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## Acronyms

BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
COD	Chemical Oxygen Demand
CSCC	Connecticut State Climate Center
CRWA	Charles River Watershed Association
CTDEEP	Connecticut Department of Energy and Environmental Protection
CWP	Center for Watershed Protection
DO	Dissolved Oxygen
FBI	Family Biotic Index
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
Ft-msl	Feet above mean sea level
IDDE	Illicit Discharge Detection and Elimination
NP	Near Peak
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
PCBs	Polychlorinated Biphenyls
PE	Pre-event
RCRA	Resource Conservation and Recovery Act
RL	Rising limb
TKN	Total Kjehldahl Nitrogen
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
UNH	University of New Hampshire
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Society
UST	Underground Storage Tank
WMM	Watershed Management Model
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

# Section 1 - Introduction

## 1.1 Project Purpose

As a part of a plan to transform the Mill River corridor into a world class urban space, the City of Stamford, Connecticut contracted CDM Smith to develop a watershed plan by expanding upon major projects in downtown Stamford completed by the US Army Corps of Engineers (USACE) and Olin Partnership by extending the study area to the entire watershed. The Rippowam/Mill River Watershed Management and Infrastructure Program encompasses five miles of river, from the origin in the North Stamford Reservoir to Stamford Harbor.

The purpose of the Watershed Management and Infrastructure Program is to address water quality and quantity concerns in the river by assessing existing water conditions, identifying sources of pollution, and making recommendations for improvements to protect the City's investment in the downtown Mill River Park.

The project encompassed a multi-phase approach of data collection, gap analysis, preliminary goal and conceptual model development, watershed assessment and water quality monitoring, and identification and modeling of best management practices (BMPs). In addition, stakeholder involvement through public outreach was an integral component of the watershed planning process. As part of the completion of this assessment, recommended action items are provided to the City for each reach of the Mill River. This information could be considered for future stormwater and watershed improvement planning programs and Municipal Separate Storm Sewer Systems (MS4) activities.

## 1.2 Watershed Management Team

CDM Smith completed this document under contract with the City of Stamford in cooperation with the Stamford Water Pollution Control Authority (SWPCA), the Mill River Collaborative, and with information from the USACE and Olin Partnership studies. Public involvement was invited throughout the project development, particularly during the initial phases of the program.

## 1.3 Watershed Planning Process

The watershed planning process included extensive field work, data collection, modeling existing conditions, stakeholder outreach and feedback, and watershed management BMP modeling and analysis.

### 1.3.1 Understanding the Watershed

An extensive field investigation was conducted to assess the physical characteristics of the river and the environmental factors within the watershed. Field activities included a full river walk, water quality sampling, sediment sampling, streamflow monitoring, and geomorphological and

ecological assessments. Further information on the activities, raw data, interpreted results and conclusions can be found in the Comprehensive Characterization Report dated April 19, 2011 (CDM, 2011).

### Gap Analysis

Before a full assessment was conducted, historical documents, data, and city GIS information were reviewed<sup>1</sup> to identify gaps and shape the focus of the full field assessment. Existing data were summarized<sup>2</sup> along with case studies<sup>3</sup> on similar urban watershed restoration projects. Following the paper research portion of the gap analysis, a windshield survey was completed<sup>4</sup>. This survey identified areas for further investigation, potential sampling points, and a general understanding of the conditions of the river.

### River Walk

In order to assess the baseline condition of the river and to identify ideal sample locations, CDM Smith deployed a field team to walk the length of the river corridor downstream of the North Stamford Reservoir dam in April 2009. The team reported general geomorphic characteristics, anomalies in the channel form and function, fundamental channel form components, and identified representative segments within each reach. The representative segments were selected based on the general characteristics of each reach and chosen based on accessibility, distance from stormwater outfalls, and distance from potential high polluting sites. The team completed an initial assessment of human impacts to the river and river corridor including:

- Bank armoring
- In-stream structures
- Over-stream structures (bridges, culverts)
- Water intakes
- Stormwater outfalls
- Stormwater outfalls with dry weather flow

The river walk was documented using GPS, field notebooks, data sheets, and observation photographs. A technical memorandum, dated February 2009 and attached to the Comprehensive Characterization Report, included a summary of all findings from this activity<sup>2</sup>.

### Water Quality Sampling

The water quality monitoring program of the river consisted of four dry-weather sampling rounds and two wet-weather sampling rounds, conducted at 18 separate sampling locations along the river over the course of 18 months starting in the fall of 2008. Sample sites were located on the main stem of the Mill River and at each of the six major tributaries: Poorhouse Brook, Haviland Brook, Holts Ice Pond Brook, Ayers Brook, Toilsome Brook (culverts), and the drain from the downtown area that discharges to the

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<sup>1</sup> Memorandum: Rippowam/Mill River Watershed Study Task 1.4 – Project GIS Data. 1/16/2009, CDM

<sup>2</sup> Memorandum: Rippowam/Mill River Watershed Study Task 1.3 – Existing Conditions. 2/3/2009, CDM

<sup>3</sup> Memorandum: White Paper on Urban Watershed Restoration/Revitalization. 3/12/2009, CDM

<sup>4</sup> Memorandum: Mill River Watershed Study – Windshield Survey. 12/8/2009, CDM

former Mill Pond. Dry-weather rounds were conducted over the course of four seasons. Wet-weather rounds were collected in early summer and fall and included pre-event, rising limb, near peak, and receding limb grab samples.

Water quality samples were analyzed for an array of biological and chemical constituents including: dissolved oxygen, temperature, conductivity, pH, biological oxygen demand, metals, nutrients, bacteria, and pesticides. Specific analyses for each sample round and location were refined throughout the sampling program.

### **Sediment Sampling**

River sediment samples were collected to characterize areas of excessive sedimentation and downstream of potential sources of water quality pollution to check for source specific pollutants of concern within the deposited sediment. Fifteen physical and ecological stream assessment locations were selected to determine the impact of potential chemical stresses on the abundance and diversity of indicator organisms. Additional samples were collected at impounded pools where large quantities of sediments were deposited. Samples were collected in May and September 2009 and analyzed for grain size distribution, and an array of chemical constituents including: metals, pesticides, herbicides, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

### **Streamflow Monitoring Program**

The stream flow monitoring program consisted of two continuous flow meters and four staff gages. The continuous flow meters collected paired stage-discharge readings in the culvert outfalls of Toilsome Brook and the Washington Boulevard drain at the Mill River dam. The program lasted 24 weeks, starting in April 2009. Staff gages were installed at four tributaries including Poorhouse Brook, Haviland Brook, Holts Ice Pond Brook, and Ayers Brook and readings were taken during each wet and dry weather sample event. These results were compared with the main stem USGS gage on each day for reference.

### **Geomorphological Assessment**

A geomorphological assessment of the river corridor was conducted to quantify key components of channel morphology at each location (considered to be representative of the corresponding river reach). The assessment categorized landforms within the river corridor and the processes responsible for making and modifying those landforms. Additionally, pebble counts were conducted to quantify the size distribution of surficial substrate particles (sediments). Data from the pebble count provided information on the availability and size variation of substrate across various feature types, which are important aspects of benthic habitat.

## **1.3.2 Stakeholder Involvement**

Stakeholder involvement has been central to the development of this Plan. Projects for Public Spaces (PPS) assisted CDM Smith with stakeholder involvement, public coordination and educational efforts. The goal of stakeholder involvement was to solicit input on issues and goals surrounding restoration of the Mill River watershed, cultivate stewardship by involving the public in improvement activities, and provide status updates to the community during every phase of the project. The following summarizes the public coordination efforts that were conducted:

- A project briefing meeting to neighborhood groups was also held on July 31, 2008 to introduce the project to the public.

- Coordination meeting with SWPCA and other interested parties on March 9, 2009 to provide overall program update, including summary of monitoring program results, update on modeling and next steps in the project.
- An Advisory Committee meeting was held on March 16, 2009.
- Participated in the Stamford Sustainable Garden Expo, held on May 28, 2009.
- A Working Group meeting was held on June 25, 2009 at SWPCA.
- A public workshop was held on November 12, 2009 to solicit public input on issues and goals for the project.
- Attended Long Island Sound Study alewife fish release to the Rippowam River at Cloonan Middle School on April 20, 2010.
- Attended LISS Green Cities/Blue Waters Citizens Summit on May 7, 2010 in Bridgeport.
- A project status meeting was held on April 25, 2011 with SWPCA and city staff.
- A presentation was given to the Mill River Collaborative on July 25, 2011 that summarized the project status.
- A meeting was held with Mayor Michael Pavia and his staff from the City of Stamford on December 8, 2011 to discuss the status of the Mill River Watershed Study and implementation of the Basin Management Plan.
- The initial meeting of the stakeholders for the Basin Management Plan took place on January 26, 2012.

