local nurseries, and plantings lists
- Underscore the benefits of riparian buffers with regard to improving property values, beautifying property, and reducing property maintenance.

Maintaining Septic Systems

As described in *Section 2*, failing septic systems on residential property can cause significant loading of bacteria and nutrients. Adverse effects to water quality typically become more severe the closer those properties with problematic septic systems are located to waterbodies and storm drains. Since septic failure or potential failure rates can be difficult to quantify, preventative measures, including homeowner education, may be the best way to manage this problem.

Outreach and education for septic system owners should:



- Educate owners of septic systems about proper care and maintenance, and the benefits of a properly functioning system
- Encourage homeowners to have periodic inspections of their septic system to ensure proper functioning
- Identify common signs of malfunctioning septic systems
- Provide list of proper steps to take if a malfunction is suspected
- Communicate the potential water quality issues associated with leaking or malfunctioning septic systems.

Ideally, educational materials would be distributed by the municipality or local health districts to all new homeowners and/or when a deed transfer occurs. A brochure created by PRWC and the North Atlantic States Rural Water Association should be updated, reprinted, and disseminated in coordination with local health, municipal land use and/or building officials. Distribution of outreach materials pertaining to septic system maintenance could also be used to meet the public outreach/education minimum control measure of the MS4 Permit and related municipal stormwater management plans.

Outreach to Municipal Staff and Volunteer Commissions

A key objective of this Plan and the MS4 General Permit, applicable to some of the watershed municipalities, is to advance local government awareness, understanding, and stewardship of the watershed through pollution prevention, best management practices education, regulatory enhancements, and involvement in watershed restoration activities. Municipal facilities and operations such as public works yards, street and bridge maintenance, winter road maintenance, stormwater system maintenance, vehicle and fleet maintenance, parks and open space maintenance, and municipal building maintenance can impact water quality by contributing pollutants to the storm drainage system or directly to surface waters or groundwater. Improving the awareness of municipal employees about the potential impact of their operations on water quality and environmental resources in the watershed is an important objective.

The science of watershed protection, including management and regulatory mechanisms that promote and protect watershed resources, has advanced significantly over the past decade. For example, many communities in Connecticut have adopted regulations promoting or requiring the use of LID and green infrastructure techniques and implementing illicit detection and elimination programs. Volunteer members of land use commissions within the watershed should be provided educational opportunities to learn about advancements in watershed science and protection, and the regulatory enhancements being implemented in other communities in Connecticut. Suggested outreach topics include common municipal activities and operations that can reduce bacteria loads to the Pomperaug River including parks and open space maintenance, green infrastructure and LID implementation, storm sewer system and BMP maintenance, and identification and removal of illicit connections.

Outreach to municipalities should:

- Support municipalities with regard to providing annual pollution prevention and good housekeeping training for all municipal employees whose activities potentially impact stormwater and water quality. The training should include municipal personnel with responsibility for public works, parks and recreation, building maintenance, lakes and pond management, and water/wastewater.

- Provide training for municipal reviewers (municipal land use commissions and boards, planners, etc.) of land development projects and designers (developers, architects, engineers, contractors, etc.). Suggested training topics include riparian buffer protection; LID and green infrastructure; operation and maintenance, and testing/reporting requirements for larger, permitted wastewater treatment systems; and construction erosion and sediment controls. Training on these topics could be offered by:

    - Building on previous PRWC stream buffer outreach and educational programming (e.g., native riparian buffer demonstration site at Cedarland Park, Southbury and resources included in the *Be RiverSmart* campaign materials).
    - Providing targeted workshops for municipal parks and recreation employees on how to maintain riparian buffers on public property, invasive plant management, and organic lawn care practices. Include discussion of Connecticut's Greenway program as a mechanism for identifying and prioritizing riparian parcels for consideration in open space acquisitions, as many greenways follow river corridors.
    - Promoting and co-hosting topical training opportunities offered by Connecticut Sea Grant, UCONN Center for Land Use Education and Research (CLEAR), NEMO, CTDEEP, regional Councils of Governments, and partnering environmental organizations.
    - Collaborating with PDDH, CTDPH, and CTDEEP to provide outreach related to performance and compliance with large wastewater treatment system permits.

- Encourage building inspectors in each watershed municipality to receive regular training on stormwater and related topics. Building inspectors in Connecticut must earn a requisite amount of continuing education credits each year. Existing training programs may not address stormwater, LID, green infrastructure or erosion and sedimentation control methods. Training should also be encouraged on sanitary sewer and stormwater connection inspections.

- Continue the practice of inviting and involving municipal staff and land use commission members in ongoing and upcoming Pomperaug River restoration projects, outreach events, and clean-ups.

- Include the continued participation by PRWC in municipal stormwater management committees and provide ongoing assistance to municipalities in achieving the minimum control requirements of the MS4 permit program.

- Offer notification to municipal partners of funding opportunities for the implementation of LID and GI projects, riparian buffer enhancements, and other polluted runoff reduction initiatives that could be implemented on town-owned properties.

Outreach to Businesses, Commercial Landowners, and Institutions

Many different kinds of business and institutional properties are located within the watershed. Whether located directly adjacent to the river or in upland areas of the watershed, these activities contribute in some way to stormwater runoff that ultimately reaches the Pomperaug River. An objective is to advance local business and institutional awareness, understanding, and stewardship of the Pomperaug River watershed through pollution prevention and best management practices education, and involvement in watershed restoration activities. Recommendations include:

- Conduct targeted outreach to residential builders in the watershed on environmental site design and LID methods that reduce and infiltrate runoff in new construction and redevelopment projects. (Note: Large properties or intensive development projects may already be subject to CTDEEP stormwater general permits; the MS4 Permit includes also provisions for onsite stormwater management in new construction and redevelopment projects).

- Provide targeted outreach for other types of businesses in the watershed whose activities have the potential to impact water quality (e.g., heavy and light industry, commercial retail centers, landscaping companies, and restaurants). The education and outreach programs could consist of a variety of printed and electronic media, seminars and workshops, and training opportunities. Specific outreach topics could include:
    - Sustainable lawn care practices
    - Protection and restoration of vegetated buffer areas
    - Parking lot and road maintenance (deicing, snow management)
    - Drainage system inspection and maintenance (catch basins, storm drains, stormwater BMPs)
    - Water quantity and flooding issues
    - Low Impact Development and green infrastructure approaches
    - Dumpster and trash management issues

- Wastewater system operation and maintenance, as well as testing and reporting requirements established by CTDPH and CTDEEP.

- Promote continued involvement of businesses in restoration efforts, outreach events, stream monitoring programs, and river clean-ups.

Outreach to Agricultural Operations

PRWC's outreach efforts to the agricultural community have been limited and represent a key area for increased collaboration. Agricultural operations, both large scale and hobby farm size, are common throughout the watershed and, according to the pollutant loading model results, represent key drivers of bacteria loads. In areas where livestock are present, poor manure management can allow bacteria, sediment, and nutrients to be transported to waterbodies via stormwater runoff. Presence of these pollutants may also increase when livestock have direct access to waterbodies.

As described in *Section 3.5*, outreach messages to the agricultural community should contain information about:

- Improving manure management practices, including stockpiling, placement, covering, timing for spreading and composting options
- Establishing and maintaining vegetated buffers, filter strips and exclusionary fencing near waterbodies
- Maintaining healthy soils (e.g. conducting soil tests and amending based on needs for selected crop production and/or rotating crops)
- Using integrated pest management techniques

These messages should be approached with great sensitivity, recognizing the multitude of challenges faced by the agricultural community, including size/scale of operation, financial resources and human resources, to name a few. It will be important to begin a dialogue with members of the local agricultural community to better understand their challenges before presenting potential BMP strategies. In this light, it will also be important to work closely with one or two local agricultural partners to establish demonstration projects that may also be suitable for other operations.

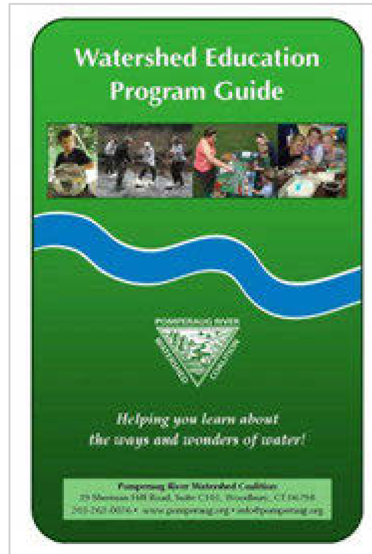
Education and outreach to the agricultural community should be done in collaboration with Northwest Conservation District and the local Natural Resource Conservation Service field office, as they have a long history of working with area farmers. They also represent a key funding partner for agricultural BMPs.

Outreach to Youth and Students

The Pomperaug River watershed and its surrounding area are home to numerous public and private primary and secondary schools, many of which offer environmental education and community service programs. The watershed is also home to two sizable nature centers, Audubon Center at Bent of the River and Flanders Nature Center & Land Trust, which both offer a wide variety of education programs for youth, including summer camps, after school programs and class field trip opportunities. These nature centers are not alone in their youth programs; they are complimented by town parks and recreation camps, church camps, scouts, and more. These existing programs and resources provide an excellent opportunity to promote youth education on issues related to watersheds, water quality, water conservation, and the Pomperaug River.

PRWC has already established a menu of educational activities that it brings into the classroom or facilitates outdoors, many of which are aligned to local public school curriculum requirements and the Next Generation Science Standards. These programs cover a wide variety of topics including stream ecology, water quality, water conservation, non-point source pollution, pollution prevention and the water cycle. Specific programs are outlined on the watershed education page of PRWC's website: http://www.pomperaug.org/watershed-education-programs.

Specific recommendations for program expansion include:



- Working with the local school districts (within the watershed, the surrounding towns and, nearby urban areas like Waterbury) to identify specific schools and grade levels that would benefit from new or expanded watershed or related environmental education programs.

- Establishing a formal program for local and nearby high school and college students to participate in volunteer watershed stewardship efforts such as stream and road-side cleanups, invasive species removal, trail and park maintenance, rain garden installations, and other ecological restoration projects.
    - Continue to provide similarly focused summer employment opportunities under the PRWC Youth Conservation Corps program established in 2017.

- Working with the local afterschool and summer camp programs to identify specific youth groups that would benefit from new or expanded watershed or related environmental education programs.

- Continuing to recruit student volunteers to participate in water quality and macroinvertebrate monitoring and streamwalk surveys in the Pomperaug River watershed.

- Marketing education program offerings to summer camp and scouting programs.

- Continuing to collaborate with college faculty and research staff on ongoing and future research activities focused on the Pomperaug River watershed, such as recent research conducted by hydrology students in the Yale School of Forestry.

3.3.4 Additional Education and Outreach Strategies

The education and outreach recommendations outlined above are just a brief sampling of strategies and messages to consider incorporating within the Pomperaug River watershed. Other strategies that reach multiple audiences at once could include:

- **Increased Watershed Stewardship Signage.** Such signage can increase public awareness and visibility of the Pomperaug River and the connection between the community, the watershed, and the river. Watershed signage can take the form of kiosks in public areas, storm drain markers or stencils (an ongoing local effort), anti-dumping signs, proper pet waste management signs, and roadside/stream side signage (examples include "adopt a stream/roadway" programs). Storm drain stenciling and other watershed signs are already present in some areas of the watershed. PRWC and local partners should consider developing a more formal and consistent watershed sign program that could be implemented as a component of the recommended green infrastructure public outreach program. The signs should incorporate a simple, yet consistent message and logo. Watershed signs are recommended in highly-visible public areas of the watershed such as municipal facilities (schools, parks, libraries, other municipal properties, commercial areas, nature centers, land trust properties, etc.) and public access areas along the river. Examples of existing signage include interpretative signs placed at the Community House Park Rain Garden and the Cedarland Park Riparian Buffer, both in Southbury.

- **Increased Collaboration with Local Volunteer Groups and Civic Organizations.** Ongoing education and outreach to and collaboration with those that work as volunteers of local stewardship groups is also important. Partnerships with local, volunteer-based, nonprofit groups such as Friends of the Southbury Dog Park, Southbury Garden Club, Pomperaug Valley Garden Club, Woodbury Junior Women's Club, Southbury Women's Club, Scouts, Rotary, Lions and area land trusts may result in new and expanded opportunities for volunteers from these groups to participate in and/or assist with presentations and BMP implementation projects led by PRWC and/or watershed municipalities, working to comply with their MS4 Permit requirements.

- **Increased Participation in Community Events.** Promote, publicize, and support existing community engagement events where PRWC has an opportunity to interface with the general public including Woodbury Earth Day, Flanders' Farm Day, Bent Fest, Woodbury Fall Fest, Southbury Celebration, Bethlehem Garlic & Arts Festival, farmers' markets, and others yet to be identified. Events such as these also represent an opportunity to recruit volunteers as representatives of PRWC who could be trained as "Watershed Ambassadors".

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
Homeowner Outreach and Education					
Continue to implement the *Be RiverSmart* public outreach campaign, including: • Develop/refine and distribute outreach message(s) • Distribute and collect pledge forms • Develop a recognition program for river-friendly properties that integrate GI/LID, native buffers, rain gardens, downspout disconnection, etc.	PRWC, HVA, Rivers Alliance, Municipalities	2-5 years	• *Be RiverSmart* program implemented throughout watershed • Public outreach messages delivered through a variety of media • Number of pledges submitted • Number of properties recognized	$$$$	CTDEEP 319 NPS Grants, River Network, EPA EE Grants
Provide homeowner education and outreach on using LID • Develop outreach message(s) • Distribute outreach materials • Facilitate public education programs	PRWC, Municipalities, UCONN NEMO, NWCD, Long Meadow Pond Management Committee	Ongoing	• LID education program implemented throughout watershed • Number of people reached (website traffic, social media, email click rates, brochures distributed, print media readership metrics) • Number of program participants	$$	Municipal, grants
Evaluate and implement residential LID incentive programs • Identify and build upon existing programs (e.g., River Network's *Project Rain Barrel* program; Save the Sound's *Reduce Runoff* initiative) • Evaluate feasibility of alternative programs	PRWC, Municipalities, NWCD	2-5 years establish program Ongoing implementation thereafter	• LID incentive program implemented throughout watershed • Number of homeowners participating • Volume of water diverted from MS4 • Area of land utilized for LID retrofits	$$$$	Housatonic NRD Fund, future stormwater fees, NFWF Long Island Sound Futures Fund

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
Promote Rooftop Disconnection • Develop outreach message(s) • Distribute outreach materials • Facilitate public education programs	PRWC, Municipalities	2-5 years	• Rooftop disconnection program implemented throughout watershed • Number of people reached (website traffic, social media, email click rates, brochures distributed, print media readership metrics) • Volume of water diverted from MS4 • Number of rain barrel workshop participants • Number of rain gardens installed	$	Workshop fees; stormwater fees
Provide homeowner outreach on sustainable lawn care practices and backyard habitat • Develop outreach message(s) • Distribute outreach materials • Facilitate public education programs (tours, workshops, etc.)	PRWC, Municipalities, UCONN NEMO, NWCD, Long Meadow Lake Management Committee, Land Trusts, Audubon Center at Bent of the River	Ongoing	• Sustainable lawn care / backyard habitat outreach program implemented throughout watershed • Number of people reached (website traffic, social media, email click rates, brochures distributed, print media readership metrics, program participation) • Increased buffer widths • Decreased use of synthetic fertilizers and pesticides • Increased use of native plants in landscaping • Increased number of Audubon Backyard Habitat program recognitions	$$	Municipal, grants, business sponsors

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
Provide homeowner outreach on pet waste disposal • Develop outreach message(s) • Distribute outreach materials • Installation / maintenance of pet waste stations	PRWC, Municipalities, UCONN NEMO, NWCD, Long Meadow Lake Management Committee, Land Trusts, Audubon Center at Bent of the River	Ongoing	• Pet waste disposal program implemented throughout watershed • Number of people reached (website traffic, social media, email click rates, brochures distributed, other media metrics) • Increased availability of pet waste stations • Fewer observations of pet waste in public spaces	$$	Municipal, grants
Provide homeowner outreach on benefits of vegetated buffers • Develop outreach message(s) • Distribute outreach materials • Facilitate public education programs	PRWC, Land Trusts, Nature Center, Municipalities	Ongoing	• Vegetated buffer program implemented throughout watershed • Number of people reached (website traffic, social media, email click rates, brochures distributed, print media readership metrics, program participation) • Improved buffer conditions • Increased buffer widths • Increased use of native plants in landscaping	$	NFWF Long Island Sound Futures Fund, CTDEEP Supplemental Environmental Project Funds, CTDEEP 319 NPS Grants
Provide homeowner outreach on septic systems • Updated and refine outreach message(s) based on existing brochure • Distribute outreach materials • Implement voluntary inspection / repair incentive program in older neighborhoods along impaired stream segments	PRWC, PDDH, TAHD, Municipalities	Ongoing	• Septic systems program implemented throughout watershed • Number of people reached (website traffic, social media, email click rates, brochures distributed, print	$ - $$$$	NFWF Long Island Sound Futures Fund, CTDEEP Supplemental Environmental Project Funds, CTDEEP 319 NPS Grants