A detailed summary of the public coordination efforts described above is provided in Appendix A.

### 1.3.3 Modeling and Analysis

A Watershed Management Model (WMM) was developed for the Mill River watershed to quantify known pollution sources and the loading of contaminants to the river in order to identify ideal pollution control strategies. Nonstructural controls, structural controls, and low impact development retrofits were modeled to gauge relative benefits of each option. The model was used to develop alternative management strategies of combined source and stormwater controls as part of this Plan. A summary of model development, analysis, and results can be found in Appendix B.

### 1.3.4 Plan Development

The US Environmental Protection Agency (USEPA) Watershed Plan Builder was used to create this Plan. The Watershed Plan Builder is a companion tool for the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* developed by the USEPA to provide municipalities, watershed groups, and private entities with an open framework that can be used to build a management plan. The USEPA recommends a comprehensive approach focused on stakeholder involvement, partnerships, and localized, watershed-specific management strategies which best meet the needs of the watershed. The USEPA checklist can be found in Appendix C.



This Plan was developed in collaboration with the City of Stamford and local stakeholders interested in addressing the needs of the Rippowam/Mill River. Over the course of several years, a comprehensive study was conducted to assess the health of the river and its response to a variety of weather conditions. This data was analyzed and presented in the *Comprehensive Characterization Report* published in 2011. From the findings presented in that report and subsequent meetings with stakeholders, the action items outlined in Section 6 and Section 7 were developed, evaluated, and applied to the sub-watersheds of the Rippowam/Mill River.

## 1.4 Document Overview

This Plan is organized into seven sections, as follows:

- Section 1 – Introduction
- Section 2 – Watershed Description
- Section 3 – Watershed Conditions
- Section 4 – Pollutant Source and Load Assessment
- Section 5 – Watershed Management Objectives
- Section 6 – Watershed Management Strategies
- Section 7 – Watershed Management Plan

Supporting documents are provided in trailing appendices.

This Plan was developed for the City of Stamford and local watershed management planning groups to use in future City planning and watershed management development projects. While the document provides overview and detail into the objectives and strategies of the Plan, Appendix E includes summary one-page documents which outline each suggested action item including identification of the problem, objectives, and benefits. These one-pagers were developed as a supporting resource for use during implementation of this Plan.

## Section 2 – Watershed Description

The Mill River has had historic significance for the City of Stamford for hundreds of years. As a natural resource that supported development of mills along the waterway, development, increased population, and prosperity soon followed. While this resource aided in development of the surrounding area, it has also been adversely affected by that development. According to the Mill River Collaborative, water from the Mill River has historically been dammed for grist mills, fulling mills, a flax mill, a planing mill, rolling mills, a woolen mill, and other industrial purposes. The first grist mill was built in 1662 and over the course of the next century, several mills followed. While several buildings burned down in 1886, the last mill remained in operation until 1960. The following is a summary of the existing conditions within the Mill River watershed.

### 2.1 Physical and Natural Features

The Mill River originates in southern New York State and western Connecticut, and flows south through the City of Stamford, discharging into the waters of Long Island Sound. The Mill River watershed covers a large portion of the City of Stamford, extending into the bordering town of New Canaan, CT and into New York. The complete watershed area is approximately 37.5 square miles, including approximately 18 square miles within the City of Stamford.

#### 2.1.1 Watershed Boundaries

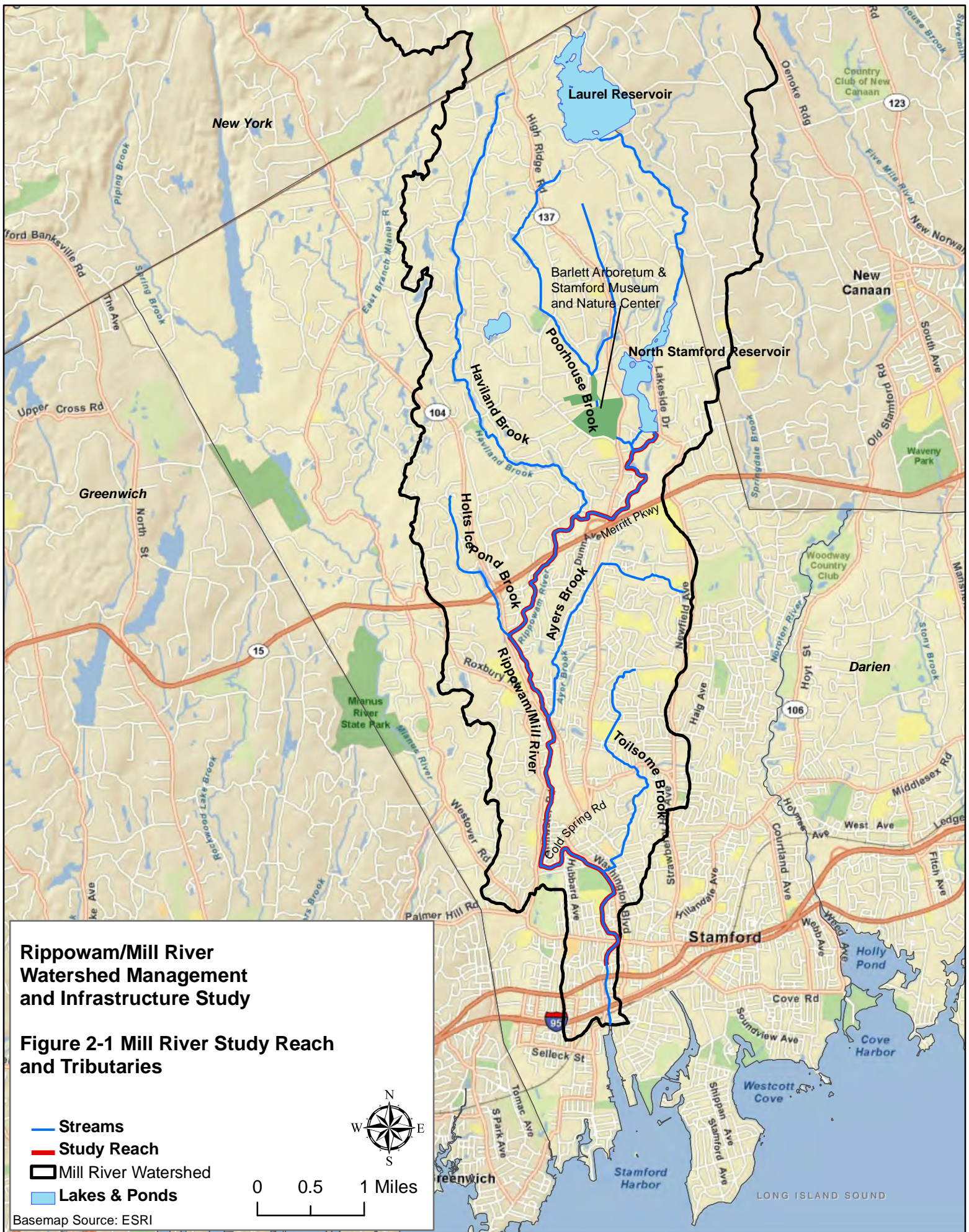
The focus of this study was the mainstem portion of the Mill River and its major tributaries within the City of Stamford, from the New York State line to the mouth of the river in Long Island Sound. The Stamford area of study is defined as the portion of the Mill River corridor downstream of the North Stamford Dam within the City of Stamford corporate limits. The limits of the watershed are shown in Figure 2-1.

For the purpose of this study, the Mill River watershed was divided into three subwatersheds based on tributaries, development, and water flow patterns. The following describes each of these areas, which are delineated in Figure 2-2.

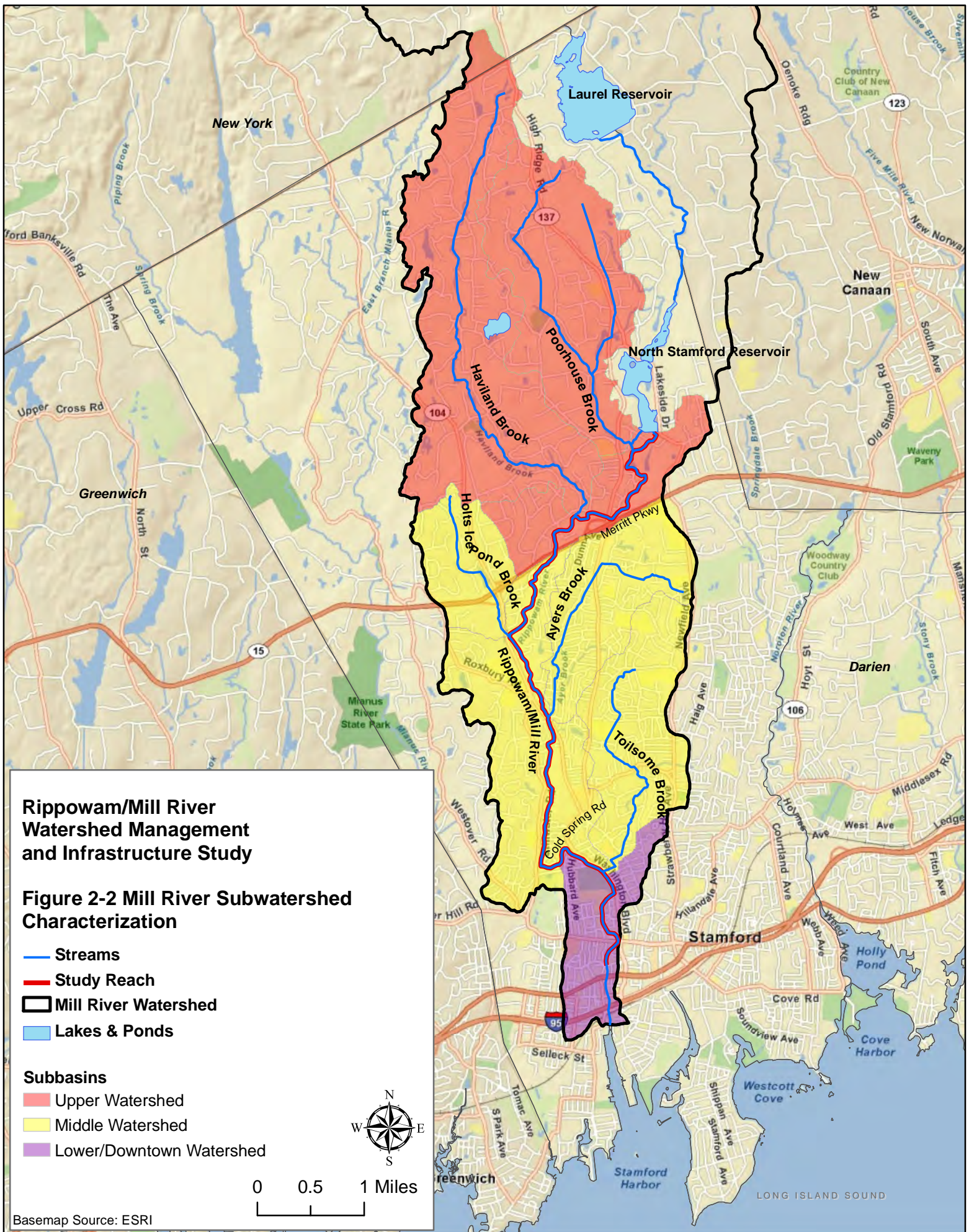
#### **Upper Subwatershed**

North Stamford refers to the section of river from the North Stamford Reservoir, Poorhouse Brook, and Haviland Brook to the Merritt Parkway/Route 15. Some of the land surrounding the North Stamford Reservoir, which is located eight miles upstream of the harbor, is protected under the ownership of Aquarion Water Company. Aquarion Water Company releases water from the North Stamford Dam at a rate of about 4 cubic feet per second. During storm events or periods when the water level is high, water also discharges over the reservoir spillway. Downstream of the reservoir, the Mill River flows through a residential area and remnants of forested land. Residential lawns line the river as it passes under several road crossings and meets with Poorhouse Brook and Haviland Brook. Before entering the











mainstem Mill River, Poorhouse Brook flows through the Bartlett Arboretum Historic Preserve and Stamford Museum and Nature Center, where approximately 200 acres of the watershed is protected from development. Two of the five reservoirs in the Stamford Reservoir system, operated by Aquarion Water Company, are impoundments of the Mill River. The Laurel Reservoir is situated in north Stamford, near the New York state line, on the border with New Canaan, CT. The North Stamford Reservoir is within the borders of the City of Stamford north of the Merritt Parkway, and downstream of the Laurel Reservoir dam.

### **Middle Subwatershed**

The area identified as the Central Watershed includes Holts Ice Pond Brook and Ayers Brook, covering the main stem from the Merritt Parkway to the Cold Spring Road crossing. The land cover in this portion of the watershed is mixed-use, defined by medium density residential neighborhoods and densely developed commercial areas along High Ridge and Long Ridge Roads. Notable in-stream features in this reach of the river are the several low-head dams that impound the mainstem and tributaries. Six of these mainstem dams are reported and mapped, but more have been identified through field reconnaissance as part of this study.

### **Lower Subwatershed**

The area identified as Downtown includes the section of main stem river from Cold Spring Road to Stamford Harbor. The subwatershed becomes increasingly developed south of the Merritt Parkway, where industrial and residential complexes and parking lots abut the river more frequently. At Cold Spring Road, land use abutting the river changes from mostly single-family residences to low-rise apartment complexes. Evidence of invasive species, household debris, and direct stormwater runoff from parking lots and roadways are evident in the lower reaches of the river. Toilsome Brook, an historic tributary that is now culverted and consists mainly of urban runoff, enters the mainstem at Scalzi Park, approximately two miles upstream of Stamford Harbor.

At the onset of this project, the Mill River was impounded by the Main Street Dam in downtown Stamford and lined with vertical concrete walls on both banks. This portion of the watershed is highly urban, with a majority of impervious surfaces contributing runoff directly to the river or to the drainage system that discharges to the river. Within Mill River Park, the largest park in downtown Stamford, the pond is lined on both sides just upstream of the dam.

The Mill Pond was heavily laden with scum, trash, and debris and was home to a large population of water fowl, which contributed to the poor water quality in this section of the river. Stormwater from downtown Stamford entered the river at the Main Street Dam via the Washington Boulevard drain. The US Army Corps of Engineers (USACE) has removed the Main Street Dam and restored the Mill Pond to a more natural stream.

The river becomes tidal approximately 900 feet downstream of the former Main Street Dam. The South arm of the Stamford Harbor has a mean tidal range of 7.2 feet. The watershed for this reach is a combination of residential, industrial, commercial, and city-owned parkland. Several road bridges, including the Interstate 95 Highway and a railroad trestle, span the river downstream of the former Main Street Dam.

### 2.1.2 Hydrology

The United States Geological Survey (USGS) maintains one real-time streamflow gage on the Mill River (gage #1209901) just upstream of the Bridge Street crossing. Data from the USGS gage show high and fast storm peaks, likely due to runoff from development, a limited and ill-defined floodplain, and steep river embankments, all which constrain river flow.

Land cover in more developed areas of the watershed is largely impervious from the multitude of parking lots, roadways, roofs, and sidewalks. This condition limits infiltration of rainfall, increases overland flow, and results in periodic high river flow over short periods of time. This is confirmed by stream gage data which shows peak flow occurring rapidly during rainfall, sometimes before the storm ends. Because of this sudden increase in the volume of water reaching the river, flow and velocity increase significantly. These extreme flows cause unstable embankments, scouring, and localized flooding. During periods of low flow, when rain events are less frequent and conditions increase evaporation, reducing overall flow throughout the river. Such conditions result in reaches and tributaries which are impassable to aquatic life and recreational activities, decreased water quality, and degraded habitat.

#### Climate/Precipitation

Stamford shares the diverse climate of southwestern New England. According to the Connecticut State Climate Center (CSCC), the state's climate can be summarized as follows: equal distribution of precipitation among the four seasons; large ranges of temperature both daily and annually; great differences in weather for the same season over different years; and considerable diversity of weather over a short period of time.

The CSCC collects climate data at several stations across the state, one of which is located in Stamford. The average monthly temperature ranges from 29°F in January to 74°F in July. The range of average minimum and average maximum temperatures for January and July are 19-38°F and 62-85°F, respectively.

Precipitation data are uniformly distributed throughout the year, ranging between 3.5 inches and 5 inches for any given monthly average. Snow falls primarily from December to March, with less than one inch recorded on average for the months of November and April. The annual average precipitation in Stamford has been recorded as 47.5-inches.