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
			media readership metrics, program participation) • Number of homeowners participating in incentive program		
Continue to recruit and train community volunteers to participate in water quality and benthic monitoring and streamwalks	PRWC	Ongoing	• Volunteer recruitment and orientation/training program implemented • Number of new and returning project volunteers	$	CTDEEP 319 NPS Grants, NFWF Long Island Sound Futures Fund
Advance Local Government Awareness					
Provide education and training for municipal employees and land use boards on: LID retrofit opportunities, septic systems, landscaping practices, invasive plant management, Connecticut's Greenway program, and stormwater "good housekeeping" practices • Develop topic-specific outreach message(s) • Distribute outreach materials • Facilitate education and training programs in conjunction with appropriate partners (listed at right)	Municipalities (as part of MS4 Permit Outreach), PRWC, UCONN NEMO / CLEAR, NVCOG, NWCD, CTNOFA, CIPWG	2-5 years	• Municipal outreach and education program implemented • Number of people reached (website traffic, social media, email click rates, brochures distributed, print media readership metrics, program participation) • Number of homeowners participating in incentive program • Continued MS4 compliance • Targeted acquisitions of land along the river corridors • Inclusion of LID and other BMPs in approved site designs	$$	NVCOG; CTDEEP Supplemental Environmental Project Funds; further stormwater fees;

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
Encourage pet waste stations at parks; popular walking paths; and enforcement of dog rules	PRWC, Municipalities	0-2 years	• Installation and regular restocking of pet waste stations • Regular waste removal from trash receptacles • Reduced incident of pet waste not cleaned up	$	Municipal
Provide municipal outreach on sustainable lawn care practices and riparian habitat • Develop outreach message(s) • Distribute outreach materials • Facilitate education and training programs in conjunction with appropriate partners (listed at right)	PRWC, UCONN CLEAR / NEMO, CTNOFA, CIPWG	2-5 years	• Municipal outreach and education program implemented • Increased buffer widths on municipal properties; • Decreased use of synthetic fertilizers and pesticides • Increased invasive plant removal efforts • Increased use of native plants in landscaping	$$	
Outreach to Business Community					
Conduct outreach to commercial and industrial property owners on LID retrofit opportunities, septic systems, and landscaping practices • Develop topic specific outreach message(s) • Assemble categorical list of business contacts • Distribute outreach materials • Facilitate education and training programs in conjunction with appropriate partners (listed at right)	PRWC, municipalities, NVCOG, UCONN CLEAR / NEMO, NWCD, CTDEEP	Ongoing through existing land use permitting processes; Implementation of a more formal outreach strategy 5-10 years	• Business outreach and education program implemented • Implementation of LID retrofits • Increased buffer widths • Decreased use of synthetic fertilizers and pesticides • Increased use of native plants in landscaping • Reduction in septic system back-ups or failures	$$$	CTDEEP Supplemental Environmental Project Funds

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
			• Compliance with reporting requirements in the case of DEEP permits for septic and or stormwater management		
Outreach to Agricultural Operations					
Conduct outreach to farm owners and operators on riparian buffer and manure management practices • Develop topic specific outreach message(s) • Assemble categorical list of farmer contacts • Distribute outreach materials • Facilitate education and training programs in conjunction with appropriate partners (listed at right)	PRWC, NRCS, CT Ag. Experiment Station, NWCD, UCONN Extension Service	2-5 years	• Hobby farm outreach and education program implemented • Number of direct interactions with farmers • Updated contacts list • Improved manure management • Increased buffer widths	$$	USDA, NRCS
Conduct outreach to equestrian facilities and farm owners/operators on vegetated buffers, manure storage and spreading practices, and exclusionary fencing • Develop topic specific outreach message(s) • Assemble categorical list of agricultural contacts • Distribute outreach materials • Facilitate education and training programs in conjunction with appropriate partners (listed at right)	PRWC, NRCS, CT Ag. Experiment Station, NWCD, UCONN Extension Service	0-2 years	• Agricultural outreach and education program implemented • Updated contacts list • Number of direct interactions and/or participants in workshops and/or demonstration project tours • Improved manure management • Installation or improved placement of exclusionary fencing	$$$	USDA, NRCS, CTDEEP

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
Youth Education, Community Service, and Stewardship Programs					
Expand existing relationships and educational programs with schools • Update list of academic contacts (curriculum coordinators, teachers, principals, PTOs by school/region) • Distribute educational program marketing materials • Facilitate school-based educational programs	PRWC, Region 14 Schools, Region 15 School, Oxford Public Schools, Region 12 Schools	Ongoing	• School based outreach and education programs implemented • Updated contacts list • Increased number of classroom visits and students reached • Increased knowledge of water, hydrologic systems, environmental impacts and corrective actions • Increased stewardship by area youth	$$	Program fees
Expand Pomperaug Watershed Youth Conservation Corps to implement and steward water quality-focused BMPs on publicly owned lands • Identify BMP project sites and secure permissions and funding for BMPs • Secure funding to hire YCC team members (4+ crew members with growth each year at/or greater than 24 hours per week for 6+ weeks) • Recruit, hire, and train crew members • Implement BMP projects • Provide crew enrichment / professional development opportunities	PRWC	0-2 years	• YCC program continuation and expansion • Increased hours of employment • Increased number of crew members hired • Increased knowledge of water, hydrologic systems, environmental impacts and corrective actions	$$$	EPA EE Grants, Foundation grants, program sponsorship
Continue to recruit student volunteers to participate in water quality and benthic monitoring and streamwalk surveys	PRWC, CTDEEP	Ongoing	• Volunteer recruitment and orientation/training program implemented	$$	

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
			• Number of new and returning project volunteers		
Expand existing relationships and educational program offerings with summer camp and after school programs • Update list of camp and after school program contacts • Distribute educational program marketing materials • Facilitate camp and after school educational programs	PRWC, parks and recreation departments, nature centers, land trusts	Ongoing	• Camp and after school outreach and education programs implemented • Updated contacts list • Number of programs conducted • Number of participants Updated contacts list, increased number of camp visits and youth reached • Increased knowledge of water, hydrologic systems, environmental impacts and corrective actions • Increased stewardship by area youth	$	Program fees
Additional Education and Outreach Strategies					
Watershed Stewardship Signage • Develop outreach message(s) and appropriate signage type (kiosk, road sign, interpretative sign, etc.) • Identify location(s) for signage (with or without associated demonstration project) • Secure necessary landowner permission for installation and/or sign permits • Install signage	PRWC, parks and recreation departments, nature centers, land trusts	2-5 years	• Increased signage and associated follow-up interaction with PRWC via phone and email inquiries and/or web visitation and social media followers	$$$	

Table 3-3. Education and outreach recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
Engage local, state, and regional organizations in the Pomperaug River watershed • Promote, publicize, and support existing events such as the annual Woodbury Earth Day Festival hosted by PRWC • Engage local organizations in volunteer monitoring and stewardship activities	PRWC	Ongoing	• Updated contacts list • Increased number of community organizations participating in PRWC sponsored events • Increased number of volunteers	$$	
Provide education and outreach to volunteers of local non-profit organizations (i.e., garden clubs, scouts, etc.) • Update list of community organization contacts • Distribute educational program marketing materials • Facilitate educational programs • Cultivate a team of "Watershed Ambassadors" to represent PRWC within other organizations and at community events ○ Develop volunteer training program ○ Recruit & train volunteers ○ Schedule volunteers for tabling at events	PRWC	Ongoing	• Increased number of education programs or presentations to community organizations • Increased number of volunteers • Increased participation or representation in area community events • Increased follow-up interaction with PRWC via phone and email inquiries and/or web visitation and social media followers • Increased watershed knowledge among volunteers	$$$	EPA EE grants

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition
PDDH = Pomperaug District Department of Health
TAHD = Torrington Area Health District
NVCOG = Naugatuck Valley Council of Governments
CTNOFA = Connecticut Chapter Northeast Organic Farmers and Growers Association
CTDEEP = Connecticut Department of Energy and Environmental Protection
NWCD = Northwest Conservation District
NRCS = Natural Resource Conservation Service
HVA = Housatonic Valley Association
CPWIG = Connecticut Invasive Plant Working Group

3.4 Urban/Suburban BMPs

3.4.1 Green Infrastructure and Low Impact Development

Green Infrastructure (GI) can be defined as the natural and man-made landscapes and features that can be used to manage runoff. Examples of natural green infrastructure include forests, meadows and floodplains. Examples of man-made green infrastructure include green roofs, rain gardens and rainwater cisterns.

Low Impact Development (LID) is a land development approach that is intended to reduce development related impacts on water resources through the use of stormwater management practices that filter, infiltrate, evapotranspire, or harvest and use stormwater on the site where it falls.

Green infrastructure (GI) and Low Impact Development (LID) refer to systems and practices that reduce runoff through the use of vegetation, soils, and natural processes to manage and cleanse water and create healthier urban and suburban environments (EPA, 2014). GI/LID includes stormwater management practices such as rain gardens, permeable pavement, green and blue roofs, green streets, infiltration planters, trees and tree boxes, and rainwater harvesting. These practices capture, filter, manage, and/or reuse rainfall close to where it falls, to remove pollutants, reduce stormwater runoff volume, recharge ground water supplies, and control flows to receiving surface waters. GI/LID practices can remove bacteria in stormwater through filtration, sedimentation, and inactivation by exposure to sunlight.

In addition to reducing runoff and improving water quality, GI/LID has been shown to provide other social and economic benefits such as reduced energy consumption, decreased urban heat island effects, better air quality, increased carbon reduction and sequestration, higher property values, new recreational opportunities, improved economic vitality, greater adaptation to climate change, and enhanced human health and well-being (Center for Neighborhood Technology and American Rivers, 2010; EPA Green Infrastructure Website http://water.epa.gov/infrastructure/greeninfrastructure/gi_why.cfm; Oregon Health and Outdoors Initiative, 2018). For these reasons, many communities are exploring the use of and are adopting GI/LID within their municipal infrastructure programs.

Although conventional stormwater drainage systems are prevalent throughout the watershed, there are also several examples of GI/LID stormwater treatment practices in the watershed. One example is the use of permeable pavement in the lower parking lot behind the commercial plaza at 7 Garage Road in Southbury. Permeable pavement has also been used for the parking lot of the New Morning Market in Woodbury and Prime Publishing in Southbury. Underground infiltration practices are also located at the new Riverview Cinemas and Playhouse at 690 Main Street South in Southbury and at the Southbury Medical Building.

Regular maintenance is required for the successful operation of GI/LID practices, which is true for all stormwater management practices. Accumulated sediment and debris can reduce treatment effectiveness, hydraulic performance, and infiltration capacity. Some GI/LID practices such as infiltration and bioretention systems require more intensive or frequent maintenance. Below-ground practices such as subsurface infiltration systems are generally more susceptible to maintenance issues, as compared to surface practices such as bioretention systems, swales, and surface infiltration basins, since subsurface practices are less visible and may suffer from an "out-of-sight, out-of-mind" mentality by property owners.

There are many opportunities for GI/LID practices throughout the Pomperaug watershed given the available land area and relatively permeable soils in many parts of the watershed. Good candidates for GI/LID retrofits include public rights-of-way, municipal and commercial parking lots, and parking lots and roads associated with residential developments such as Heritage Village. Candidate stormwater retrofit sites exist in virtually all of the subregional basins but are most prevalent in the Pomperaug River subregional basin. *Table 3-4* contains GI/LID recommendations for the Pomperaug River watershed.

Care should be taken when siting and designing infiltration-based stormwater BMPs under the following conditions and settings:

- In mapped Aquifer Protection Areas (APAs) and other groundwater drinking supply areas to avoid inadvertent impacts to groundwater quality. Adequate separation distance between the bottom of the infiltration practice and seasonal high groundwater (typically 2 to 3 feet) is critical to allow for sufficient removal of pollutants from the infiltrated runoff before reaching the water table.

- Infiltration of stormwater from land uses or activities with potential for higher pollutant loads (also referred to as stormwater "hotspots"), such as industrial facilities, vehicle fueling facilities, commercial parking lots with high intensity use, etc., should include appropriate pretreatment designed to remove the stormwater pollutants of concern.

- In areas served by on-site sewage disposal (septic) systems, infiltration measures should be appropriately sized, located, and constructed in a manner consistent with the Connecticut Department of Health's Technical Standards for Subsurface Sewage Disposal Systems, Section 19-13-B100A of the Regulations of Connecticut State Agencies, and/or CTDEEP requirements for on-site sewage disposal systems.

- Infiltration of stormwater is not recommended in areas with soil or groundwater contamination.

Additional guidance on infiltration of stormwater under various conditions and settings is available in Appendix C of the CTDEEP MS4 General Permit.

Recommended Actions

- Pursue funding for and implement site-specific GI/LID retrofits on public lands based on the BMP concepts identified in *Section 4* of this plan. Other potential retrofit projects, such as those listed in *Appendix D*, should be identified through future streamwalks, track down surveys, and subwatershed action plans.

- The watershed municipalities should incorporate GI/LID into municipal projects, including parking lot upgrades and roadway projects using "green streets" approaches. Use of GI/LID in municipal projects will allow the MS4-regulated communities in the watershed (Southbury and Woodbury) to satisfy the stormwater retrofit and impervious area disconnection requirements of the MS4 Permit.

Table 3-4. Green Infrastructure and Low Impact Development recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Implement GI/LID retrofit projects on public lands • Conduct retrofit inventory • Pursue and obtain funding • Design and construct projects	PRWC, municipalities, consultants	0-2 years (retrofit inventory) Ongoing implementation	• Inventory completed • Funding obtained • Projects designed and constructed	$$$$	Municipal funding, 319 NPS Grant, NFWF Long Island Sound Futures Fund
2. Incorporate GI into municipal projects including parking lot upgrades and "green streets" projects • Identify capital projects • Pursue and obtain funding • Design and construct projects	Municipalities	0-2 years (identify capital projects) Ongoing implementation	• Projects identified • Funding obtained • Projects designed and constructed	$$$$	Municipal funding, 319 NPS Grant, NFWF Long Island Sound Futures Fund, STEAP Grant
3. Develop and implement a GI/LID master plan for the Main Street South corridor, Southbury • Inventory GI/LID opportunities • Develop master plan and design concepts • Pursue and obtain funding • Design and construct projects	Town of Southbury	2-5 years (develop plan) 5-10 years (plan implementation)	• GI/LID opportunities identified • Master plan completed • Funding obtained • Projects designed and constructed	$$$$	Municipal funding, 319 NPS Grant
4. Develop and implement a GI/LID master plan for Heritage Village • Inventory GI/LID opportunities • Develop master plan and design concepts • Pursue and obtain funding • Design and construct projects	PRWC, Heritage Village Development Group	2-5 years (develop plan) 5-10 years (plan implementation)	• GI/LID opportunities identified • Master plan completed • Funding obtained • Projects designed and constructed	$$$$	319 NPS Grant
5. Incorporate GI/LID into potential future re-use or redevelopment of the Southbury Training School	State of Connecticut, Town of Southbury	5-10 years	• Redevelopment plan and completed projects	$$$$	

Table 3-4. Green Infrastructure and Low Impact Development recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
6. Pursue sustainable, long-term funding sources for large-scale GI implementation	PRWC, Regional Planning Agencies, Municipalities, NWCD	5-10 years	• Framework and action plan to evaluate and implement stormwater infrastructure financing	$$$$	Stormwater utilities, property tax credits and incentive rate structures, green bonds, public private partnerships, CWF

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition CTDEEP = Connecticut Department of Energy and Environmental Protection NWCD = Northwest Conservation District
CWF = Connecticut Clean Water Fund STEAP = Connecticut Small Town Economic Assistance Program

- Develop and implement a GI/LID master plan for the Main Street South corridor in Southbury between Route 6/Southbury Plaza and South Britain Road (Route 172). The master plan could include GI/LID retrofits of municipal and commercial properties and within the municipal right-of-way. Potential municipal retrofit sites include:
    - Southbury Police, Fire, and Department of Public Works
    - Southbury Town Hall
    - Southbury Parks and Recreation / Senior Center
    - Rochambeau Middle School
    - Pomperaug Elementary School
    - Southbury Library
    - Roadway right-of-way.

- Develop and implement a GI/LID master plan for Heritage Village using the concepts identified in *Section 4* of this watershed plan. Stormwater infrastructure in Heritage Village is privately-owned and is not part of the Southbury municipal separate storm sewer system (MS4). The Heritage Village storm system is therefore not regulated under the statewide MS4 Permit. The Section 319 Nonpoint Source Grant program could potentially be used to fund GI/LID retrofits at Heritage Village.

- Incorporate GI/LID approaches into redevelopment projects, such as the potential future re-use or redevelopment of the Southbury Training School.

- Cost-effective, large-scale implementation of LID/GI will require non-traditional financing. Possible long-term funding sources including user fees, stormwater utilities, property tax credits or rebates, green bonds and community-based public-private partnerships.

3.4.2 Homeowner Best Management Practices

Residential land use accounts for a large percentage of the developed land in the Pomperaug River watershed. Residential areas are a significant source of runoff and nonpoint source pollutant loads to the Pomperaug River and its tributaries. The actions of individual homeowners can also help to reduce runoff and pollutant loads that flow overland and directly into waterbodies or into the storm sewer systems in residential areas that, in turn, discharge at outfall pipes into waterbodies. The previous section describes larger-scale green infrastructure recommendations primarily targeted at the watershed municipalities, institutions, and private development. However, LID and other small-scale best practices can also be implemented by homeowners on individual residential lots.

Residential BMPs on individual lots target small areas, requiring the participation of many homeowners to make a measurable difference across a watershed. A coordinated effort is required for widespread

Best Practices for Homeowners – River Smart

River Smart is an education and outreach program that provides steps homeowners can take to reduce the impact of nonpoint source pollution from residential properties. The program is led cooperatively by Housatonic Valley Association, Pomperaug River Watershed Coalition, Kent Land Trust, Weantinoge Heritage Land Trust, Rivers Alliance of Connecticut, and the Farmington River Watershed Association. http://www.pomperaug.org/riversmart

participation in such a program, which typically includes a combination of targeted education, technical assistance, and financial subsidies to homeowners. Successful implementation of residential/small-scale practices therefore requires homeowner education and incentive programs.