#### Surface Water Resources

According to Aquarion Water Company's 2007 Water Quality Report for the Stamford system, six reservoirs and two well fields supply approximately 99% of the 14.4 million gallons per day demand for the 97,000 people in the system. These six reservoirs include Laurel, North Stamford, Mill, Trinity, Hemlocks, and Siscowit. Because less than 20% of the five-reservoir system watershed is protected land, Aquarion regularly inspects potential pollutant sources including homes, businesses, farms, and other border properties in addition to participating in the new land development project review to ensure minimal impact to water quality.

The Connecticut Department of Public Health conducted a source water assessment of the Stamford Reservoir System in 2003. The strengths of the system are that point source pollution discharges are not present in the watershed and that the public water system has a comprehensive source protection program. The potential risk factors include the fact that diffuse or non-point contaminant sources are present in the watershed (road salt, herbicides, hazardous material spills), less than 20% of the watershed

area is owned by the public water system, and local regulations or zoning initiatives for the protection of public drinking water sources do not exist.

There are two major reservoirs within the upper portion of the study area. The Laurel Reservoir is 282 feet above mean sea level (ft-msl) and the North Stamford Reservoir is 194 ft-msl, both of which are impoundments of the Mill River. These reservoirs are managed and operated by Aquarion Water Company for water supply. As a result, the study focused on the portion of the Mill River corridor downstream of the North Stamford Reservoir within Stamford city limits.

Four major tributaries are located within the study area downstream of the North Stamford Dam: Poorhouse Brook, Haviland Brook, Holts Ice Pond Brook, and Ayers Brook. Two other major tributary flows are culverted discharges to the river: Toilsome Brook culverts near Scalzi Park and the Washington Boulevard drain that empties into the Mill River. Water quality samples were collected at the mouths of these key tributaries and at nearby stormwater outfalls to assess their affect on the Mill River.

### **Groundwater Resources**

The Mill River basin is underlain with crystalline rock and stratified drift aquifers. One aquifer protection area lies within the watershed boundaries in Stamford, just north of the Merritt Parkway near the intersection of Haviland Brook and the Mill River mainstem. The aquifer protection area within the Mill River watershed covers approximately 240 acres, or 1% of the total watershed area. The presence of stratified drift aquifers indicates the potential for significant groundwater-surface water interaction and the possibility of surface water contamination from failing septic systems and other groundwater pollution.

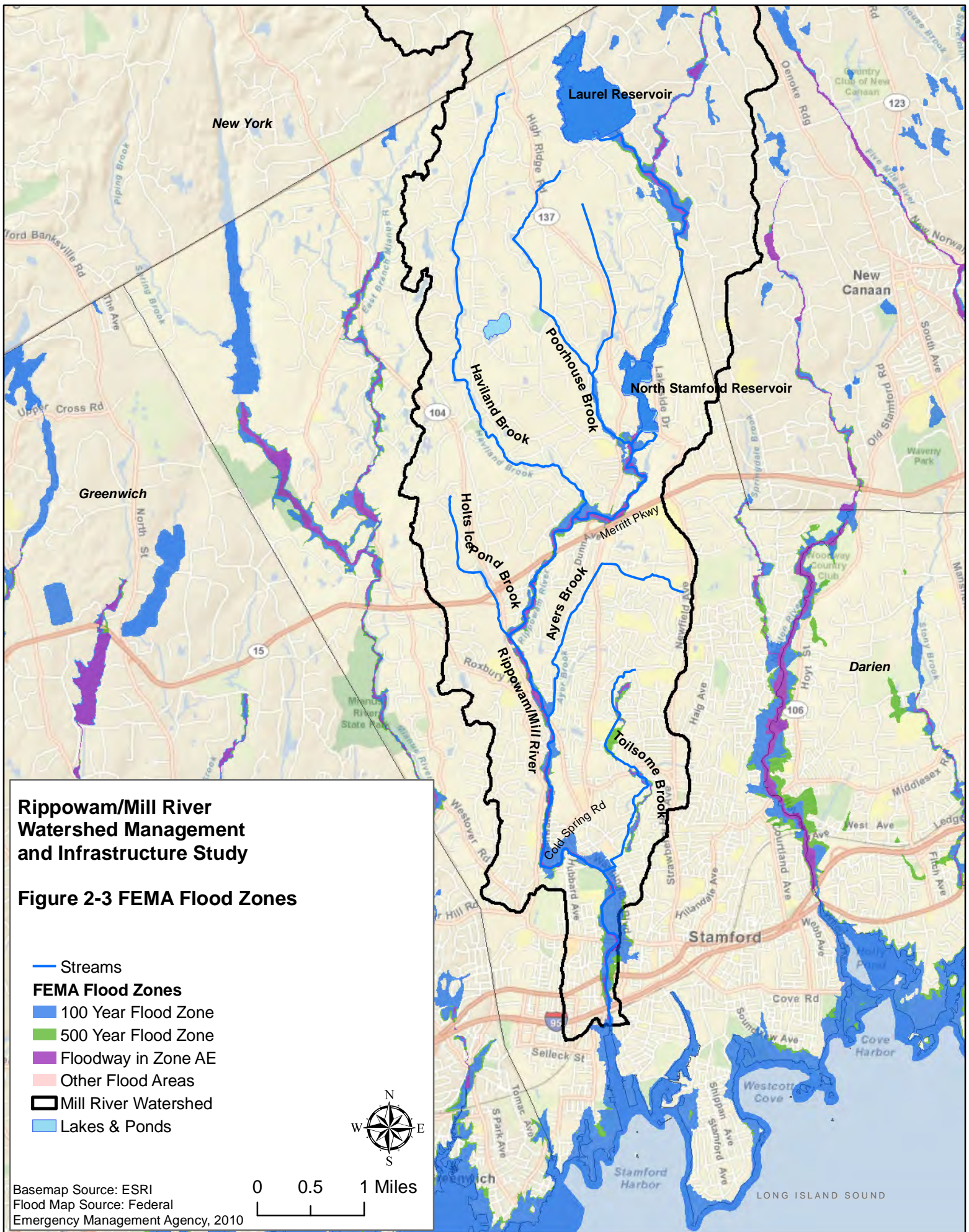
### **Flood Plains**

According to the USACE, flooding occurs along the low-lying areas of the Mill River within the floodplains. Properties immediately adjacent throughout the length of the river are within local floodplains and are at risk of flooding. However, the lower portion of the river which borders Washington Boulevard is particularly flat, with a wide, shallow channel consistent with floodplain characteristics. The published FEMA floodplain for the Mill River in Stamford is shown in Figure 2-3. The FEMA map was published prior to the dam removal in the downtown area, and does not reflect any improvements to flooding as a result of the removal.

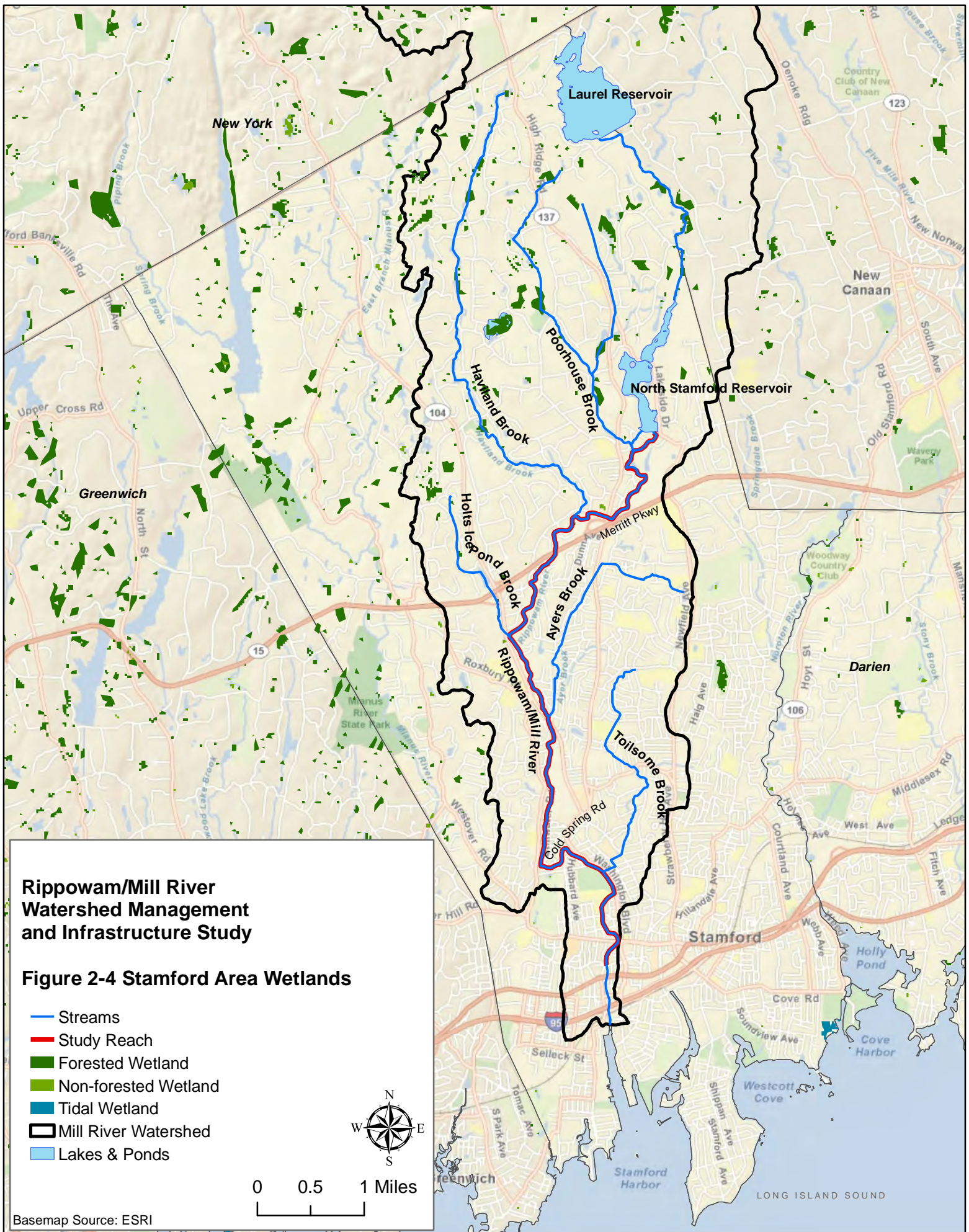
The majority of the main stem of the Mill River is within a 100- or 500-year flood zone. The 100- and 500-year floods have a 1 percent and 0.2 percent chance, respectively, of occurring on an annual basis. Other water bodies within the City are within the FEMA-designated AE Zone, which is generally delineated by the flood level resulting from storm surge flooding during a 100-year flood. Residents who live inside of the zone's boundaries are required by the federal government to purchase flood insurance and are subject to inundation during a 100-year flood.

In general, the floodplains remain somewhat undeveloped along or within private and publicly-owned land due to the potential flood hazard associated with building in sensitive areas. Minor development may include mowed lawns, greenways, parks, and other forms of undeveloped open space. According to the City, approximately 4,800 properties in Stamford are within flood hazard areas. The remainder of the floodplain consists of marshes, wetlands, and other sensitive water resources that buffer the river and absorb overflow during heavy seasonal rains. These areas are highlighted in Figure 2-4.









## Navigation Channels, Ports, and Harbors

The Mill River is generally not a navigable waterway as much of the stream is too shallow for watercraft to pass through. There are a few areas, however, where small recreational craft such as canoes or kayaks could be used, if access were provided at a private launch site.

Originating at the border of New York State, the river travels more than 5 miles before becoming tidal and emptying into the Stamford Harbor in Long Island Sound. The end of the river meets a small channel at the Stamford Landing Marina, which is lined with docks with small private watercraft, as well as various industrial and commercial businesses, roadways, housing developments, and single family homes. Several small islands exist within the Stamford Harbor, including Grass Island and Jack Island.

## Structures

Dams have been a part of the history of the Mill River since 1708. Currently, there are eight dams located along the Mill River between the North Stamford Reservoir and Stamford Harbor. Three of those dams allow fish passage. Six of the dams are located between approximately five and six miles upstream of the river mouth. From the mouth of the river, the dams are located on Long Ridge Road, two on Arden Lane, Maltbie Avenue, Hunting Lane, Merritt Parkway, and at the North Stamford Reservoir.

In 2010, the dam formerly located on Main Street was completely removed, allowing the river to flow unconstrained through the greenway in downtown Stamford. Construction continues to improve the buffer area surrounding that segment of the river.

In addition to dams, storm drains also affect the natural processes of the river. Historically, storm drains have directed stormwater runoff from urban areas within Stamford to empty into the Mill River. As a result, water quality is degraded and foreign sediment is introduced to the riverbed, affecting plant growth and slowing biodegradation of organic material.

The main stem of the Mill River is punctuated frequently by bridges and culverts, especially in the downtown area. These river crossings can restrict flow at high flows and cause debris to build up behind the structures, possibly contributing to localized street flooding and degraded in-stream habitats. From south to north, the following roads and streets rest across the study reach of the Mill River:

- Pulaski Street
- Railroad Tracks for Stamford Station
- McCullough Street
- Connecticut Turnpike (I-95)
- Richmond Hill Avenue
- Tresser Boulevard
- Main Street
- Broad Street
- North Street
- Bridge Street
- Cold Spring Road
- Long Ridge Road
- Buckingham Drive
- Barnes Road
- Cedar Heights Road
- Merritt Parkway (Rte 15)
- Studio Road
- High Ridge Road

### 2.1.3 Wildlife

The diversity of wildlife generally correlates with the development and vegetation patterns along the river. Mammals such as white tail deer, woodchuck, beaver, coyote, muskrat, red fox, cottontail rabbit, and striped skunk can be found in areas suitable for spacious and generally wooded or less developed



habitats. Grey squirrel is found throughout the river length. Reptiles and amphibians found within the river include 22 varieties of salamander, toad, snake, turtle, and frog.

There are 31 nesting bird species found in the greater Stamford area. The river is heavily populated with waterfowl, including Canada geese, mallard ducks, black ducks, and mute swans. Water fowl in such dense populations can pose a threat to water quality as stormwater runoff collects animal waste, contributing to high bacteria levels in receiving ponds and streams.

Several areas in the southern Mill River watershed have been identified on separate occasions as being congregation spots for waterfowl. Within Scalzi Park, waterfowl congregate in the river and floodplain just north of the Broad Street crossing and in the river and floodplain between the Toilsome Brook confluence and the Cloonan Middle School. Waterfowl were also observed at Bendels Pond at the Stamford Museum and Nature Center. Regular feeding of ducks and other water fowl has been reported near Buckingham Drive in the area that borders Mill River.

There are no federal or state listed protected or endangered species in the project area.

## 2.2 Land Use and Land Cover

Land use within the Mill River watershed study area is generally urban and suburban, resulting in high wet-weather flows and impaired water quality during dry- and wet-weather conditions. From north to south, the watershed transitions from primarily forested 1-2 acre lots and detached single-family dwellings in North Stamford to a more developed, urban landscape as the river flows toward downtown Stamford and the Stamford Harbor.