Recommendations for implementation of homeowner BMPs in the Pomperaug River watershed are described below and summarized in *Table 3-5*.

Recommended Actions

- Continue to promote residential BMPs by homeowners, including practices promoted by the River Smart program:
    - Nurture native trees, shrubs, and flowers
    - Reduce the size of grass lawns
    - Limit the amount of paved areas and create natural places for the water to soak into the ground
    - Plant or grow natural buffers at the edges of rivers/streams, lakes/ponds, and wetlands
    - Reduce or eliminate use of fertilizers and pesticides
    - Dispose of pet waste in the trash or a pet-waste processor
    - Have your septic tank pumped and inspected regularly
    - Check and fix all the taps on sinks, baths, toilets, and hoses for leaks and drips
    - Dispose of unused and unwanted medications in the trash; do not flush them down the toilet.

- Encourage disconnection of rooftop runoff from the storm drainage system by redirecting exterior roof leaders to pervious lawn areas and through the use of dry wells, rain barrels or rain gardens. Downspout disconnection can be a cost-effective option for reducing the volume and cost of stormwater that requires public management. The use of pervious materials for patios, walkways and driveways, as well as pavement removal and planting new native and/or non-invasive trees, shrubs and herbaceous plants, can also reduce impervious surfaces on residential lots and the contribution of runoff and pollutant loads to waterbodies.

- In addition to the River Smart "pledge," consider other residential BMP incentive programs to encourage implementation of LID practices by homeowners, which will help reduce the burden on municipal stormwater infrastructure for managing runoff from residential lots. Other incentives to encourage residential property owners to use LID include:
    - Youth Conservation Corps – expanding the PRWC Youth Conservation Corps program to include residential landowner assistance creating rain gardens, planting riparian buffers, etc.
    - Stormwater Fee Discounts or Credits – reduced fees or utility bills by installing LID practices; requires a stormwater utility or similar fee-based system
    - Rebates and Installation Financing – funding, property tax credits (i.e., reduction in property taxes), or reimbursements to property owners who install green infrastructure
    - Workshop and Give-Away Programs - rain barrel workshops for homeowners that provide a free (or reduced cost) rain barrel to each participating household, along with training on how to install and maintain the rain barrel
    - Certification and Recognition Programs – certification of residential properties as watershed-friendly by implementing LID practices
    - Municipal sponsored public workshops on how to build rain gardens emphasizing the increase in property value and curb appeal of LID landscaping.

Incentive programs can also serve as a mode of public outreach. Several examples of successful residential BMP incentive programs are highlighted in the following text box.

Residential BMP Incentive Programs

Lake Champlain BLUE® Certification Program
Program developed by Lake Champlain International that certifies residential properties as watershed friendly, or BLUE®, if they follow simple, yet scientifically accepted, practices that reduce water pollution runoff starting on their properties. Certified homeowners receive a BLUE certification lawn sign, increased property values, and the satisfaction of improving local water quality.
http://www.mychamplain.net/blue-program

Montgomery County, MD Rainscapes Rewards
Montgomery County coordinates RainScapes Rewards, a rebate program used to meet part of its municipal separate storm sewer system (MS4) permit goals. The county provides rebates based on the amount of runoff captured. Residential properties are capped at $2,500.
https://www.montgomerycountymd.gov/DEP/water/rainscapes-rebates.html

Table 3-5. Homeowner recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Promote residential BMPs by homeowners, including River Smart practices (see Education and Outreach recommendations)	PRWC, municipalities	Ongoing	• Materials disseminated • Number of homeowners participating	$$	
2. Encourage disconnection of rooftop runoff • Integrate disconnection into River Smart materials (see Education and Outreach recommendations) • Incorporate disconnection as a BMP in local land use regulations	PRWC and River Smart partners Municipalities	0-2 years 2-5 years (land use regulations)	• Updated River Smart BMPs • Updated land use regulations • Volume of runoff diverted	$ $	
3. Evaluate and implement other residential BMP incentive programs • Build upon existing River Smart pledge • Evaluate feasibility of alternative programs • Implement program(s)	PRWC and River Smart partners	2-5 years establish program Ongoing implementation thereafter	• Program(s) identified, funding secured • Program established • Number of homeowners participating • Volume of runoff diverted	$$ (initial program implementation) $ (individual residential actions)	Grants, future stormwater fees, property tax credits

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition

3.4.3 Municipal Stormwater Management Programs

The stormwater collection and drainage systems within the watershed are owned and maintained by the watershed municipalities (with the exception of Heritage Village, which is privately-owned) and the Connecticut Department of Transportation. Stormwater discharges from the municipal storm drainage systems in the Town of Southbury and the Town of Woodbury (as well as the Town of Middlebury and Town of Watertown) are regulated under the CTDEEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 Permit).[1] Stormwater discharges associated with the state drainage system are regulated under a similar MS4 permit issued specifically to the Connecticut Department of Transportation (CTDOT), which will become effective July 1, 2019. Both permits establish requirements for implementing BMPs that will reduce pollutant discharges from municipal and state storm drainage systems.

Through their MS4 Permit stormwater management programs and other planning initiatives, the watershed municipalities have developed and are implementing a variety of BMPs to address stormwater quality issues associated with municipal activities as well as land development and redevelopment projects.

Compliance with MS4 Permits

Connecticut's revised MS4 General Permit went into effect on July 1, 2017. The watershed communities of Southbury and Woodbury are regulated under the MS4 General Permit. These communities have developed Stormwater Management Plans that outline steps that each town will take to comply with the 6 minimum control measures in the permit, which include public education, public involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention and good housekeeping.

Stormwater discharges associated with the state drainage system are regulated under a similar MS4 permit issued specifically to the Connecticut Department of Transportation, which will become effective July 1, 2019.

Reduction of bacteria loads in stormwater discharges from the municipal and state storm drainage systems will be a focus of efforts by the Pomperaug River watershed municipalities and CTDOT in complying with their MS4 permits.

Compliance with the illicit discharge detection and elimination (IDDE) program requirements of the permit can help to significantly reduce bacteria loadings, where illicit connections are present and particularly where they contribute to the recreational impairments in the watershed. Outfall screening for bacteria is required where a MS4 discharges to an impaired water for which bacteria is the pollutant of concern. Other minimum control measures apply to municipal operations, such as reducing road sanding or increasing street sweeping. The permit also requires reduction in Directly Connected Impervious Area (DCIA) through the use of green infrastructure and Low Impact Development practices that retain/infiltrate stormwater runoff from impervious surfaces, either through private or municipal redevelopment projects or retrofits.

Municipal stormwater management recommendations are summarized in *Table 3-6*.

Recommended Actions

- The Town of Southbury and Town of Woodbury (and other MS4 watershed municipalities) should continue to implement municipal stormwater management programs for their regulated MS4s, as

[1] The Town of Bethlehem is not a regulated MS4 community based on its population density.

required by the MS4 General Permit. Specific actions relevant to the recreational and aquatic life impairments in the Pomperaug River watershed include:

- Dry weather screening of outfalls in "priority areas" (defined by the MS4 permit) for evidence of illicit discharges
- Catchment investigations for outfalls known or suspected of having illicit discharges
- Elimination of illicit discharges identified
- Wet weather monitoring of stormwater outfalls that discharge directly to impaired waterbodies
- Update of local land use regulations to reflect more stringent stormwater retention and treatment standards and promote the use of green infrastructure and LID practices
- Development of a stormwater retrofit plan to identify opportunities for LID retrofits on municipal properties and within the municipal right-of-way, such as the site-specific BMP concepts presented in *Section 4* of this watershed plan
- Tracking and disconnection of impervious area through private or municipal redevelopment projects and stormwater retrofits
- Education and outreach on septic systems, sanitary cross connections, waterfowl, and pet waste targeted at homeowners, commercial businesses, and municipal staff
- Education and outreach on manure management and vegetated buffers targeted at farm owners.

- CTDOT will be developing and implementing a Stormwater Management Plan to comply with its MS4 Permit. PRWC and watershed municipalities should review and comment on the draft Stormwater Management Plan during the public comment period, which is 90 days prior to the effective date of the MS4 Permit (July 1, 2019).

- PRWC should work collaboratively with the Town of Southbury, the Town of Woodbury (and other MS4 watershed municipalities), and CTDOT during implementation of their MS4 Stormwater Management Programs to share stormwater outfall screening and monitoring results, the results of streamwalks and track down surveys, the results of illicit discharge investigations, and opportunities for GI/LID retrofits in the Pomperaug River watershed.

- The Naugatuck Valley Council of Governments (NVCOG) should continue to explore the possibility of providing regional training and outreach materials to its member communities to facilitate sharing of resources and identify additional ways to comply more cost-effectively with the MS4 General Permit, borrowing from the successes of regional stormwater coalitions in Massachusetts such as the Central Massachusetts Regional Stormwater Coalition (http://centralmastormwater.org/Pages/index).

Table 3-6. Municipal stormwater management program recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Continue to implement municipal Stormwater Management Programs	Southbury, Woodbury and other watershed MS4 municipalities	Ongoing	• Compliance with permit deadlines for mapping, outfall monitoring, regulatory updates, etc.	$$$$	Municipal funds (permit requirements not eligible for federal 319 NPS Grant funding)
2. Develop and implement Transportation MS4 Stormwater Management Program	CTDOT	0-2 years (develop plan by July 1, 2019) Ongoing thereafter	• Draft and final Stormwater Management Program • Compliance with permit deadlines for mapping, outfall monitoring, regulatory updates, etc.	$$$$	State funds (CTDOT)
3. Review and comment on the CTDOT draft Stormwater Management Plan	PRWC Watershed municipalities	0-2 years (spring 2019)	• Review comments submitted	$	
4. Coordinate with watershed MS4 municipalities and CTDOT during implementation of MS4 Stormwater Management Programs • Stormwater outfall monitoring results • Illicit discharge investigation results • Opportunities for GI/LID retrofits	PRWC, Southbury, Woodbury, other watershed MS4 municipalities, and CTDOT	Ongoing	• Shared data and information	$	
5. Provide regional training and outreach materials for MS4 Permit • Develop training materials • Implement training	NVCOG UCONN CLEAR / NEMO	0-2 years	• Training materials developed • Training provided/number of municipalities receiving training	$$$	Member communities

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition   NVCOG = Naugatuck Valley Council of Governments   CTDOT = Connecticut Department of Transportation

3.4.4 Subsurface Sewage Disposal Systems

Most of the Pomperaug River watershed is served by on-site subsurface sewage disposal systems, also referred to as septic systems. Failing or older, sub-standard septic systems can impact surface water and groundwater quality and can be a source of bacteria to the Pomperaug River. Recommendations regarding subsurface sewage disposal systems are summarized in *Table 3-7*.

Recommended Actions

- Inventory and map the larger, State-regulated subsurface sewage disposal systems in the Pomperaug River watershed. Coordinate with CTDPH and/or CTDEEP to review system records related to system performance and corrective actions taken to resolve prior performance issues. Identify high-priority systems for ongoing oversight based on consideration of system size, soils, proximity to waterbodies, and performance history.

- Continue to encourage regular maintenance of septic systems by providing homeowner education and outreach (see the River Smart website http://www.pomperaug.org/riversmart) on how to identify improperly functioning systems and procedures to have systems inspected, cleaned, and repaired or upgraded. Septic system educational materials should be made available and disseminated to homeowners in the watershed, which could also be used to meet the public outreach/education minimum control measure of the MS4 Permit.
    - Explore options for offering group discounts to homeowners to pump and repair septic systems.

- Consider strengthening state and local regulations in the watershed to require regular septic system inspection and maintenance and upgrades to sub-standard systems, such as requiring systems to pass an inspection upon the sale of a property and be upgraded if necessary.

Subsurface Sewage Disposal Systems in the Pomperaug River Watershed

The **Pomperaug District Department of Health** has authority over most of the subsurface sewage disposal systems (also called septic systems) in the watershed, including system installation, site inspections, plan review, the issuing of permits and inspections of new, repair and replacement systems. The **Torrington Area Health District** serves most of the other watershed communities. Plans for septic systems serving buildings with design flows of 2,000 to 7,500 GPD must be approved by the **Connecticut Department of Public Health**. Disposal systems on sites with design flows exceeding 7,500 GPD, alternative sewage disposal systems, and community sewage systems are permitted by the **Connecticut Department of Energy and Environmental Protection**.

3.4.5 Illicit Discharges

Illicit discharges are non-stormwater flows that discharge or leak into the stormwater system and drain directly into surface waters. Wastewater connections to the storm drain system, sanitary sewer overflows, and illegal dumping or improper disposal of wastes down storm drains are among the types of illicit discharges that may exist in residential and commercial areas within the watershed. Identifying and eliminating these discharges is an important means of pollution source control for the watershed. Dry weather sources of bacteria such as illicit connections are the most likely to include human sources and need to be identified and effectively managed. Controlling dry weather sources of bacteria is typically more cost-effective than trying to address elevated bacteria in wet weather conditions.

The Town of Southbury and the Town of Woodbury (and other MS4 municipalities) are subject to the requirements of the CTDEEP MS4 Permit. The permit requires these municipalities to implement an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the municipal storm drainage system, as well as sanctions to ensure compliance. This includes developing and implementing an Illicit Discharge Detection and Elimination (IDDE) program to systematically find and eliminate sources of non-stormwater discharges to the municipal separate storm sewer system and implement procedures to prevent such discharges. CTDOT is also subject to similar IDDE requirements under its own MS4 Permit, effective July 1, 2019. Although not currently subject to the CTDEEP MS4 Permit, the watershed municipalities of Bethlehem, Morris, Roxbury and Washington are also encouraged to set up a program to identify and address illicit discharges to stormwater systems in their communities.

Recommendations relative to illicit discharges in the Pomperaug River watershed are summarized in *Table 3-8*.

Recommended Actions

- Southbury, Woodbury, and the other watershed MS4 municipalities should continue to implement IDDE programs as required by the MS4 Permit, including an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the MS4 and an IDDE program to detect and eliminate existing and future non-stormwater discharges, including illegal dumping.
    - Educate municipal staff and the public about illicit discharges and the importance of eliminating or avoiding such discharges.
    - Conduct follow-up illicit discharge investigations at priority outfalls identified during the towns' outfall screening processes and during streamwalks and track down surveys.

Table 3-7. Subsurface sewage disposal systems recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Inventory, review, and prioritize larger, State-regulated subsurface sewage disposal systems in the watershed	PRWC, PDDH, Torrington Area Health District	2-5 years	• List and map of high priority systems for additional oversight	$$	
2. Provide homeowner education and outreach on septic systems and explore options for group discounts to homeowners to pump and repair septic systems	PRWC, PDDH, Torrington Area Health District	0-2 years Ongoing	• Outreach materials provided or made available to homeowners	$	
3. Strengthen municipal regulations regarding septic system inspection, maintenance, and repair/upgrade	CTDPH/CTDEEP, municipalities	5-10 years	• Amended regulations	$$$$	CTDEEP Supplemental Environmental Project Funds, CTDEEP 319 NPS Grants

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition   CTDPH = Connecticut Department of Public Health   CTDEEP = Connecticut Department of Energy and Environmental Protection   PDDH = Pomperaug District Department of Health

Table 3-8. Illicit discharge recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Implement IDDE program consistent with MS4 Permit requirements • IDDE legal authority • Outfall mapping • IDDE Plan • Outfall screening and sampling • Catchment investigations and discharge removal projects • Education and outreach to municipal staff and the public	Southbury, Woodbury, other watershed MS4 municipalities, CTDOT	2017-2022 (5-year permit term)	• Compliance with permit deadlines for mapping, outfall monitoring, regulatory updates, etc. • Refined data for identifying BMP priority areas	$$$$	Municipal funds (permit requirements not eligible for federal 319 NPS Grant funding) State funds (CTDOT)
2. Encourage non-MS4 communities in the watershed to set up and implement a program to identify and address illicit discharges to stormwater systems in their communities	Bethlehem, Morris, Roxbury, and Washington	2-5 years	• Voluntary IDDE Program in place, number of illicit discharges identified and eliminated	$$$	Municipal funds. Non-MS4 communities in the watershed may be eligible for 319 NPS Grant funding.

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition   CTDOT = Connecticut Department of Transportation

3.4.6 Commercial Businesses and Industrial Facilities

Commercial and industrial land uses have the potential for higher pollutant loads due to the contaminant sources associated with these activities and the significant runoff generated from these often highly impervious sites. Much of the commercial development in the watershed is concentrated along the major transportation corridors in Southbury and Woodbury, with several industrial properties, such as the O&G quarry, also located in the southern part of the watershed. While many of these facilities may be subject to the CTDEEP General Permit for the Discharge of Stormwater associated with Commercial Activity (Commercial General Permit) or General Permit for the Discharge of Stormwater associated with Industrial Activity (Industrial General Permit), smaller facilities or certain activities may fall outside of these general permits. However, even entities that are not subject to these general permits should take stock of their facilities and activities to identify and address potential nonpoint pollutant sources. Recommendations related to reducing the impacts from commercial and industrial land uses are summarized in *Table 3-9*.

Recommended Actions

- Conduct outreach to commercial business owners in the watershed explaining how their activities can contribute to the water quality impairments of the Pomperaug River and its tributaries.

- Consider establishing or strengthening municipal ordinances requiring covered trash enclosures, setback distances from streams and catch basins, and frequent cleaning to reduce the bacteria load associated with dumpsters, consistent with the good housekeeping requirements in the CTDEEP industrial and commercial stormwater permit programs, which apply to certain categories of industrial facilities and to larger commercial sites such as shopping centers (e.g., Southbury Plaza, Southbury Green). Leaking dumpsters can be a major source of fecal indicator bacteria during wet weather. Include dumpster and trash management issues in commercial and industrial outreach.