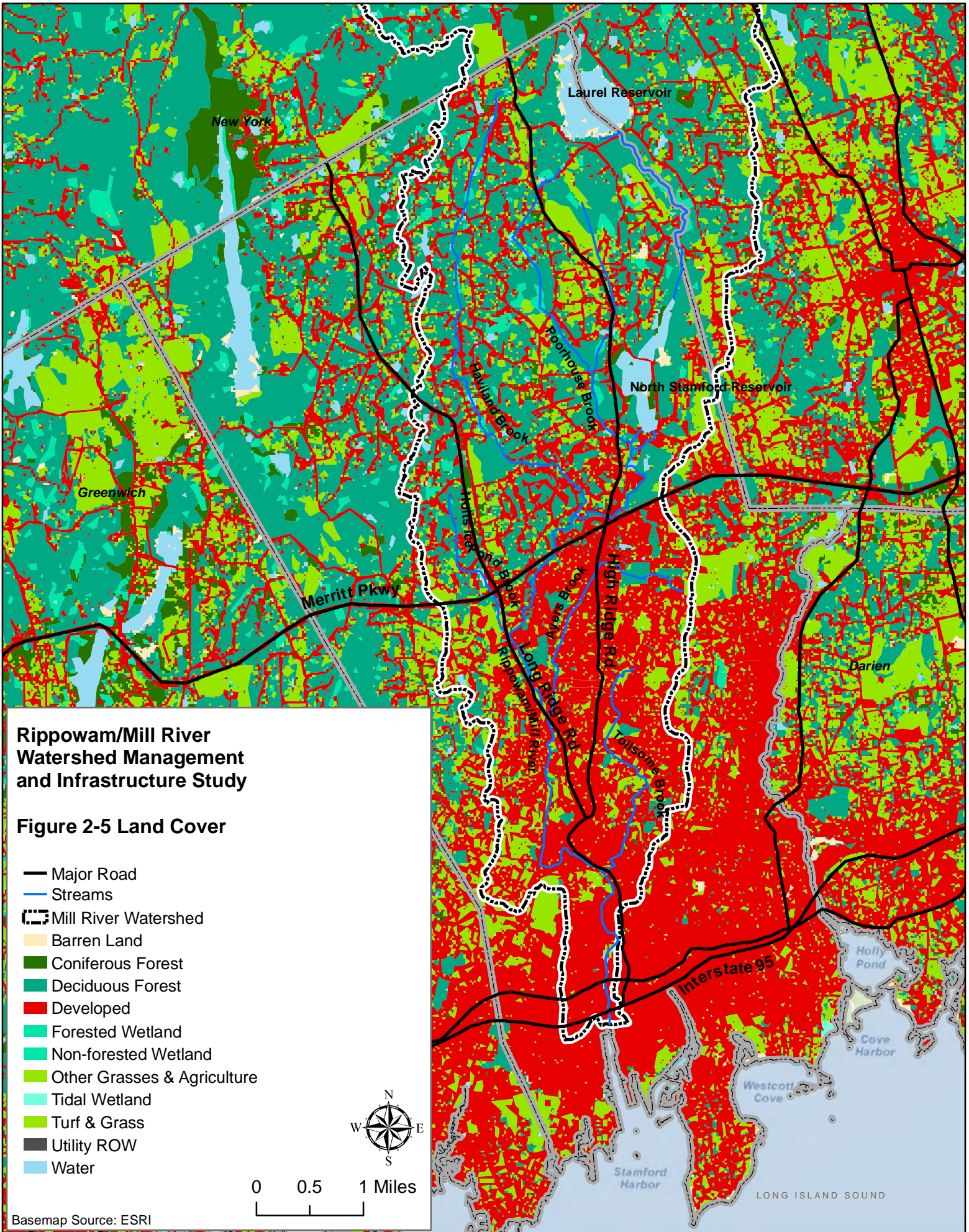
Land use within the watershed north of the Merritt Parkway is primarily low to medium density suburban. Most of the homes in the watershed north of the Merritt Parkway have onsite wastewater disposal (septic systems). In contrast, the land use south of the Merritt Parkway is densely suburban and urban, with the most highly urban and industrialized areas located near downtown Stamford. Merritt Parkway is the general separating line between onsite wastewater disposal and sanitary sewers. Many tributaries of the Mill River south of the Merritt Parkway are contained in culverts and function primarily for stormwater drainage. Downstream of the North Stamford Reservoir, watershed characteristics change significantly. Data for individual subbasins within the Mill River watershed, including varying land cover statistics, are shown in Figure 2-5. Land cover is evenly split between forested land and highly developed areas, with the forested land concentrated in the upper watershed and becoming increasingly more developed in the lower watershed.

### 2.2.1 Current Land Use

The following describes current land use in the City of Stamford used in the development of this Plan. Land use designations include open space, developed areas, and the portions of land which are designated wetlands, forest, and recreational areas.

#### Open Space

Apart from managed public space, including parks and recreational areas discussed below under recreation, there is no designated open space along the Mill River.



## Wetlands

The Connecticut Department of Energy and Environmental Protection (CT DEEP) defines wetlands strictly by soil type. Wetlands include any land or submerged land, such as a swamp, marsh, or bog, which consists of soil types designated as poorly drained, very poorly drained, alluvial, or floodplain by the National Cooperative Soils Survey of the Natural Resources Conservation Service (NRCS) of the US Department of Agriculture (USDA). Wetlands naturally prevent flooding by absorbing excess water and providing an opportunity for ponding during seasonal variations and periods of excess rain. Wetlands also provide habitat for rare and protected species, provide nesting locations for waterfowl, and impede movement of potential pollutants commonly found in stormwater.

Over time, residential and commercial development has encroached into the riparian zone, resulting in extensive loss of floodplain forests along the river. Some small pockets of wetlands can still be found along the less developed banks of the middle portion of the river. Observed wetlands were found in relatively good condition, with the exception of several locations that contained predominantly invasive exotic species. Japanese knotweed (*Polygonum cuspidatum*) and oriental bittersweet (*Celastrus orbiculatus*) are the most widespread invasive species along the river.

No wetlands were found along the lower portion of the river. This is likely due to the high-density residential and commercial development throughout these downstream reaches.

## Forested Areas

The origin of the river, in the upper portion of the watershed outside of the study area, is primarily wooded with limited development and mostly natural landscape. The middle to upper portion of the river includes wooded patches and some natural landscape bordered by landscaped areas and well-spaced housing. Farther downstream, the number of trees decreases as the river passes through more populated suburban areas. In downtown Stamford, forested areas give way to the abutting commercial and industrial portions of the city.

## Fisheries

Upstream of the recently removed Mill Pond and Main Street Dam, the river is primarily a warm water fishery, supporting shiners, dace, and bass. CT DEEP annually stocks this portion of the river with trout and alewife. Downstream of the Mill Pond, the river supports alewife, blueback herring, and white perch. Prior to the dam removal when the field investigations took place, the dam inhibited upstream fish migration for spawning.

## Recreation

Along the Mill River corridor, there are several recreational resources, including Scalzi Park, Stamford Museum and Nature Center, and the Bartlett Arboretum. Within the study area, Scalzi Park is the largest recreational facility currently situated in the Mill River corridor, located near the Bridge Street crossing on the west bank of the river. This multi-use public park, equipped with night lighting, accommodates baseball, Little League, softball, soccer, basketball, tennis, a playground, bocce courts, a fitness course, and roller hockey rinks.

The site of the former Mill Pond in downtown Stamford is surrounded by a public park which is undergoing revitalization as part of the dam removal. There is a riverside walking/biking/running trail that runs along the banks of the river intermittently between this area and Scalzi Park. The City of

Stamford recently completed a new playground facility in the downtown area along the river downstream of the former dam.

### Developed Areas

The upper third of the Mill River is primarily in low-density wooded areas, where development is spaced enough to make room for natural landscape to border between properties. The middle portion of the river abuts mid-density residential areas with varying levels of development and mostly well-sized residential lots, trees, and increasing landscaped areas. The lower third of the river passes through higher density development, including downtown Stamford, where it meets the improved greenway and several parks, followed by high-density development through the commercial and industrial districts, before terminating in Long Island Sound.

### Transportation

Stamford is primarily suburban, with heavily wooded areas throughout the northern portion of the watershed. Roadways are somewhat rural, with narrow lanes and limited buffers on each side. The few crossways that pass over the river are short span bridges (less than 20-feet in length) on residential, limited traffic roadways. Within the more urbanized areas, particularly downtown Stamford, roads are heavily traveled, particularly on and around the access ramps to Interstate 95, near commuter parking areas, and within the downtown shopping and restaurant areas in the City.

The City Highways Division maintains over 315 miles of roadway, according to the City of Stamford website, and as such it is the largest municipal road system in the State. Roadway maintenance includes rehabilitation projects, storm drain maintenance, snow plowing, and leaf pickup. The Highways Division also coordinates city-wide leaf pickup in recyclable paper leaf bags on designated pick-up times and allows residents to bring bagged leaves to two recycling centers. Brush, grass clippings, and bulk yard waste is not part of the collection program.

### 2.2.2 Desired Use

The City of Stamford intends to transform the downtown area which abuts the Mill River into a continuous greenway and outdoor recreation area. Since 2001, the City has been working with a variety of organizations, including the USACE, environmental groups, citizen action groups, and private consultants, to improve water quality in the river through a comprehensive watershed improvement plan. In the years to follow, the goal is for the water quality in the lower portion of the Mill River to improve, allowing for more opportunity for leisure and recreational activities to take place.

The Stamford Museum and Nature Center and the Bartlett Arboretum are located in North Stamford, near the confluence of Poorhouse Brook and the mainstem of the Mill River. A major increase of recreational parks and facilities is planned as part of the Mill River Park and Greenway Master Plan, published by the City of Stamford in July 2007. After the complete removal of the former Main Street Dam, the city plans to redevelop the downtown river corridor with a state-of-the-art natural, cultural, and recreational park facility. The Master Plan states:

*“The recreational program elements are found throughout the park and help bring activity to different park areas at different times of the year. With an ice skating rink, dynamic fountains, a basketball court, fishing piers/overlooks and an extensive recreational path, the Mill River Park and Greenway Project offers abundant recreational experiences”.*



## Section 3 – Watershed Conditions

Watershed health can be measured through physical observation, biological assessment, and water quality sampling. Water quality sampling results offer a measureable indication of underlying pollutant sources that may not be recognizable or fully understood by physical observation or biological assessment alone. Water quality testing is a directly comparable way to assess the condition of a water body, and its individual reaches, to prioritize impaired waters or segments.

Water quality is affected by conditions at the time of assessment. The season, stream flow, and recent rain events can all influence chemical levels at the time of sampling, making it important to sample multiple times. Water quality monitoring included four full dry-weather sampling rounds and two rounds of wet weather sampling. Sampling locations included sites located on the mainstem Mill River, between the New York State line and the Interstate-95 crossing and the six major tributaries to the mainstem.

The Mill River downstream of the North Stamford Dam is designated as Class B/A by the State of Connecticut. The Connecticut Department of Energy and Environmental Protection (CT DEEP) defines this class of surface water designation as “may not be meeting [Class A] criteria or one or more designated uses.” Class A designated uses are defined as: habitat for fish and other aquatic wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture. The Mill River has been listed as an impaired water body by CT DEEP for inadequate fish passage and for inadequate life support.

**Table 3-1 2010 Impaired Waters List, CT DEEP**

ID/Name	Location	Miles	Aquatic Life	Recreation	Fish Consumption
CT7404-00_01 Mill River (New Canaan/Stamford)-01	Mouth of Rippowam River, near Ponus Ridge crossing of Rippowam River, US to Laurel Reservoir Dam, just US of Reservoir Lane crossing, along New Canaan/Stamford town line.	0.74	U	U	FULL*
CT7405-00_01 Rippowam River-01	From Rippowam River West Branch dam (head of tide, US of Route 1 and Main Street crossings), US to Merritt Parkway (Route 15) crossing (midway between exit 34 and exit 35), Stamford.	5.22	NOT	U	FULL*
CT7405-00_02 Rippowam River-02	From Merritt Parkway (Route 15) crossing (midway between exit 34 and exit 35), US to North Stamford Reservoir dam outlet (US of Interlaken Road crossing.)	2.09	NOT	U	FULL*
CT7405-00_02 Rippowam River-02	From Merritt Parkway (Route 15) crossing (midway between exit 34 and exit 35), US to North Stamford Reservoir dam outlet (US of Interlaken Road crossing), Stamford.	2.09	NOT	U	FULL*

**Note:** FULL=Designated use supported; NOT=Designated use Not Supported; see 303(d) listing for details. U=Unassessed, data not sufficient for assessment.

Every two years the State of Connecticut studies water quality to identify waters where water quality is not sufficient to meet standards. In 2002, the Mill River was added to the “Impaired Waters List” by the CT DEEP under Section 303(d) of the Federal Clean Water Act. In 2010, the Mill River was designated as “use not supported” for aquatic life. Table 3-1 summarizes the CT DEEP Impaired Waters List for the Mill River.

The majority of the Mill River is non-supportive of aquatic life. Fish consumption is acceptable with the exception of saltwater species of blue crab, bluefish over 13-inches, striped bass, and weakfish, according to the CT DEEP Angler’s Guide for 2011.

## 3.1 Water Quality Standards

Water quality standards have three elements: 1.) designated uses assigned to waters (e.g., swimming, the protection and propagation of aquatic life, drinking); 2.) criteria or thresholds that protect aquatic life and humans from exposure to levels of pollution that may cause adverse effects; and 3.) anti-degradation policy intended to prevent waters from deteriorating from their current condition. Since the Mill River is listed as an “impaired waterbody” under Section 303(d) of the Federal Clean Water Act, which identifies the need to improve water quality based on the use of the area. The following summarizes the water quality standards used for the Mill River.

### 3.1.1 Desired Use

The purpose of this comprehensive assessment is to determine watershed management best practices that would allow the river to be used for recreational purposes. Thus, Connecticut State water quality Standards will be used as a basis for comparison in the following discussion of water quality.

### 3.1.2 Numeric and Narrative Criteria

The Mill River is rated Class B/A by the State of Connecticut. This means that it must meet criteria suitable for fish and wildlife, recreation, agriculture, and industrial water supply. Dissolved oxygen (DO) should not be less than 5 mg/l. Total fecal coliform should average less than 100 colonies per 100ml over a 30-day period; the geometric mean of *Escherichia coli* (*E. coli*) must be less than 126 colonies per 100 ml. For recreational uses, taste and color must be of natural origin. Turbidity should not exceed 5NTU and no presence of suspended or settleable solids.

The data for bacteria are compared with the criteria for three designated use classifications: designated swimming, non-designated swimming, and all other recreational uses. The freshwater bacteria standard for Connecticut is based on the concentration, in cfu/100 ml, of *E. coli* bacteria. The most stringent one-time, grab sample concentration is designated swimming, at 235 cfu/ 100 ml.

Based on the Connecticut water quality Standards and B/A classification for the Mill River, the following parameters were including in the sampling:

- Bacteria
- Dissolved Oxygen
- Chlorophyll-a
- Particulate carbon and nitrogen
- Total phosphorus
- Nutrients
- Soluble Total Kjeldahl Nitrogen (TKN) and orthophosphates
- Metals and hardness
- Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
- Solids and alkalinity
- Copper and Zinc
- Pesticides
- Polychlorinated Biphenyls (PCBs)



### 3.1.3 Antidegradation Policies

According to the CT DEEP Water Quality Report 2010, the Mill River is a category 5 waterbody, meaning that “available data indicate at least one designated use is not being supported and a total maximum daily load (TMDL) is needed.” The rating system assigns water bodies using a five-category approach from the US Environmental Protection Agency (USEPA). Water bodies that do not meet state water quality standards are assigned into either a 4a-c or 5 category. A TMDL has not been established for this watershed. Under 305(b), ongoing assessment of the state of water bodies may allow for re-classification. For instance, if pollution control requirements are found to be more beneficial in overall reduction of contaminants, or if these control measures will allow the waterbody to meet applicable standards, the waterway may be reclassified.

## 3.2 Water Quality Monitoring Data

Water quality data on the Mill River was collected over the course of a multi-year field program which assessed water quality during seasonal, wet weather, and dry weather conditions. These efforts provided a range of values for varying conditions. The complete presentation and analysis of the data are included in the Comprehensive Characterization Report (CDM, 2011).

### 3.2.1 Previous Sampling Programs

Several small scale water quality sampling programs have been conducted in the Mill River over the past 20 years:

- The US Geological Survey (USGS) website for the gage at Bridge Street contains results of water quality data collected in the fall of 1994. The one time sampling event yielded data on a variety of metals, organic and non-organic compounds.
- CT DEEP collected similar data from the same location three times – twice in the summer of 1998 and once in the fall of 2000. Bacteria counts were also included in this sampling effort.
- As part of a program called Project SEARCH, a local high school collected water quality samples a few times per year from 1995 to 2002. These data include bacteria counts, basic nitrogen and phosphorus data, and other standard measurements.
- The US Army Corps of Engineers (USACE) collected sediment quality data from within the Mill Pond as part of the Mill River and Mill Pond Restoration Environmental Assessment. These data include metals, hydrocarbons, phenols, semi-volatile organic compounds, and polychlorinated biphenyls (PCBs) analyses. Sample analysis revealed trace metal concentrations below all applicable standards and the presence of few semi-volatile compounds. This analysis concluded that the concentrations observed were within typical ranges for urban stormwater catchments. A portion of the sediment exceeded state standards and required special handling and disposal in a designated landfill site.

### 3.2.2 Comprehensive Sampling Program

A comprehensive water quality sampling program was conducted from 2008 through 2010 to assess river water quality during a variety of conditions in order to characterize the general water quality of the stream system and identify target areas of concern. Water was sampled during various seasons and during dry and wet weather conditions.

### Dry Weather Sampling

Dry weather water quality sampling was performed to gain an understanding of baseline conditions in the mainstem Mill River and all major tributaries during periods of dry weather flow. Dry weather water quality data collection provides an understanding of the problems and opportunities in the river and watershed as well as a basis for identification of cost effective solutions.

One full dry weather survey was performed during each season over the course of one year. In addition to the four full dry weather surveys, two partial dry weather surveys were performed for added overall understanding of the dissolved oxygen dynamics within the system during the algae growing season. The water quality surveys, in conjunction with streamflow data, were used in water quality model development and ultimately in the formulation of the basin management plan to improve the water quality and flows in the river.