- Review the commercial and industrial facilities in the watershed to identify sites that are subject to the CTDEEP industrial and commercial stormwater permit programs and the APA program, but that are not currently registered.

- Promote green infrastructure and vegetated buffer restoration during redevelopment of large commercial and industrial sites such as the proposed redevelopment of a portion of Southbury Plaza.

Table 3-9. Commercial business and industrial facility recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Conduct outreach to commercial and industrial business owners • See Education and Outreach recommendations	Municipalities (as part of MS4 Permit outreach)	2017-2022 (5-year permit term)	• Outreach completed as documented in MS4 annual Reports	$$	
2. Establish or strengthen municipal ordinances requiring covered trash enclosures and frequent cleaning • Review existing regulations/ordinances • Amend regulations or adopt new ordinances	Municipalities (as part of MS4 Permit IDDE Ordinance)	2016-2021 (5-year permit term)	• New or modified ordinance or other enforceable regulatory mechanism	$$	
3. Review commercial and industrial facilities to identify sites that need to be registered under the CTDEEP stormwater general permit programs • Develop list of facilities in watershed • Identify which facilities are not registered • Notify unregistered facilities of need for permit coverage	PRWC, CTDEEP	2-5 years	• Non-compliant sites identified and notified	$$	
4. Promote green infrastructure and vegetated buffer restoration for redevelopment of commercial sites	Municipalities	Ongoing	• Outreach to commercial property owners • Modified land use regulations to require GI/LID for commercial redevelopment	$$$	

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition CTDEEP = Connecticut Department of Energy and Environmental Protection

3.4.7 Wildlife and Pet Waste

Wildlife and domesticated animals within the Pomperaug River watershed are a source of fecal indicator bacteria that can impact stream water quality. Fecal material can be deposited directly into waterbodies, as well as from stormwater and dry-weather washing of feces deposited on the ground into storm sewers and receiving waters (ASCE, 2014). Domesticated animals (dogs and cats) and wildlife such as birds, raccoons, and rodents can be significant contributors, particularly in parks (including dog walking parks), golf courses, and commercial areas in the watershed. Several golf courses directly border the Pomperaug River, and waterfowl have been observed in these areas as well as public parks and playing fields close to watercourses.

Most of the watershed communities have existing bans on feeding of waterfowl and ordinances on pet waste (i.e., "pooper scooper" laws). However, enforcement of such regulatory controls is difficult. Furthermore, there are no easy solutions to nuisance waterfowl problems. Canada geese are persistent when they become habituated to an area (CTDEEP, 2015b).

A more effective nuisance waterfowl control strategy is needed, focusing on education and outreach and other proven control methods. Creation of a vegetated buffer, consisting of tall grasses, shrubs, or trees, along ponds or streams is a recommended form of habitat modification. Geese prefer to feed on short grass in areas that are open and within sight of a body of water. Tall grasses, shrubs, and trees can serve as a deterrent and cause them to relocate. Vegetated buffers can also reduce nonpoint source pollution. Recommendations related to wildlife and pet waste are summarized in *Table 3-10*.

Recommended Actions

- Continue nuisance waterfowl deterrent efforts – habitat modification, barriers/exclusion and other methods – to reduce feeding of waterfowl by the public, waterfowl nesting, and terrestrial waterfowl habitat in the watershed. Creation of vegetated buffers along ponds and streams as a form of habitat modification (to disrupt travel and sight lines) is the preferred deterrent method since it also provides water quality benefits.

- Existing regulatory controls prohibiting the feeding of waterfowl should be augmented through additional and/or more effective signage in public parks including the potential for fines. Signage should emphasize that feeding of waterfowl such as ducks, geese, and swans can be harmful to their health. People feed geese and other waterfowl because they love them; emphasizing protection of waterfowl health is often the most effective strategy.

- Provide pet waste bag dispensers and disposal cans at high-use areas and conveniently spaced intervals on trails, in open space areas, and along popular walking routes along Main Street areas in Woodbury and Southbury. Provide park and trail signs regarding pet waste disposal requirements and leash laws at the disposal cans. Consider allowing advertising on signs placed at pet waste bag dispensers and disposal cans to partially offset the cost. Provide educational materials regarding the impact of improperly disposed pet waste in pet stores, animal shelters, veterinary offices, and other sites frequented by pet owners.

Geese Deterrent Methods

Habitat Modification: As long as favorable habitat is available, geese will be attracted to an area. Plant unpalatable vegetation or allow grass to grow tall, which makes it unpalatable to the geese. Plant hedges, shrubs, or visual barriers between feeding areas and water. Be sure the geese are not being fed by people.

Barriers and Exclusion Methods: Low fences are very effective at keeping geese from lawns especially during June and July when geese have molted their flight feathers and are unable to fly. A 3-foot high chicken wire or weld wire fence should be used. Soft or hard nylon fences are also potential barriers.

Table 3-10. Wildlife and pet waste recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Continue waterfowl deterrent efforts • Physical barriers • Regulatory controls • Signage • Educational programs • Other	MS4 Municipalities (as part of MS4 Permit compliance) and non-MS4 municipalities on a voluntary basis Audubon Center at Bent of the River	2017-2022 (5-year permit term)	• Waterfowl programs implemented • Number of municipalities participating	$$	Municipal funds, NFWF
2. Implement and enforce pet waste programs • Provide bag dispensers and disposal cans at parks, trails, and dog parks • Provide park and trail signage • Provide educational materials	MS4 Municipalities (as part of MS4 Permit compliance) and non-MS4 municipalities on a voluntary basis Local veterinarians, pet stores, dog kennels, pet supply and feed stores, etc. to help educate the public and encourage participation	2017-2022 (5-year permit term)	• Pet waste programs implemented • Number of municipalities participating • Number of businesses and other partners participating	$$	Municipal funds, contributions from businesses

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

NFWF = National Fish and Wildlife Foundation

3.4.8 Vegetated Buffers

Vegetated buffers are vegetated areas adjacent to streams, ponds, lakes, and wetlands. Vegetated buffers help encourage infiltration of rainfall and runoff and reduce flooding. The buffer area provides a living "cushion" between upland land use and surface water resources, protecting water quality, the hydrologic regime of the waterway and stream structure. Vegetated buffers filter out pollutants, capture sediment, protect streambanks from erosion, regulate stream water temperature, and process many contaminants through vegetative uptake. Vegetated buffers can also provide habitat and travel corridors for animals, many of which are dependent on riparian features for survival. Changes to buffer width and vegetative cover can reduce the water quality and other benefits of vegetated buffers and contribute to water quality impairments. In general, vegetated buffers are more effective along small streams than large streams since most water delivered to stream channels from uplands enters along small streams.

The stream corridors in many areas of the Pomperaug River watershed are characterized by limited or no vegetated buffer due to residential and commercial development and farming practices. Residential lawns and some agricultural practices extend down to the banks of the stream in many areas.

Recommendations related to vegetated buffers in developed areas are summarized in *Table 3-11*. Recommendations for restoration of vegetated buffers and filter strips for agricultural operations are addressed later in this section.

Recommended Actions

- Encourage the creation and protection of backyard buffers in residential areas near stream corridors, including the importance of maintaining healthy vegetated buffers to streams, ponds, and wetlands, and recognize the efforts of homeowners and other land owners.
    - Educate homeowners about the value and importance of vegetated buffers by building on existing vegetated buffer outreach and educational programming (e.g., River Smart program, public recognition programs for cooperating landowners, *Streamside Landowners' Guide to the Quinnipiac Greenway,* Audubon's backyard program, and others).

- Implement priority buffer restoration projects based on streamwalks and track down surveys.
    - Focus efforts on publicly-owned, high-profile restoration sites such as the recent buffer restoration demonstration project in Cedarland Park in Southbury.
    - Potential buffer restoration approaches for the watershed include installation of new buffers, widening of existing buffers, invasive species removal/management, and tree planting/reforestation.
    - Target acquisition of riparian parcels to preserve vegetated buffers that provide public access to the Pomperaug River and its tributaries.
    - Engage the participation of volunteers in buffer implementation projects.
    - Further evaluate the feasibility of buffer restoration at specific sites based and consider site-specific factors including: site access, available land area, land ownership, soil conditions, slope, buffer width need to accomplish intended goal(s), and appropriate native plant species.

- Provide vegetated buffer protection through aggressive implementation and enforcement of setback zones in local Inland Wetlands and Watercourses regulations. Consider modifying existing land use regulations as part of the regulatory updates required by the MS4 Permit to incorporate incentives for developers to restore or establish vegetated buffers as part of new development or redevelopment.

Table 3-11. Vegetated buffer recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Encourage backyard vegetated buffers • Provide homeowner education by building on existing materials and programs (see Education and Outreach recommendations)	Municipalities (as part of MS4 Permit compliance), PRWC	2017-2022 (5-year permit term)	• Educational materials disseminated	$$	Municipal funds
2. Implement priority buffer restoration projects • Conduct more detailed assessment to identify priority restoration project sites • Pursue and obtain funding • Design and construct projects	Municipalities, PRWC	Ongoing	• Priority projects identified • Funding secured • Projects designed and constructed	$$$	Section 319 NPS Grant Program and other grants NFWF; CT Open Space Grants (Greenway Program); Trout Unlimited; America the Beautiful tree grant program
3. Implement and enforce setback zones in local Inland Wetlands and Watercourses regulations • Review existing regulations • Amend regulations	Municipalities	Ongoing	• Modified or updated land use regulations	$$$	Municipal funds

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition   NFWF = National Fish and Wildlife Foundation

3.5 Agricultural BMPs

Agricultural operations can be a source of pollutants to surface waters and groundwater. Water quality contaminants associated with agricultural operations include excess nutrients (nitrogen and phosphorus primarily from fertilizers and animal wastes), bacteria/pathogens and organic materials (primarily from animal wastes), sediment (from field erosion), pesticides (applied to crops), salts (from evaporation of irrigation water), and petroleum products (from farm equipment). These pollutants enter watercourses through direct surface runoff or through seepage to groundwater that discharges to surface water.

A variety of agricultural BMPs are available to reduce the potential water quality impacts of agricultural nonpoint source runoff, including:

- Livestock exclusion fencing
- Manure collection and storage
- Nutrient management (remove, reuse, land application)
- Cover crops
- Contour planting
- Vegetated buffers, filter strips
- Filter berms
- Covered heavy use areas
- Diverting clean water
- Soil health management (disturbing the soil as little as possible, growing as many different species of plants as practical, keeping living plants in the soil as often as possible, and keeping the soil covered).

The following sections describe several of these agricultural BMPs that are more effective for reducing bacterial loads and are therefore recommended as part of the site-specific BMP concepts presented in *Section 4* of this plan. *Table 3-12* summarizes recommendations relative to agricultural operations in the Pomperaug River watershed.

3.5.1 Manure Management

Livestock waste is a source of bacteria (and associated pathogens) and excess nutrients, requiring ongoing management. Different types of livestock produce wastes that vary in bacteria and nutrient concentration (Ruddy et al. 2006, Wagner and Moench 2009). Poor manure management can allow bacteria, nutrients and sediment to be transported to waterbodies via stormwater runoff and when livestock have direct access to these waterbodies. Bacteria can also attach to soil particles that are washed into streams during a storm.

Manure management can take various forms depending on the type and scale of the agricultural operation. Dairy operations and equestrian facilities typically collect and store manure. In such cases, manure piles should, at minimum, be located away from streams and lakes and not drain toward catch basins. Where feasible, piles should be covered and stored in a containment structure (*Figure 3-2*). Covering piles reduces the exposure to rain. Containment structures also reduce the potential for bacteria and nutrients from impacting groundwater. The size and scope of management practices should be customized based on the scale of the operation.

Small farms and equestrian operations with few head appear to be common in the watershed and may not have the resources to implement the most stringent manure management practices. Educational outreach may provide better results in such instances, where the solutions offered can be tailored to the scale and situation of each operation.

Table 3-12. Agricultural operations recommendations

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs	Potential Funding Sources
1. Provide outreach to farm owners on the water quality impacts of agricultural operations and agricultural BMPs • See Education and Outreach recommendations	PRWC	0-2 years	• Outreach materials disseminated	$$	USDA/NRCS, USDA Farm Service Agency, Connecticut Department of Agriculture, University of Connecticut Cooperative Extension System, Connecticut Agricultural Experiment Station, Connecticut Conservation Districts
2. Work with farm owners and operators to implement site-specific agricultural BMPs (see BMP concepts in *Section 4*) • Reach out to owners and operators • Partner with owners and operators to identify projects and financial/technical assistance • Design and construct projects	PRWC, USDA/NRCS, land owners, Northwest Conservation District	2-5 years Ongoing	• Farm owners and operators contacted • Number of partners participating • Technical and financial assistance provided • Projects completed	$ to $$$$	USDA/NRCS, USDA Farm Service Agency, Connecticut Department of Agriculture, University of Connecticut Cooperative Extension System, Connecticut Agricultural Experiment Station, Connecticut Conservation Districts, CTDEEP 319 NPS Grants

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000

PRWC = Pomperaug River Watershed Coalition   USDA = U.S. Department of Agriculture   NRCS = Natural Resources Conservation Service

Figure 3-2. Examples of covered manure storage facilities (left - Rutgers Equine Science Center, Rutgers University; right - Michigan State University Extension)

3.5.2 Vegetated Buffers and Filter Strips

As described in *Section 3.4.8*, vegetated buffers are vegetated areas adjacent to streams, ponds, and wetlands that can provide a variety of water quality and other benefits. Filter strips, similar to vegetated buffers, are small strips or areas of vegetated land, often used at the edges of fields, to reduce agriculture nonpoint source pollution (*Figure 3-3*).

In the Pomperaug River watershed, agricultural operations are commonly located close to streams and often have intermittent or perennial streams flowing through them. On these sites, providing vegetated buffers and filter strips can be effective at decreasing the velocity of water, trapping sediment, and allowing runoff and dissolved inorganic pollutants to infiltrate the soil for uptake by vegetation. Many operations in the watershed have animal grazing areas through which intermittent streams or drainage channels pass. In these cases, exclusion fencing should be used to keep animals out of the stream and out of the vegetated buffer or filter strip. In the Pomperaug watershed, space is often limited at farms located adjacent to rivers or streams and on smaller parcels, limiting the use or size of vegetated buffers or filter strips. As such, incentive programs should be considered to offset the cost of land taken out of active use or production, including exploring vegetated buffers that might also have an economic benefit to the land owner by providing a crop that could be harvested or sold for a profit for another use while still providing a water quality benefit.

Fencing vegetated buffers and filter strips from pastures is often necessary to protect water quality. Exclusion fencing (board, barbed, high tensile or electric wire) is commonly used to exclude livestock from streams and vegetated buffers and filter strips to improve or protect water quality and reduce soil erosion and sedimentation. Where a stream or pond serves as a source of drinking water for livestock, provisions for an alternative water supply for livestock (off-channel watering hole or groundwater well) may be necessary.

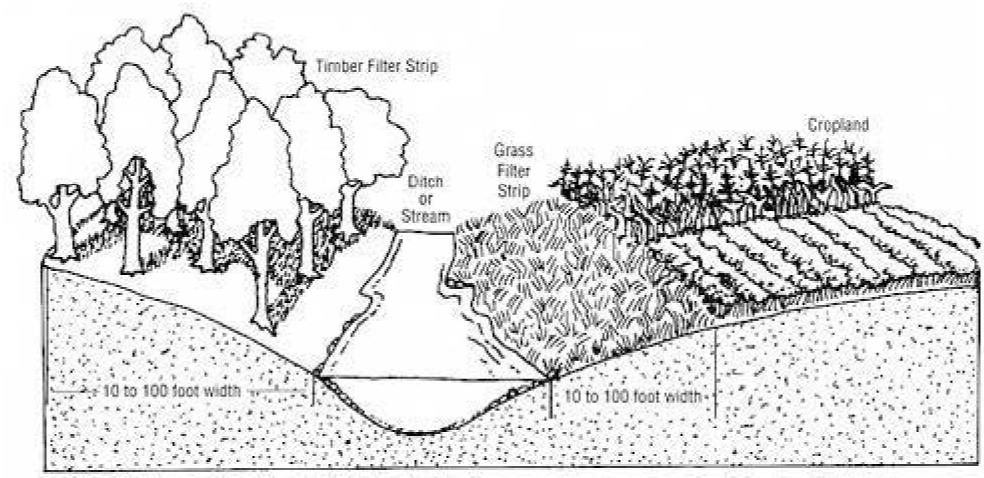


Figure 3-3. Vegetated buffer schematic (top, NRCS) and example vegetated buffers (bottom), including a model riparian buffer restoration project at Cedarland Park in Southbury (bottom right).

3.5.3 Filter Berms

Filter berms are structural BMPs that consist of a stable, permeable berm such as gravel or compost, placed at the downgradient edge of an agricultural field, manure storage and composting facilities, and areas with high livestock use. The filter media in the berm serves to both filter the runoff from the fields and provide some opportunity for cation exchange of dissolved pollutants. Filter berms are designed to follow an elevation contour and are turned up at the ends, resembling a horseshoe, to provide runoff storage (*Figure 3-4*). Runoff temporarily pools behind the berm, then filters through it and infiltrates into the ground. For that reason, berms are best located downgradient from sources of bacteria and nutrients. Filter berms are best suited to treating small, frequent storms, where water is captured and infiltrated. In larger storms, the berm stores stormwater, allowing sediment-bound pollutants to settle, before the treated stormwater is slowly released.

Filter berms typically have a small constructed footprint and represent simple and cost-effective solutions to runoff management and pollutant reduction. When properly designed and sited, they blend into the landscape. Maintenance requirements are also low: stored sediment must be periodically removed and the grass on the filter berm mowed, if desired.

Figure 3-4. Schematic and example of a filter berm (Guffey, 2012)

3.5.4 Farm Financial and Technical Assistance

Implementing improvements on farms requires some capital investment that is often beyond the means of the individual farmer. The State of Connecticut and U.S. Department of Agriculture both recognize this challenge and administer programs to support farmers in conservation efforts. Outreach and technical assistance programs provided by federal and state agencies include the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), USDA Farm Service Agency, Connecticut Department of Agriculture, University of Connecticut Cooperative Extension System, Connecticut Agricultural Experiment Station, Connecticut Conservation Districts, and CTDEEP.

Connecticut offers technical and financial support to farm businesses in their farm waste efforts through the "Partnership for Assistance on Agricultural Waste Management Systems." Through this partnership, a farm business may obtain waste management planning, facility design, and qualify for financial assistance as well as help in procuring required permits. Technical assistance is also available in selecting and implementing agricultural BMPs and soil erosion control methods and technologies.

As part of the National Water Quality Initiative (NWQI), the USDA NRCS offers financial and technical assistance to farmers and forest landowners interested in improving water quality and aquatic habitats in priority watersheds with impaired streams. The NWQI directs technical assistance to farmers as part of the Environmental Quality Incentives Program (EQIP). This is a voluntary conservation program to assist agricultural producers with implementing structural and management conservation practices to their farms that promote agricultural production and environmental quality as compatible goals. Through EQIP, agricultural producers receive financial and technical assistance to implement practices on working agricultural land.

The Connecticut Department of Agriculture further provides funding through its Farmland Restoration Program (FLRP) that may support the goals of this plan. Where BMP recommendations include relocating grazing areas, the voluntary FLRP provides funding opportunities to "enhance use of agricultural lands that are currently underutilized". This program provides support to projects that include installation of fencing to keep livestock in reclaimed pasture areas and/or out of riparian areas, as well as funding to clear and remove trees, stumps, stones and brush to create or restore agricultural use.

4 Site-Specific BMP Concepts

Visual Field Assessments

Visual field investigations were performed by Fuss & O'Neill in September 2017 to further assess potential sources of water quality impairments in the Pomperaug River watershed and to identify possible restoration opportunities. The assessments focused on identifying potential projects that would reduce bacteria loads in areas of the watershed with documented impairments. Concepts for site-specific Best Management Practices (BMPs) were developed at priority sites based on the results of the visual assessments and input from the PRWC Land Use Committee.

The site-specific BMP concepts presented in this section and indicated on the accompanying map (*Figure 4-1*) are intended to serve as potential on-the-ground projects for future implementation. They also provide examples of the types of projects that could be implemented at similar sites throughout the watershed. It is important to note that the concepts presented in this section are examples of potential opportunities, yet do not reflect site-specific project designs. Individual project proponents (e.g., municipalities, private property owners, developers) are responsible for evaluating the ultimate feasibility of, as well as design, permitting, and maintenance of these and similar site-specific concepts.

Preliminary, planning-level costs were estimated for the site-specific concepts presented in this section, including operation and maintenance costs. These estimates are based upon unit costs derived from published sources, engineering experience, and the proposed concept designs. A range of likely costs is presented for each concept, reflecting the inherent uncertainty in these planning-level cost estimates. A more detailed breakdown of estimated costs is included in *Appendix E*.

The table in *Appendix D* contains information on pollution sources and potential BMP opportunities for other sites visited during the field assessments.

4.1 Residential 1

This residential neighborhood sits on the side of a hill that slopes down to the Pomperaug River, near its confluence with the Housatonic River in Southbury. Two catch basins collect stormwater from the curbed road, which includes a paved cul-de-sac, and ultimately discharge to an impaired segment of the Pomperaug River. A number of single-family homes are located at the river's edge. These may once have been seasonal residences, but now may be occupied year-round. The proposed BMP concept for this neighborhood, shown in *Figure 4-2*, could be implemented by the Town of Southbury within the public right-of-way.

- **Stormwater Infiltration.** The paved cul-de-sac in this neighborhood presents an opportunity to reduce the amount of impervious surface, runoff, and pollutant loads to the Pomperaug River through a stormwater retrofit project. The soils at the site are believed to have good permeability (mapped as Hydrologic Soil Group A) and are conducive to stormwater infiltration. The proposed concept is to construct a subsurface infiltration system below the cul-de-sac, which would receive stormwater from the two upgradient catch basins on Pascoe Drive (see *Figure 4-3* for an example subsurface infiltration system). The existing downgradient catch basin on the eastern side of the cul-de-sac could serve as an overflow structure to allow excess stormwater to be conveyed to the storm drain system. As an alternative, a portion of the cul-de-sac could be converted to permeable or pervious pavement (see *Figure 4-4* for examples), which would serve to capture and infiltrate runoff from the cul-de-sac. The cul-de-sac isn't large enough to install a bioretention island in the middle of the cul-de-sac.

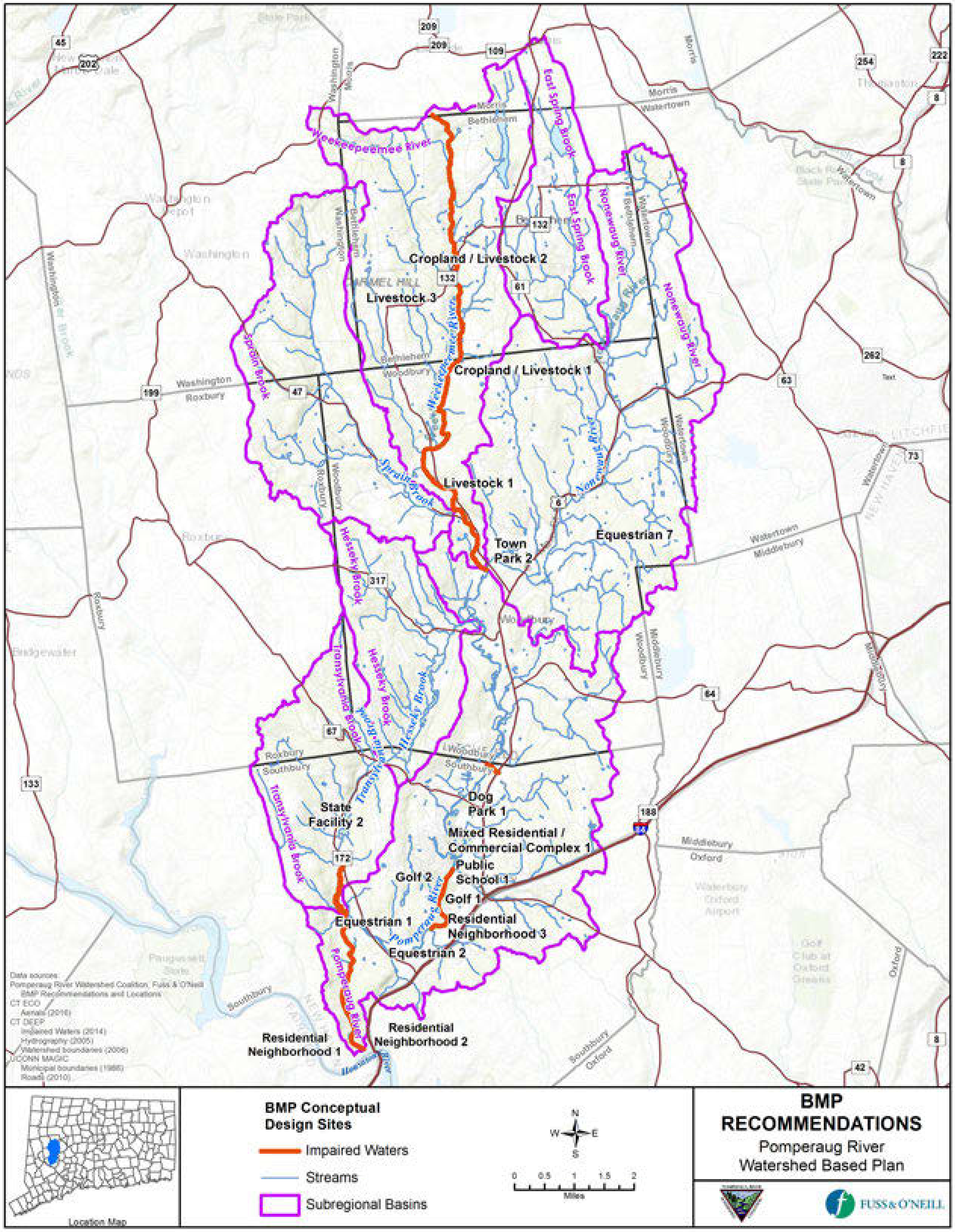


Figure 4-1. Locations of proposed site-specific BMP concepts in the Pomperaug River watershed

Figure 4-2. BMP Concept: Residential 1

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

Figure 4-3. Examples of subsurface infiltration systems for parking lots (top) and within the road right-of-way (middle and bottom)

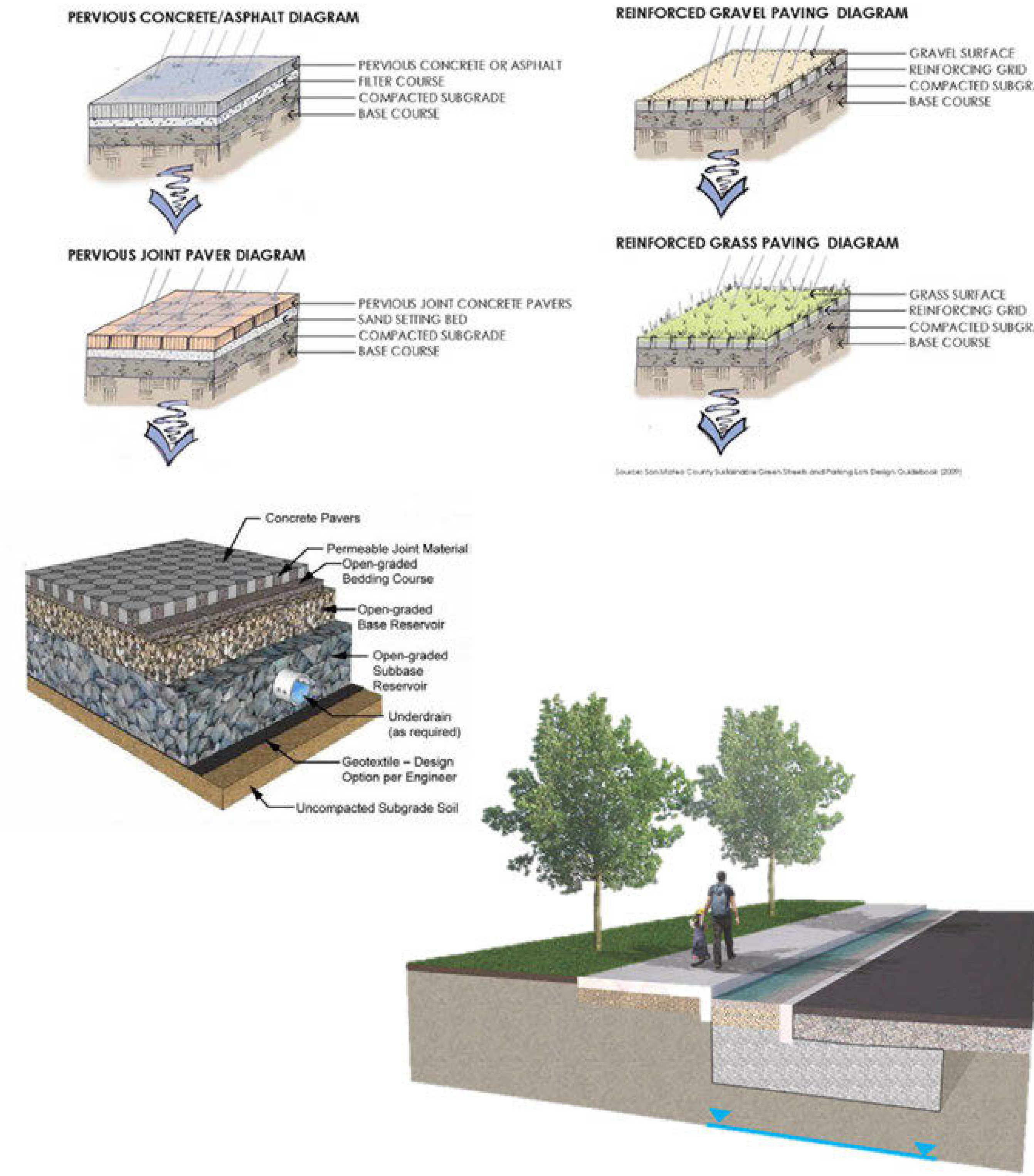


Figure 4-4. Examples of permeable pavement types (top) and use within the road right-of-way (bottom right)

4.2 Residential 2

Across the Pomperaug River from Residential 1, this approximately 78-acre residential neighborhood consists of houses on 1/8- to 1/4-acre lots. The neighborhood is characterized by greater than 15% impervious cover consisting of buildings, driveways, and streets. Most of the stormwater from this neighborhood drains to catch basins, which discharge to the same impaired segment of the lower Pomperaug River as the Residential 1 site. As with Residential 1, many of the homes in this neighborhood may once have been seasonal residences that may now be occupied year-round. Parcels along the river tend to have landscaped lawns that extend to the river's edge.

The public right-of-way is narrow in this neighborhood, limiting options for surface stormwater treatment practices. Streets along the river's edge have catch basins, but stormwater treatment options may be limited by the narrow right-of-way and minimal groundwater separation in these areas.

The proposed BMP concepts for this residential neighborhood are shown in *Figure 4-5*.

- **Subsurface Infiltration.** The limited area within the public right-of-way, typically only a few feet wide along the side streets, makes subsurface infiltration the most feasible BMP type given the underlying soils and space constraints. Given the location of existing catch basins, there exists approximately 400-feet of potential space for subsurface infiltration chambers. These chambers are typically 3 to 4 feet in width. Using existing catch basins as an inlet for stormwater, as well as an overflow for larger storms, represents the most efficient use of space and requires the least excavation. Subsurface infiltration systems could be located in the vicinity of 40 Oakdale Manor Road, 96 Oakdale Manor Road, 12 Hillside Road, and 63 Hillside Road. The proposed infiltration systems could be implemented by the Town of Southbury within the public right-of-way.

- **Infiltration Basins.**

    - An approximately 600-ft^2 infiltration basin is proposed southeast of the intersection of Oakdale Road and the Exit 13 on-ramp on State-owned property. At the intersection are 4 catch basins that discharge to an outfall in this location. A portion of the runoff from this drainage area, which consists of approximately 27,000 ft^2 of impervious surfaces, could be captured and treated by a proposed infiltration basin. An existing, but abandoned, single lane path near property owned by Oakdale Manor Water Users could potentially be repurposed as an access road for maintenance. Some tree clearing may be necessary to construct an infiltration basin at this location.

    - An approximately 2,200-ft^2 infiltration basin is proposed at the southern end of Oakdale Road, in a gravel pull-off area, on property owned by Eversource (formerly Connecticut Light & Power). The infiltration basin could be designed to infiltrate the water quality volume, i.e., the first one inch of runoff, from the approximately 24,000 ft^2 of impervious cover in this drainage area, including the area that drains to the three upgradient catch basins. The infiltration basin could be designed to overflow into the existing drainage system at the intersection of Oakdale Road and River Road.

Figure 4-5. BMP Concept: Residential 2

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

Figure 4-6. Examples of infiltration basin installations at an outfall (top), along a parking lot (middle), and in the road right-of-way (bottom)

4.3 Residential 3

Located north of the Flood Bridge Road crossing and on the west bank of the Pomperaug River in Southbury, this residential neighborhood contains several single-family houses on 1/4- to 1-acre lots. The total area of the neighborhood is approximately 40 acres, and the neighborhood has in excess of 15% impervious cover, including some 4 acres of buildings, driveways, and other impervious surfaces. Stormwater drains to two outfalls located near the intersection of Flood Bridge Road and Riverhill Road and the intersection of Riverhill Road and Branch Road.

As with the other residential areas, many of the homes in this neighborhood may once have been seasonal residences that may now be occupied year-round. Parcels along the river also tend to have landscaped lawns that extend to the river's edge.

Figure 4-7 shows the proposed BMP concepts for this residential neighborhood.

- **Bioretention.** Two bioretention cells with sediment forebays are proposed north and south of the intersection of Flood Bridge Road and Riverhill Road. This arrangement would capture stormwater flowing down Riverhill Road, as well as from the catch basins along Flood Bridge Road. These bioretention practices would have to be sited with consideration for flooding given their proximity to the river and location within the floodplain. Given their location in the floodplain, these could be flow-through, rather than infiltration, bioretention practices, and would have be designed to capture and treat runoff from small to medium-sized storms but also withstand periodic inundation during floods. Tree clearing within the floodplain would also be required, which would add cost and complicate the regulatory approval process.

    - The southern bioretention practice, located on several parcels owned by the Town of Southbury, would be installed near the existing outfall. It could be designed to capture flow from catch basins along Flood Bridge Road, draining approximately 1 acre of impervious cover. The proposed 1,000-ft^2 bioretention could treat the entire water quality volume from this catchment area.

    - The northern bioretention practice, located on a parcel owned by the Town of Southbury, would disconnect the existing catch basin from its current alignment, redirecting flow to a low-lying area to the east. It would capture approximately 10,000 ft^2 of impervious cover, which could be treated by an approximately 350-ft^2 bioretention area. This practice could also be designed as an infiltration basin.

- **Subsurface Infiltration.** A subsurface infiltration system is proposed near the intersection of Riverhill Road and Branch Road to capture stormwater runoff from portions of both roads. Stormwater would enter the infiltration system from the existing catch basins. Approximately 50,000 ft^2 of impervious cover could be infiltrated/treated by this practice. Flow in excess of the water quality volume would bypass the system and discharge to the existing stormwater outfall south of the intersection. Alternatively, road-side bioswales could be installed along Riverhill and Branch Roads upgradient of the catch basins at the intersection, which would be a less expensive option, but would capture runoff from a smaller drainage area and could face opposition from the neighboring homeowners. This proposed BMP concept could be implemented by the Town of Southbury within the public right-of-way.

Figure 4-7. BMP Concept: Residential 3

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

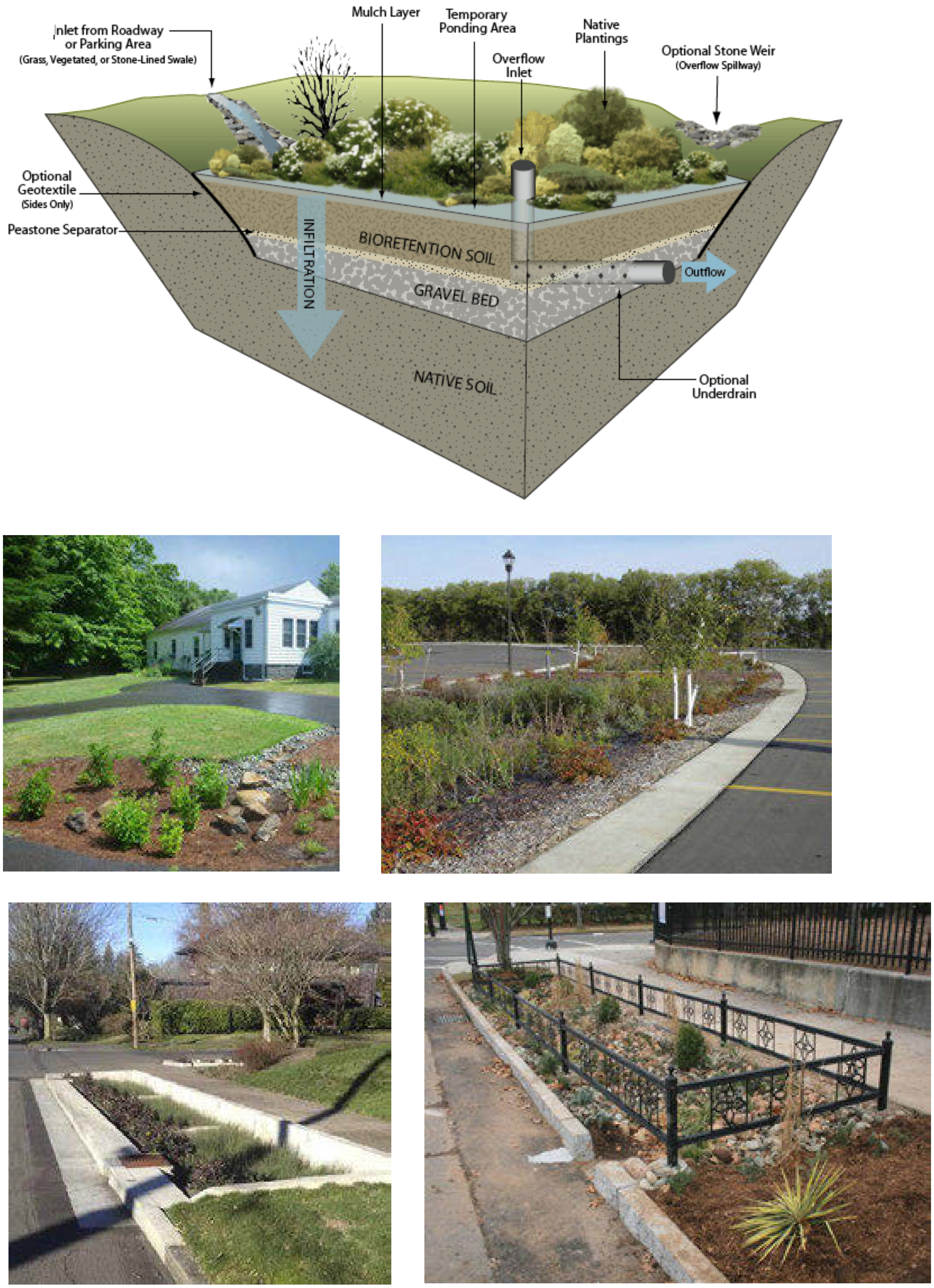


Figure 4-8. Examples of bioretention schematic (top), parking lot bioretention systems (middle), and road-side bioretention or bioswales (bottom)

4.4 Golf Course, Public School, and Town Park

Multiple golf courses, municipal properties, including a school and athletic fields, and some residential development are located near the Poverty Road crossing of the Pomperaug River in Southbury, along impaired segment Pomperaug-03. Stormwater runoff from impervious surfaces and waterfowl are potential sources of bacteria in this area. During the field assessments, numerous Canada geese were observed on the golf courses and in the field below Gainfield Elementary School.

Several large stormwater outfalls, some at least 36 inches in diameter, discharge to this segment of the Pomperaug River. Most of the stormwater runoff is conveyed by the municipal storm drainage system along Poverty Road and discharges near the Poverty Road Bridge. Runoff is generated from the residential development on the west side of the river, and from the elementary school on the east side. Additional catch basins are located in the unpaved parking lot at the athletic fields, which discharge directly to the Pomperaug River.

The proposed BMP concepts for these sites are shown in *Figure 4-9* and described below. The first three BMP concepts described below are located on property owned by the Town of Southbury or within the municipal right-of-way.

- **Bioretention.** A bioretention or infiltration practice is proposed in the triangular island in the parking lot of George Ewald Park. In this public park setting, the proposed BMP would be highly visible and could present an opportunity for public education. Some re-grading of the parking lot may be required to maximize surface runoff toward the bioretention area. Because the parking lot is unpaved, the bioretention system would likely receive a heavy sediment load. Filter strips are therefore proposed as pretreatment to reduce the frequency of required maintenance. Alternatively, the parking lot could be paved and the bioretention system constructed as part of the parking lot upgrades. The existing island configuration has approximately 1,400 ft^2 of available space for a potential bioretention area, which is sufficient to treat the water quality volume.

- **Subsurface Infiltration.** Subsurface infiltration is proposed along Poverty Road in-line with the existing stormwater infrastructure. Depending on the pipe connectivity at the intersection of Poverty Road and Old Field Road, the catchment includes a minimum of approximately 2 acres of impervious cover. West of Old Field Road on the north side of Poverty Road, subsurface infiltration chambers could be installed from approximately 204 Poverty Road to the entrance to George Ewald Park.

- **Permeable Pavement.** Parking stalls in the Gainfield Elementary School parking lot could be converted to permeable pavement, which would reduce runoff and pollutant loads from the site. Permeable pavement is a type of pavement that allows stormwater to pass through and infiltrate into the soil. A variety of permeable pavement types exist, including porous asphalt and concrete, interlocking pavers, grass pavers, and various grid systems.

- **Vegetated Buffer.** The riparian buffer along this segment of the Pomperaug is largely forested, though opportunities for buffer enhancement exist. At the eastern end of the driving range, enhancement of the existing vegetated buffer is proposed in an underutilized section of the golf course. A net is also proposed, since golf balls were found in the river, though this may shorten the driving range distance. Buffer enhancement is also proposed at the golf course on the east side of the river, by the water hazard on Hole 2. Both sites are located on privately-owned property.

- **Waterfowl Management Strategies.** Given the number of geese observed in the area, non-structural and non-lethal waterfowl management strategies are recommended, such as audio or visual repellants. Creation of a vegetated buffer, consisting of tall grasses, shrubs, or trees, along ponds or streams is a recommended form of habitat modification. Geese prefer to feed on short grass in areas that are open and within sight of a body of water. Tall grasses, shrubs, and trees can serve as a deterrent and cause them to relocate. Vegetated buffers can also reduce NPS pollution. Lethal control methods are also possible, but require regulatory approvals due to the goose's status as a migratory bird.

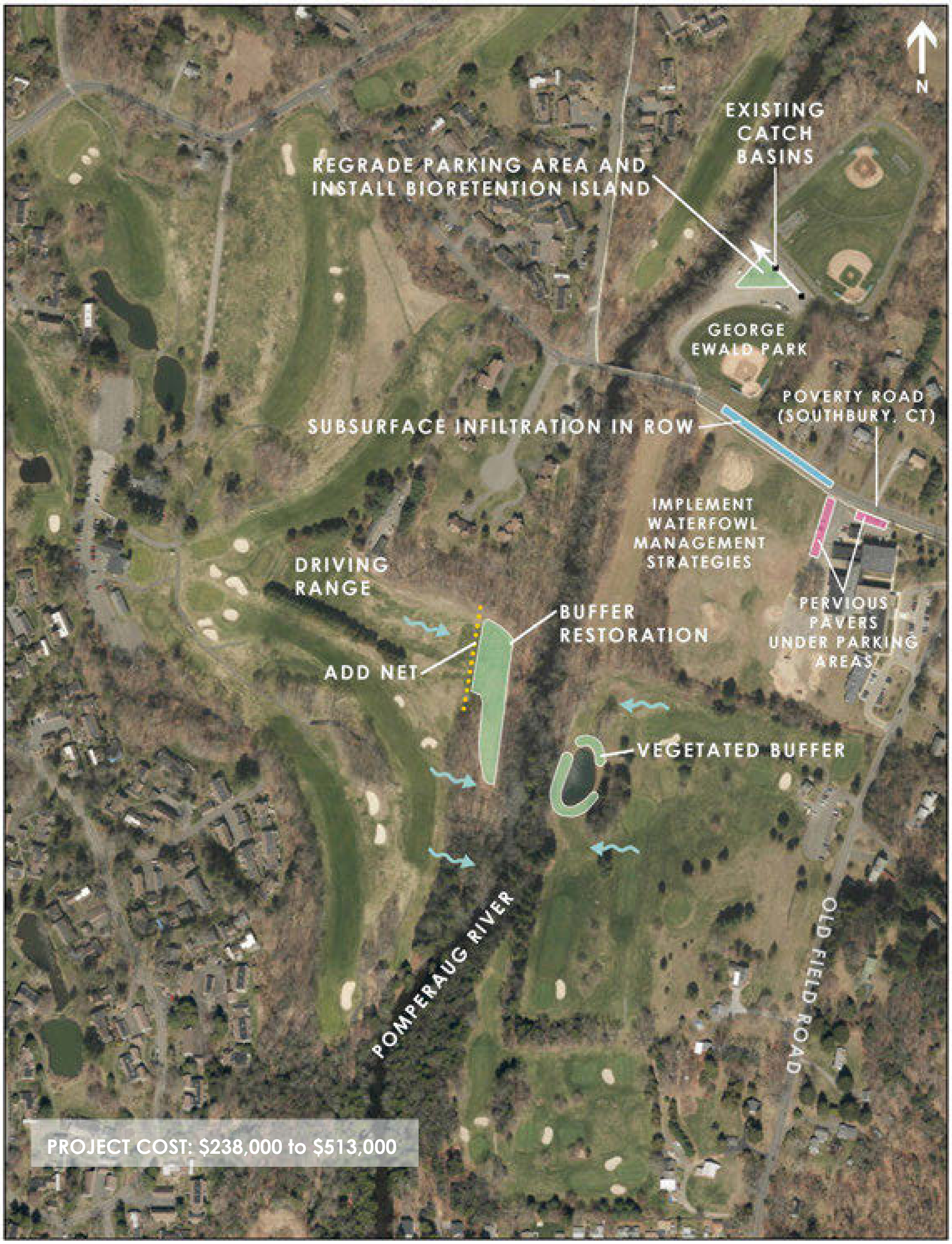


Figure 4-9. BMP Concept: Golf Course, Public School, and Town Park

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.5 Mixed Commercial/Residential 1

On the west side of the Pomperaug River-03 segment is a privately-owned planned retirement community containing nearly 2,600 residential units over approximately 2.3 square miles. The eastern end of this community houses commercial space, including a hotel, restaurants, stores, office space, and a library, along with more than 10 acres of impervious cover. Individual stormwater outfall catchments that serve this area have high levels of impervious cover. Some of the residential units are located on higher elevations over unconsolidated lodgment till, while others are located on melt-out till. The commercial area sits on top of sandy, glaciofluvial deposits. Unconsolidated till typically has a lower infiltration potential than glaciofluvial deposits, which can limit the potential for infiltration-based green infrastructure retrofits. The complex is entirely served by sanitary sewers, with its own wastewater treatment facility that discharges to the Pomperaug River near the upstream end of the impaired segment.

Stormwater runoff from this site is collected by catch basins and piped to the Pomperaug and its tributaries. Significant potential exists to disconnect impervious area and infiltrate stormwater runoff from this complex through green infrastructure and low impact development retrofits. The conceptual designs proposed here are those in and near the commercial area, which also have soils that are generally conducive to infiltration. This planned retirement community presents an ideal opportunity to showcase residential GI and LID retrofit techniques that could serve as demonstration projects for other residential and mixed-use neighborhoods in and outside of the watershed.

Proposed concepts for these sites are shown in *Figure 4-10* and *Figure 4-11*.

- **Infiltration Basin.** A 7,500-ft^2 surface infiltration basin with sediment forebay is proposed in an underutilized pervious area towards the rear of the Village Green area. Currently, it appears to serve as a short-cut to a golf course clubhouse. Upgradient of this area are two catchments draining approximately 100,000 ft^2 of impervious cover. The western catchment drains the majority of this area, while the northern catchment contains only a few catch basins. The infiltration basin could be designed to receive flow from the upgradient drainage areas to increase the impervious area that can be treated by the practice. The BMP would discharge to an existing water feature on the nearby golf course.

- **Subsurface Infiltration.** Opportunities for subsurface infiltration exist in front of a former bank and drugstore location on Heritage Road and under the parking lot for 460 Heritage Road.

    - Former Bank Site: Subsurface infiltration chambers could be installed under the sidewalk and parking stalls at this location. Capturing runoff from approximately 20,000 ft^2 of impervious area, there is sufficient area to infiltrate the entire water quality volume.

    - 460 Heritage Road parking: Four catch basins capture runoff from approximately 1 acre of impervious cover. Subsurface infiltration chambers are proposed under the parking area between 460 and 452 Heritage Road, where there is sufficient room to treat the entire water quality volume entering this catchment. Roof leaders from the surrounding buildings are buried at this location and likely drain to catch basins.

- **Permeable Pavement.** Permeable pavement is proposed to replace existing parking stalls near the library, Friendly's, meeting house, and office space. Overflow parking for the conference center is in need of repair, and represents the most feasible retrofit opportunity. If the overflow lot is substantially underutilized, then pavement removal and restoration to permeable surface would be more beneficial. Additionally, parking stalls in and around the Village Green could be replaced with pervious pavement to reduce the required size of the infiltration basin proposed above.

- **Bioretention.** A 750-ft^2 infiltrating bioretention practice or infiltration basin could be sited in an existing depression located north of the intersection of Heritage Road and Poverty Road. Capturing runoff from approximately 20,000 ft^2 of impervious cover from the meeting house and Poverty Road, the practice would require a sediment forebay and a filter strip for pretreatment of overland flow. Ample space exists to treat the entire water quality volume. The existing yard drain in this depression could be raised to function as an overflow structure.

- **Linear Bioretention.** Two rows of linear bioretention cells, also called "bioswales," are proposed at the southern approach to the intersection of Heritage Road and Village Street. Curb cuts from Heritage Road would allow water into the practice, with excess flow bypassing the bioretention cell and entering the existing catch basins and storm drainage system.

- **Water Quality Swale.** North of the intersection of Heritage Road and Poverty Road, east of the proposed pervious pavement and bioretention proposed above, a 275-foot dry water quality swale is proposed. A curb cut at the northern end would capture surface runoff along Heritage Road. A second curb cut is proposed to allow more runoff into the practice downstream of the first curb cut. This allows a greater amount of impervious cover to be disconnected and treated. Both curb cuts would first enter a pretreatment sediment forebay. In a limited-width ROW, it may be necessary to narrow the swale by the second curb cut to allow sufficient space for pretreatment. As proposed, this BMP would treat runoff from approximately 6,500 ft^2 of impervious cover, for which there is sufficient length in the ROW to infiltrate the water quality volume.

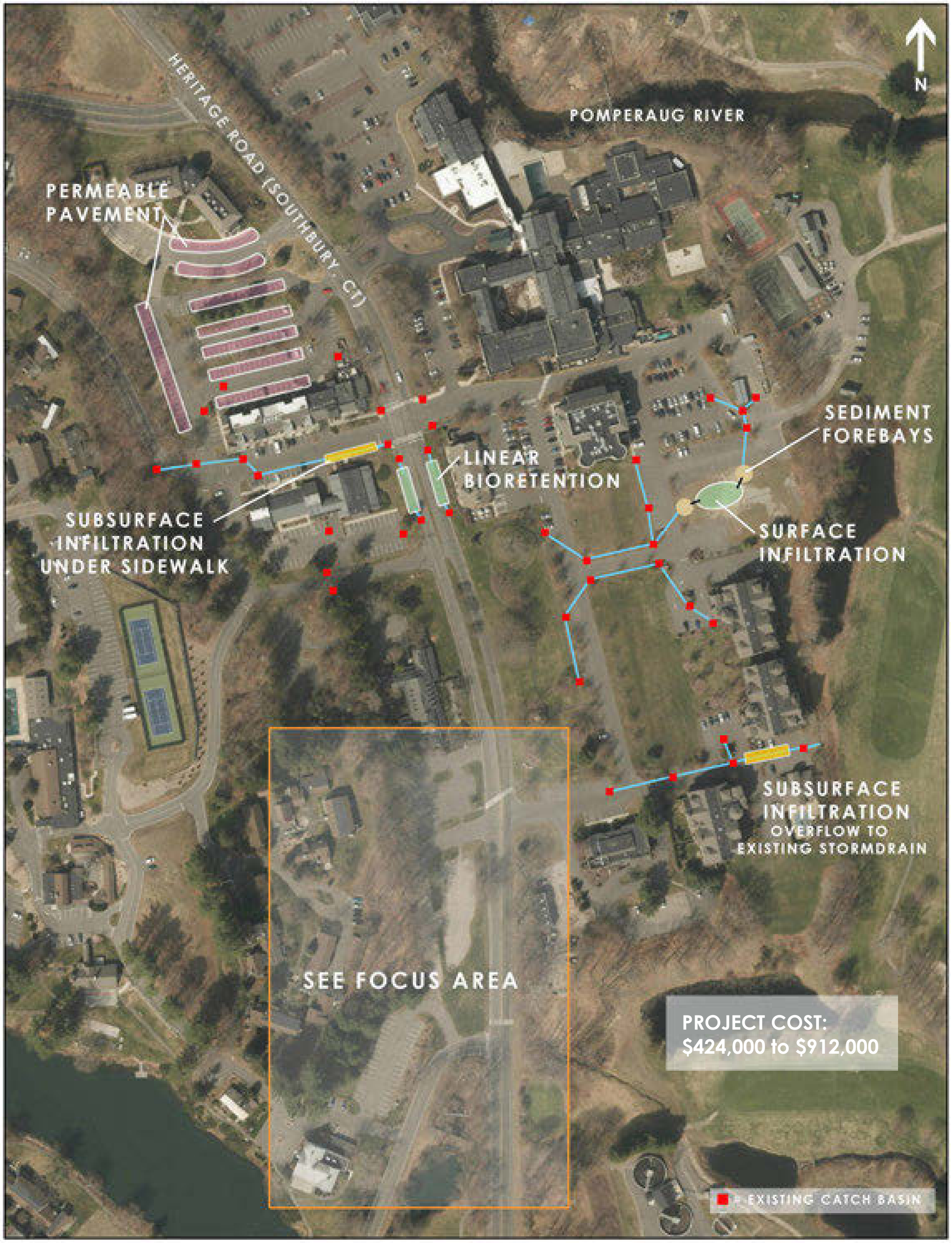


Figure 4-10. BMP Concept: Mixed Commercial/Residential 1

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

Figure 4-11. BMP Concept: Mixed Commercial/Residential 1 (focus area)

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.6 State Facility 2

This site is a 700-acre State-owned facility located on the west side of Transylvania Brook off of Route 172 (South Britain Road) in Southbury. Approximately 550 acres of the site are forested or used for agriculture, parts of which are conserved as protected open space. The remaining areas are developed with more than 35 acres of impervious cover. The developed areas of the site drain to Transylvania Brook and are characterized by over 20% impervious cover, including numerous outbuildings, access roads, and parking areas.

Most of the stormwater runoff from the site is collected by catch basins and eventually discharges directly to Transylvania Brook. Soils are typically good for infiltration, consisting of primarily Hydrologic Soil Group B soils, with some pockets of Group A soils. Some areas of locally-higher elevation are mapped as Group D soils, due to shallow bedrock. A perennial stream flows through the developed portion of the site, dividing it into roughly equal halves. Stormwater outfalls likely discharge into this tributary of Transylvania Brook. An impoundment creates Gravel Pond, which has recently been documented to host a significant inundation of invasive water chestnut plants, before Transylvania Brook continues south.

The State is currently phasing out use of the facility. Future uses of the site remain under discussion between the State, Town, and residents. The BMPs presented below, or similar LID/GI concepts could be implemented as part of a future redevelopment plan for the site, particularly in a residential, institutional, or recreational setting.

This site has been the subject of some environmental investigation in the past to assess the property for subsurface contamination associated with historical uses of the site, including underground storage tanks, maintenance shops, power generation facilities, and other potential pollution sources. As discussed in *Section 3.4.1* of this plan, infiltration of stormwater is not recommended in areas with soil or groundwater contamination. Further assessment and remediation of potential contamination will be necessary prior to implementing infiltration-based stormwater BMPs at this site.

Proposed BMP concepts for these sites are shown in *Figure 4-12*.

- **Permeable Pavement.** Multiple opportunities for permeable pavement exist across the site. Many parking areas have capacity for more than 10 vehicles. Parking is dispersed throughout the site, making larger practices less feasible.

- **Bioretention.** Three bioretention practices are proposed on Hartford Hill, Constitution Hill, and Liberty Lane.
    - Hartford Hill: A 1,000-ft^2 bioretention practice is proposed west of the intersection of Nutmeg Ave and Hartford Hill, capturing approximately 35,000 ft^2 of impervious cover from Hartford Hill and adjacent buildings. The concept includes a sediment forebay and bioretention area receiving runoff from the catch basins and storm drains on Hartford Hill. Ample space on the south side of the street exists to treat the entire water quality volume.

    - Constitution Hill: A 2,500-ft^2 bioretention practice is proposed in a lawn area northwest of the intersection of Yankee Drive and Constitution Hill, capturing approximately 88,000 ft^2 of impervious cover from Constitution Hill and adjacent buildings. The practice includes a sediment forebay and bioretention area receiving runoff from the catch basins and storm drains on Hartford Hill. While sufficient space exists to treat the water quality volume, this location is sloped, which would need to be addressed in the design.

- Liberty Lane: A 1,200-ft^2 bioretention practice is proposed east of Liberty Lane. Catch basins on Liberty Lane capture runoff from approximately 35,000 ft^2 of impervious cover. The concept includes a sediment forebay and bioretention area receiving runoff from the catch basins and storm drains. Sufficient space exists within existing landscape features to treat the entire water quality volume.

- **Water Quality Swales.** Two roadside water quality swales are proposed in the wide ROW along South Britain Road, north and south of Transylvania Brook. Curb cuts would allow water to enter the swales. Sediment forebays or filter strips could be used as pretreatment options depending on the available ROW width.

  - Northern swale: Runoff from approximately 17,000 ft^2 of impervious cover could be treated by this proposed practice. Pervious pavement proposed elsewhere in the parking lots would help to reduce the amount of runoff that would otherwise drain to the BMP. A curb cut and filter strip is proposed here where existing utility poles limit the ROW width. The ROW widens closer to Transylvania Brook to approximately 20 feet.

  - Southern swale: Runoff from approximately 1 acre could be treated by this practice, including the drainage area that serves 5 catch basins along South Britain Road. Along the east side of the road, a local depression would receive runoff from the catch basins. This difference in elevation allows more opportunity to pass water through a sediment forebay prior to treatment in the swale.

- **Buffer restoration.** At the northern end of Gravel Pond, limited riparian buffer exists along Transylvania Brook, its tributary, and Gravel Pond. Bacteria sources in this area may include pet waste and nuisance wildlife. Educational signage encouraging pet owners to clean up after their pets is recommended. Vegetative buffer restoration is proposed along the water's edge to help deter waterfowl from occupying this area by restricting their access to water and to filter runoff and encourage infiltration.

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Figure 4-12. BMP Concept: State Facility 2

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.7 Dog Park 1

On the west bank of the Pomperaug River in Southbury is a 14-acre off-leash dog park located on land owned by O&G Industries. A network of trails meanders through the forested portion of the dog park. A tributary to the Pomperaug River flows under the access road and along the southern edge of the site. A parking area for approximately 25 vehicles is located at the western edge of the site, by the access road. On the eastern side of the cleared area are an additional parking area and an access path. The owners of the park recognize that pet waste is a source of bacteria and a nuisance. They provide waste bags and trash cans at the main entrance and require that owners clean up after their pets. There are access paths to the Pomperaug River, which appear to be frequently used. Proposed BMP concepts for this site are shown in *Figure 4-13*.

- **Infiltration Basin.** A 300-ft^2 infiltration basin is proposed at the southern end of the main parking area. This area drains approximately 13,000 ft^2 of impervious cover, including the parking area and access road. A sediment forebay is proposed as pretreatment because the parking area is unpaved.

- **Buffer Restoration.** At the southeastern edge of the park, the existing riparian buffer is limited. Buffer restoration is therefore proposed along this narrow buffer area. Because the existing access path from the additional parking area is sited close to the Pomperaug River, realignment of the path is recommended to accommodate a wider buffer. A pet waste station is also recommended at the entrance from the additional parking. Recognizing that access to the Pomperaug is a popular feature of the park, river access is still recommended as part of the proposed buffer restoration project. The paths should be elevated relative to the surrounding area to prevent stormwater from short-circuiting the buffer. River access could be provided similar to the stairs installed at the Cedarland Park stream buffer demonstration project.

Figure 4-13. BMP Concept: Dog Park 1

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.8 Town Park 2

This site is a municipal park located on land owned by the Town of Woodbury at the confluence of the Weekeepeemee and Nonnewaug Rivers, which join to form the Pomperaug River. Athletic fields are located on the northern side of the river while a walking trail is to the south, surrounding a row crop field. Unpaved parking areas are located along Jacks Bridge Road. Wildlife and pet waste are the primary sources of bacteria in this location. The park provides waste bags and a trash receptacle at the main entrance. Access paths to the Pomperaug River appear to be frequently used. Proposed BMP concepts are shown in *Figure 4-14*.

- **Parking Reconfiguration and Additional Pet Waste Disposal.** The unpaved parking lot for the southern portion of the park has a maximum buffer width of 15 feet along the Weekeepeemee River. Moving the lot back from the river would allow widening and enhancement of the existing vegetative buffer in this area. Placement of another trash can at the halfway point of the trail is recommended as many pet owners leave their bagged pet waste on the trail for pick-up on their return to the car and often forget to pick it up.

- **Buffer Restoration.** The buffer width varies significantly across the northern and southern portions of the park. The vegetated buffer in the northern portion of the park ranges from 40 to 100 feet, averaging about 60 feet. While a wider buffer would be beneficial, expanding the existing buffer would result in the loss of parking, which may not be feasible given the popularity of the park. In the southern portion of the park, the vegetated buffer is much narrower, ranging from 10 to 60 feet. Buffer restoration is proposed along portions of the walking trail where it runs along the Weekeepeemee and Pomperaug Rivers (continuing along to Judson Avenue) to provide a more uniform width, which may require realignment of some trail segments. The park and the adjacent areas were the subject of a study conducted by the Yale School of Forestry and Environmental Studies in 2010 examining floodplain and geomorphic conditions and riparian buffer restoration.

Figure 4-14. BMP Concept: Town Park 2

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.9 Livestock 1

Between Weekeepeemee Road (South of Peter Road) and the Weekeepeemee River in Woodbury is a clustering of farm operations with several head of livestock, 17 acres of row crops, and two pasture areas. An intermittent stream passes between a fenced grazing area and the row crops. Further west, water is channelized in the row crop field, passes through the other pasture, and joins the Weekeepeemee River.

- **Buffer Restoration.** At 0.75 acres, the fenced grazing area represents the most significant source of bacteria. Several head of cattle are separated from the intermittent stream by no more than 10 feet of vegetated buffer. While available space is limited in this area, doubling the buffer width to at least 20 feet is recommended. The shade from a tree in the existing buffer area might be reduced by increasing the buffer width, so a new shelter/shade structure may also be needed.

- **Buffer Restoration.** The larger pasture area nearer the river contains a drainage channel from the upgradient row crops. Where this channel passes through the pasture area, a vegetated buffer is proposed on both sides to filter pollutants and promote infiltration. Moving the fence line to prevent grazing animals from accessing the buffer vegetation is also proposed. Proposed BMP concepts for this site are shown in *Figure 4-15*.

Figure 4-15. BMP Concept: Livestock 1

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.10 Livestock 3

Above Dowd Brook, a tributary to the Weekeepeemee River, a livestock farm maintains 10-20 head of cattle. The operation includes approximately 30 acres of hay fields and 2 acres of feeding and grazing areas. Both grazing areas represent the primary source of bacteria from this site.

- **Buffer Restoration/Filter Berm and Paddock Reconfiguration.** The feeding area passes through an intermittent tributary to Dowd Brook. Based on the observed lack of vegetative cover around bale feeders, livestock likely spend most of their time in the feeding lot. The paddock could be reconfigured to eliminate livestock access to the stream. If livestock currently use the tributary to Dowd Brook as a water source, then an alternative water supply may be required. Restoration of the existing vegetated buffer is also recommended to filter runoff. An optional filter berm could also be constructed to further retain agricultural runoff and enhance infiltration.

- **Buffer Restoration.** The grazing field slopes down toward a wetland and Dowd Brook. Livestock manure from grazing cattle could be washed down into the brook. Creation of a vegetated buffer along the eastern fence line is recommended to filter runoff and increase infiltration. Alternatively, rotating grazing between the areas could help to reduce the concentration of waste in a given area. Proposed BMP concepts for this site are shown in *Figure 4-16*.

Figure 4-16. BMP Concept: Livestock 3

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.11 Cropland/Livestock 1

This site is a 50-100 head livestock farm operated in close proximity to the water along the Weekeepeemee River in Woodbury. Exclusion fencing along the river appeared in good repair during the field visit, though dense buffer vegetation was minimal along part of the streambank. Adjacent to the river is a 2-acre feeding and grazing area. A 1-acre area of row crops and 11 acres of other hay and grazing fields are located uphill from the pasture area. Several intermittent streams flow down the hill and feed the Weekeepeemee River.

- **Buffer Restoration and Exclusion Fencing.** A vegetated buffer is proposed between the pasture and riverbank along the length of the existing fence line. The fence line would need to be reconfigured to provide enough space for the vegetated buffer. If the field surrounded by a fieldstone wall, located immediately north of the pasture area, is used for grazing, then additional exclusion fencing should be considered to restrict livestock access to the intermittent stream and to allow the buffer vegetation to regrow. An alternative water supply may also be needed if livestock rely on the stream for drinking water. Proposed BMP concepts for this site are shown in *Figure 4-17*.

Figure 4-17. BMP Concept: Cropland/Livestock 1

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.12 Cropland/Livestock 2

Located west of an unnamed tributary to the Weekeepeemee River in Bethlehem is a livestock farm with 50-100 head of beef cattle, sheep, and pigs. Livestock drink from several surface water bodies along the eastern edge of the farm, where there is also an approximately 4-acre grazing field. Direct livestock access to waterbodies can be a significant source of bacteria. A large feed lot is also located on the site. West of this area is an approximately 40-acre hay field. At the northern end of the hay field is a 1.5-acre pond. Proposed BMP concepts for this site are shown in *Figure 4-18*.

- **Buffer Restoration.** Restoration of a vegetated buffer is recommended between the existing fence line and the Weekeepeemee tributary that flows along the eastern edge of the site. A minimum 50-foot buffer is recommended in the grazing field. Using an existing fence line as exclusion fencing could allow a buffer greater than 100 feet wide. An additional buffer area is proposed between the hay field and the pond to the north.

- **Filter Berm.** Between the feeding area and the stream, a filter berm and optional bioreactor are proposed. The feeding area, which has minimal vegetative cover, would likely have higher loads of sediment, along with bacteria and nutrients attached to soil particles. Filter berms allow sediment loads to settle out of stormwater. The stormwater can then infiltrate into the soil, where further treatment can occur. A bioreactor is in essence a trench filled with wood chips that enhances nutrient removal, mainly by promoting denitrification.

Figure 4-18. BMP Concept: Cropland/Livestock 2

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.13 Equestrian 1

This site is an equestrian facility located west of the confluence of Transylvania Brook and the Pomperaug River. Two intermittent drainage channels pass through the paddocks and grazing areas on the facility. The southern-most drainage channel drains to the Audubon Center at Bent of the River and passes through a natural meadow. The northern drainage channel passes through a paddock and two grazing areas before spreading out and then entering an existing ditch and Transylvania Brook. The grazing area with the heaviest channelization (center) also appears to be used for horse trailer parking during equestrian events.

- **Buffer Restoration and Exclusion Fencing.** A vegetated buffer and exclusion fencing is proposed along the drainage channel that flows through the central portion of the property to filter runoff and reduce erosion. Some of the paddocks would need to be reconfigured to vegetated buffer and channel. New fencing and gates may also be needed for the reconfigured paddocks.

Proposed BMP concepts for this site are shown in *Figure 4-19*.

Figure 4-19. BMP Concept: Equestrian 1

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.14 Equestrian 2

This site is a large equestrian facility located along an impaired segment of the Pomperaug River in Southbury. An unnamed tributary splits the facility in two, draining from the north into a farm pond before passing through a culvert and entering the Pomperaug River. To the north along the unnamed tributary is a dairy farm.

Available space at the equestrian facility is limited and little buffer exists between paddocks and waterbodies. Good manure management practices are in place at this facility – paddocks are regularly cleaned and moved to a manure pile. At the time of the site visit, the manure pile was in close proximity to the Pomperaug River. Since then, the PRWC and Town of Southbury Inland Wetland Commission have worked with the owner of the facility to relocate the manure pile farther from the riverbank.

- **Paddock Relocation.** A paddock area is the primary bacteria source at this site, since the manure pile has been moved. This paddock is no more than 10 feet from the edge of the river, with little to no vegetative cover between the paddock and the river. Relocating this paddock to an area east of the stable should be considered, if feasible.

- **Buffer Restoration and Bank Stabilization.** Buffer restoration is proposed between the paddocks and the farm pond. A vegetated buffer is proposed to filter runoff from the paddock area. Bank erosion has also historically occurred along the Pomperaug River near the equestrian facility. Bank stabilization is also proposed.

- **Restriction of Livestock Access to Stream.** At the dairy farm to the north, it is unclear if livestock have direct access to the adjacent stream. The area on both sides of the stream appears to be fenced. Confirmation of livestock access to the unnamed tributary is recommended. If livestock access to the stream is confirmed, alternative approaches should be pursued to restrict livestock from this area.

Proposed BMP concepts for this site are shown in *Figure 4-20*.

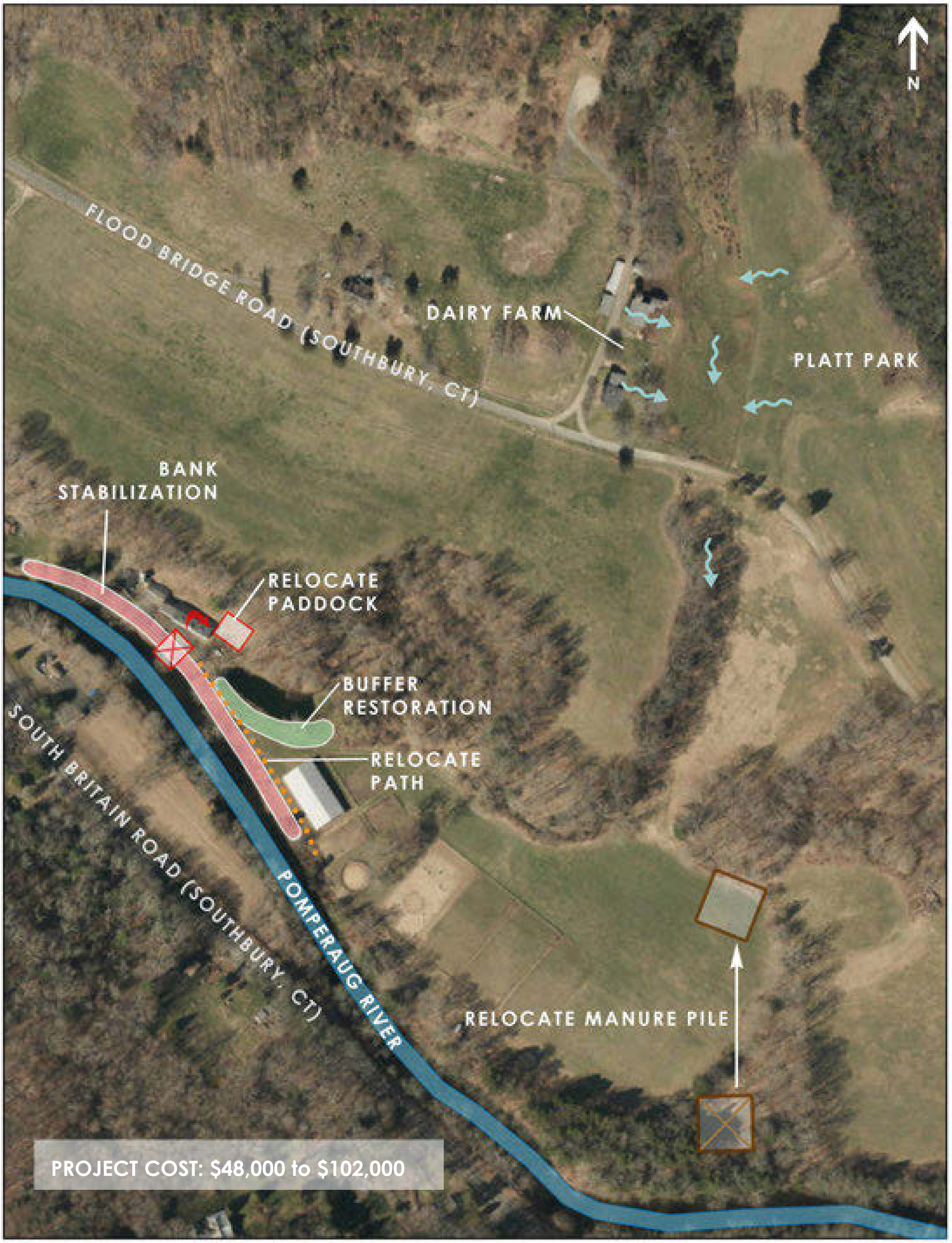

Figure 4-20. BMP Concept: Equestrian 2

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

4.15 Equestrian 7

This site is an equestrian facility with an estimated 50 horses located on Middle Road Turnpike in Woodbury. Covering approximately 60 acres, the facility includes several paddocks and fields. Three intermittent streams flow through the site, two merging in one field and flowing through a paddock and the rest of the farm before joining the third stream, which flows through the southern-most field. The stream continues to join the Nonnewaug River just north of Nonnewaug High School. Buffer widths are reasonable in some locations and manure management practices appear to be good.

- **Buffer Restoration.** Areas along portions of the on-site streams should be restored to create a relatively uniform 50-foot buffer.

- **Paddock Relocation and Exclusion Fencing.** Relocation of the paddock through which the two streams flow should be considered to accommodate an enhanced vegetated buffer. In the southern-most paddock, a reasonable buffer exists, but could be further protected from grazing by exclusion fencing. New fencing is also proposed along the proposed buffer to keep horses from grazing on the vegetation and limit access to the stream.

Proposed BMP concepts for this site are shown in *Figure 4-21*.

Figure 4-21. BMP Concept: Equestrian 7

The concepts presented in this figure illustrate potential measures that could be implemented at this and similar sites in the Pomperaug River watershed. Individual project proponents (e.g., municipalities, private property owners, developers) would be responsible for evaluating the ultimate feasibility of, as well as design and permitting for, the site-specific concepts. The measures depicted by these concepts are intended to be implemented voluntarily by willing, cooperative partners working together to protect and improve water quality. Financial and technical assistance towards the implementation of these measures may be available from sources like those listed in Appendix H.

5 Management Measures and Pollutant Load Reductions

Pollutant Load refers to the quantity or mass of a pollutant originating from point sources (permitted outfalls) and nonpoint source runoff that is delivered to a surface waterbody in a specified amount of time. For this watershed plan, annual loads of bacteria, nutrients, and sediment were modeled for each subregional basin in the Pomperaug River watershed based on the land uses and activities/sources of pollutants in each subregional basin.

Pollutant Load Reductions are estimated reductions in pollutant loads than can be expected as a result of implementing structural controls and non-structural management practices in a watershed (collectively referred to as Best Management Practices or "BMPs"). For this watershed plan, pollutant load reductions were estimated based on modeled annual pollutant loads under existing conditions and with the recommended management actions described in this section.

Pollutant load reductions were estimated for the watershed plan recommendations for which pollutant loads can be reasonably quantified. Load reductions were calculated using the Watershed Treatment Model (WTM), a screening-level land use pollutant loading model described in the technical memorandum in *Appendix C*. Annual pollutant loads were modeled for existing baseline conditions (as presented in *Section 2.9* of this plan) and with the recommended management actions described below. Load reductions were calculated relative to the existing baseline pollutant loads, which are also presented in *Appendix C*. The types of management actions (and associated assumptions) evaluated for their ability to reduce pollutant loads to the Pomperaug River and its tributaries, emanating from various types of land uses and other activities/sources, include:

- **Green Infrastructure/Low Impact Development.** Implementation of green infrastructure and Low Impact Development (GI/LID) practices is recommended throughout the watershed. GI/LID should continue to be implemented through retrofits of existing developed sites and roads (i.e., complete streets), and as part of new public and private development and redevelopment in the watershed, as required by existing and future land use regulations and policies. Potential pollutant load and runoff reductions were estimated under multiple scenarios to estimate the effect of varying levels of GI/LID implementation across the watershed, including estimates for retrofitting 10%, 25%, 50%, and 100% of the impervious area watershed-wide using stormwater infiltration treatment practices.

- **Vegetated Buffer Restoration.** Potential pollutant load reductions were estimated for restoration of impacted vegetated buffers in suburban areas and agricultural uses in the watershed. The total length of streams with impacted buffers was estimated from land cover data. Under the modeled restoration scenario, a 50-foot vegetative streamside buffer was assumed for 50% of those areas currently with impacted buffers (i.e., 50% restoration scenario).

- **Public Education.** Nonpoint source education programs can change behaviors that affect pollutant loads. Pollutant load reductions were estimated for pet waste education programs based on the number of dwellings, average fraction of pet-owners, pet-owners who already clean up after their pets, and an average fraction of those willing to change their behavior. Conservative model assumptions were used to avoid over-estimating the load reduction benefits of these programs.

- **Illicit Discharge Detection and Elimination.** Illicit connection removal was modeled based on the existing estimated number of illicit connections associated with commercial and residential land uses. The illicit connection removal scenario conservatively assumes that 15% of the existing illicit discharges are detected and eliminated.

- **Septic System Repairs.** Septic system repairs were modeled based on the existing estimated number of households served by septic systems. The septic system repair scenario assumes that 20% of failing or malfunctioning septic systems are repaired. This scenario reflects short- or mid-term recommendations to address existing failing or malfunctioning septic systems.

Other watershed management recommendations identified in this plan were not quantified due to the inherent limitations of screening-level pollutant load models and/or the lack of reliable information on the pollutant removal effectiveness of certain management measures.

Pollutant Load Reductions

Table 5-1 summarizes the anticipated pollutant load reductions for the plan recommendations for which pollutant loads can be reasonably quantified. The load reduction values presented in *Table 5-1* are for the overall Pomperaug River watershed (regional basin).

As indicated in *Table 5-1*, the watershed plan recommendations are predicted to result in an approximately 11% reduction[1] in annual fecal indicator bacteria loads for the entire Pomperaug River watershed assuming implementation of green infrastructure for 10% of the impervious area in the watershed. Of this 11% reduction, 6% is attributable to buffer restoration, approximately 2% to green infrastructure, approximately 1% to elimination of illicit discharges, and the remainder to other structural and non-structural nonpoint source pollution control measures.

Varying levels of GI/LID implementation across the watershed were modeled to manage runoff from 10%, 25%, 50%, and 100% of the impervious area in urbanized land uses. The results for the 10% scenario, which is considered a reasonable future scenario, are included in *Table 5-1*. The results for all four scenarios are presented in *Table 5-2*. The 10% retrofit scenario is predicted to result in an approximately 1.5% reduction in annual fecal indicator bacteria loads and 0.5% reduction in annual runoff volume. Higher bacteria load reductions (up to approximately 19%) could potentially be achieved by implementing GI/LID over a larger percentage of the watershed.

Illicit discharge detection and elimination (IDDE) is also predicted to result in annual bacteria load reductions comparable to a 10% GI/LID scenario. Even the modest 15% illicit discharge removal rate assumed in the model is predicted to achieve an approximately 1% reduction in annual fecal indicator bacteria loads. IDDE is generally more cost-effective than implementing structural stormwater retrofits. Dry weather sources of fecal indicator bacteria are the most likely to be identified and effectively managed and more likely to include human sources. Wet weather bacteria sources are often very challenging to identify and costly to address due to the contribution from large quantities of stormwater and other diffuse, nonpoint sources. Stream standards can also be difficult to attain during wet weather given the ubiquitous nature of wet weather bacteria sources. IDDE and other source controls focusing on dry weather bacteria sources should be aggressively implemented through municipal stormwater management programs (as required by the MS4 permit) in conjunction with green infrastructure to help address for wet weather bacteria sources.

[1] A 10.5% "effective" reduction in annual fecal indicator bacteria loads is predicted. Effective load reductions are realistically-achievable reductions that account for the natural background pollutant load. The natural background pollutant loads reflect a fully-forested condition in the entire watershed, which represents the lowest, realistically-achievable pollutant loads for the watershed.

Table 5-1. Modeled annual pollutant load reductions for the Pomperaug River watershed for proposed BMPs

Watershed Management Recommendation	Fecal Coliform (billion/year)	Fecal Coliform (%)	Runoff Volume (acre-feet/year)	Runoff Volume (%)
Green Infrastructure (10% of impervious area)	16,000 - 22,000	1.3 - 1.8	147 - 330	0.3 - 0.7
Riparian Buffer Restoration (50% of watershed, 50 foot width)	73,000	6.0	1,432	3.0
Livestock BMPs	13,000	1.1	--	--
Public Education	10,500	0.9	--	--
Illicit Discharge Detection and Elimination (IDDE)	11,000	0.9	--	--
Septic Repair	900	0.1	--	--
Total	**134,400 - 140,400**	**10.25 - 10.75**	**1,579 - 1,762**	**3.1 - 3.7**

Table 5-2. Modeled annual pollutant load reductions for varying levels of GI/LID implementation

Green Infrastructure Implementation Scenario	Fecal Coliform (billion/year)	Fecal Coliform (%)	Runoff Volume (acre-feet/year)	Runoff Volume (%)
Retrofit 10% of Impervious Area	16,000 - 22,000	1.3 - 1.8	147 - 330	0.3 - 0.7
Retrofit 25% of Impervious Area	40,000 - 56,000	3.3 - 4.6	367 - 826	0.8 - 1.7
Retrofit 50% of Impervious Area	79,000 - 112,000	6.6 - 9.2	734 - 1,652	1.5 - 3.4
Retrofit 100% of Impervious Area	159,000 - 224,000	13.1 - 18.5	1,468 - 3,304	3.1 - 6.9

Modeled Load Reductions and TMDL Load Reduction Targets

A Total Maximum Daily Load (TMDL) analysis for fecal indicator bacteria was completed for the Pomperaug and Weekeepeemee Rivers as part of CTDEEP's Statewide Bacteria TMDL. A TMDL is a "pollution budget" that identifies the reductions in point and nonpoint source pollution that are needed to meet Connecticut water quality standards for a particular waterbody and a strategy to implement those reductions to restore water quality. The Statewide Bacteria TMDL calls for a 48-65% reduction in fecal indicator bacteria loads (based on the geometric mean) to the various impaired segments within the Pomperaug watershed.

The pollutant load modeling results indicate that fecal indicator bacteria load reductions of roughly 11% are achievable with full implementation of the watershed management plan recommendations (under the 10% GI/LID implementation scenario). This suggests that additional controls or more aggressive control strategies are needed to fully achieve the load reductions specified in the TMDL. Additional load reductions may be achieved through implementation of GI/LID over a larger portion of the watershed, additional vegetated buffer restoration, increasing the public awareness in the watershed of certain best management practices and programs, and increased detection and elimination of illicit discharges.

It is important to note several limitations of both the TMDL load reduction estimates and the pollutant load reduction modeling. The TMDL is based on very limited wet and dry weather monitoring data for Pomperaug-01 and the Weekeepeemee River: fewer than five and ten samples were collected during wet and dry weather, respectively. Data collection efforts were more comprehensive for Pomperaug-03, biweekly samples collected during the summer between 2006 and 2009, but are a decade or more old.

Further, the TMDL and modeled load reductions are not directly comparable since the TMDL load reductions targets are daily, seasonal (i.e., worst-case) values, whereas the modeled pollutant loads are annual values. The modeled load reductions are also based on the use of fecal coliform rather than *E. coli*, the latter being a subset of fecal coliform which is more specific to humans and other warm-blooded animals. *E. coli* is the indicator bacteria for freshwater monitoring in Connecticut and was used in the TMDL.

As indicated in the TMDL, progress in achieving TMDL-established goals through implementation of this watershed plan may be most effectively gauged through continued fixed-station ambient water quality monitoring. A key recommendation of this watershed plan is to establish and implement a routine bacterial monitoring program at fixed stations in the watershed (refer to *Section 3.2* of this plan). The bacteria monitoring program will provide an updated baseline of recreational water quality in the watershed to support implementation of the watershed based plan and to measure progress toward achieving TMDL pollutant load reduction goals. Further coordination between PRWC and CTDEEP is also recommended to discuss the watershed based plan findings, recommendations, and modeled potential load reductions relative to the TMDL reduction goals and implications for proposed bacteria monitoring locations.

6 Funding Sources

A variety of local, state, and federal sources and private foundations are potentially available to provide funding for implementation of this watershed management plan, in addition to potential funds contributed by local grassroots organizations and concerned citizens. *Appendix H* contains a list of potential funding sources and mechanisms. The table is not intended to be an exhaustive list but can be used as a starting point to seek funding opportunities for implementation of the recommendations in this watershed based plan. The table of potential funding sources is intended to be a living document that should be updated periodically to reflect the availability of funding or changes to the funding cycle, and to include other funding entities or grant programs. Potential funding sources for specific recommendations are also listed in the tables in *Section 3* of this plan.

7 References

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Additional references for existing plans and studies on the Pomperaug River watershed are listed in Table 1-1 of this plan.

Appendix A

Quality Assurance Project Plan

Pomperaug River Watershed Based Plan

Appendix B

Technical Memorandum – Visual Field Assessments

Pomperaug River Watershed Based Plan

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Appendix C

Technical Memorandum – Pollutant Loading Model

Pomperaug River Watershed Based Plan

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Appendix D

Structural BMP Prioritization Matrix

Pomperaug River Watershed Based Plan

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Appendix E

Site-Specific BMP Concept Cost Estimates

Pomperaug River Watershed Based Plan

Appendix F

PRWC Land Use Committee Meetings

Pomperaug River Watershed Based Plan

Appendix G

Public Participation and Outreach Meetings

Pomperaug River Watershed Based Plan

FUSS & O'NEILL

Appendix H

Potential Funding Sources, Technical Assistance, and Other Resources

Pomperaug River Watershed Based Plan

The project of updating the Pomperaug Watershed Management Plan to an EPA 9-Element Watershed Based Plan is funded in part by the Connecticut Department of Energy and Environmental Protection through a United States Environmental Protection Agency Clean Water Act Section 319 Nonpoint Source Grant as well as by the Connecticut Community Foundation.