### Wet Weather Sampling

Wet weather water quality sampling was performed to gain an understanding of pollutant loadings in the mainstem Mill River and all major tributaries during rain events. Data collected from wet weather sampling events were used to develop a watershed loading model, which was used to evaluate alternatives for river and watershed improvements.

Two wet weather sampling events were conducted; one in the spring and one in the fall of 2009. Weather was tracked to predict storms of sufficient precipitation volume and coverage over the watershed. Storms of at least 0.5-inches of precipitation over the entire watershed were the conditions targeted for wet weather sampling. In order to isolate the conditions in the river to represent only the targeted storm event, each wet weather sampling event was targeted to follow a 72-hour period of rainfall not exceeding 0.1-inches over the watershed, or a period where flow in the river was approaching baseflow conditions.

Wet weather sampling consisted of four distinct rounds of sample collection during each of the wet weather events, corresponding to different stages of the storm flow hydrograph. Pre-event (PE) samples established a baseline for the water quality before runoff entered the stream. Rising limb (RI) samples captured the first flush of runoff. Near peak (NP) samples captured the concentrations during the time of highest flow during the storm. Receding limb (RC) samples were collected to correlate hydrograph recession with runoff pollutant levels.

### 3.2.3 Summary of Findings

Based on the sampling results the following pollutants of concern have been identified for the Mill River: bacteria, nutrients, and metals. Dissolved oxygen (DO) levels are low in select locations, as explained below. Sediment quality will be of concern if sediment resuspension occurs, as a result of dam removal, stream morphology alterations (managed or unmanaged). A complete analysis of the water quality and sediment quality findings from the field monitoring program can be found in the 2011 Comprehensive Characterization Report (CDM).

#### *Bacteria*

The state standards for bacteria in fresh surface waters are 235 cfu/100 ml for designated swimming and 410 cfu/100ml for non-designated swimming (single samples). Trends during dry weather suggest Poorhouse Brook, the main stem Mill River from Wire Mill Road to just south of the Merritt Parkway, Ayers Brook, Toilsome Brook, and downstream of Cold Spring Road have high levels of bacteria (generally *E. coli* > 1,000 cfu/100 ml). Tributaries had the highest bacteria levels during storm events, and the counts in the tributaries were typically greater than at the main stem stations upstream and downstream of the

confluence. 38 samples collected during wet weather had bacteria levels greater than 100,000 cfu/100 ml, 28 of which were collected from tributaries or main stem stations likely directly influenced from tributary storm flow. In general, the bacteria counts spiked during the near peak hydrograph levels. Bacteria levels in the river exceed state water quality swimming standards at 31% of stations during dry weather and at 77% of the stations during wet weather sampling.

#### *Nutrients*

Primary algal production in the river is limited by phosphorus concentrations and light availability. This is generally the case in northeast freshwater streams. Nitrogen is the more abundant nutrient, from an algae growth perspective, and thus limiting phosphorus will limit algal growth. In general, ambient levels of phosphorus in the river are moderately elevated (25-50 ug/l), and are sufficient to support the pervasive bed-attached algae, but are not sufficient to elevate floating algae concentrations in most locations. This is likely due to short residence times of the water flowing through the stream system (there is not enough time for algae to grow). High phosphorus concentrations observed during wet weather sampling were likely due to stormwater runoff, or due to the potential presence of sewage flows in Ayers Brook (by way of failing septics, leaking collection systems, or illicit connections).

Concentrations of nitrogen in the tributaries were greater than in the main stem during dry weather sampling events. High levels of nitrogen in Toilsome Brook and Ayers Brook, along with high bacteria counts at these locations, signify the likely presence of wastewater. Floating algae levels throughout the river were not generally high, with the exception of releases from the reservoir and some of the small tributary ponds.

#### *Dissolved Oxygen*

Adequate DO in the stream is necessary for aquatic life, but during the warm weather, DO levels tend to range from saturated to supersaturated, indicating elevated nutrients and enhanced productivity of algae. Algal growth is supported by nutrients; algal decay consumes dissolved oxygen in the water. During the summer months, DO levels tend to be slightly under-saturated throughout the system, which means that oxygen consumption by organic material is outpacing reaeration and photosynthesis. The lowest DO levels were observed in the discharge from the North Stamford Reservoir low flow outlet. The low flow outlet releases from the lower levels of the reservoir, where DO is depleted. Adequate DO in the stream is necessary for aquatic life.

Low DO concentrations are not widespread. The mainstem river and tributaries are generally in compliance with the CT DEEP state standard of 5.0 mg/l. Of the total readings taken over the course of the monitoring program, 96% were above the state standard of 5.0 mg/l and 83% were above 7.0 mg/l. Low DO (1-3 mg/l) was observed in the discharge from the North Stamford Reservoir low flow outlet during the two sampling events when the reservoir would have been stratified (summer). These low values occur because the low flow release water is taken from a mid-depth of the stratified reservoir, where DO and temperature are low. Other low DO concentrations were observed downstream of tributary ponds, where excess algal growth may be consuming oxygen.

#### *Metals*

Metals in freshwater can be toxic to fish and other aquatic life. Metals also bioaccumulate in the food chain, resulting in levels in fish that can be toxic to humans. Copper, lead, and zinc exceeded state water quality standards in several samples. Copper exceedances occurred during dry and wet weather sampling; lead concentrations were elevated during storm events; and zinc concentrations exceeded standards at

the more urbanized tributary locations during wet weather conditions (Ayers Brook, Toilsome Brook, and the downtown storm drain).

#### *Sediment Quality Results*

Sediment samples from the streambed measure larger particulates which have been introduced to the stream, but may have settled or been transported downstream. Sediment analysis data collected during spring and fall 2009 indicated a minor presence of the pesticides chlordane and lindane, at separate locations. The compounds were detected, but not in exceedance of standards. Metals were detected at levels greater than previously detected during the USACE investigation at the former Mill Pond. This suggests that metals deposition in the stream has not been limited to the previously dammed area downtown, and that resuspension of metals throughout is a possibility with stream channel disruptions (intentional or incidental).

## 3.3 Geomorphological Assessment

A geomorphological assessment studied features of the Mill River in order to better understand the form and physical processes within the river system. Such a study uncovers a deeper understanding of the river and its natural processes, and allows planning, nearby operations, and maintenance of the river system to be more informed. Ultimately, depending on the goal of the overall program, understanding the alluvial geomorphology allows restoration efforts to be more sustainable and long-lasting by working with the system and preventing further degradation.

### 3.3.1 Physical Stream Characterization

Physical stream conditions are often an indication of the biological health of a water system. In the case of the Mill River, a physical stream characterization and geomorphological study was necessary to better understand physical habitat for periphyton and benthic macroinvertebrates. Physical stream characterization was conducted as part of the full assessment of biological data within the river system. These data are a strong indication of water quality and physical health of the river. According to the USEPA, there are seven physical characteristics of a river which affect ecological resources:

- Channel Dimensions
- Channel Gradient
- Channel Substrate Size and Type
- Habitat Complexity and Cover
- Anthropogenic Alterations
- Channel-Riparian Interaction
- Riparian Vegetation Cover and Structure

The following summarizes the seven characteristics:

#### **Channel Dimensions**

Depositional features within the channel, including mid-channel, point, lateral and delta bars, are present in nearly all reaches and are clear indicators of a river out of equilibrium. These features are not extensive throughout all reaches. In general, the Mill River exhibits low to moderate sinuosity (channel

length/curve valley length) with ratings between approximately 1.0 and 1.25. Sinuosity for the entire valley is 1.10. Historic USGS Quadrangles indicate that overall, sinuosity has not changed dramatically during the past 100 years or more, likely due to early anthropogenic modification and stabilization of the banks and adjacent buffers. In many locations, the river makes tight meander bends that, though present for at least the last 100+ years, would probably not be naturally stable over the long term. Examples of such meander bends are just below the Cold Spring Road crossing, and near the Holts Ice Pond Brook confluence.

### **Channel Gradient**

The main stem study area is unconfined to semi-confined with gentle to moderate slopes. The steepest slopes and most confined reaches tend to occur in the upstream reaches. However, the river exhibits a generally consistent gradient throughout the study area until the Scalzi Park area, where slopes are at or near 0%. These slopes are consistent with a head-cutting stream where incision is occurring near the source and deposition at the bottom. The incision and deposition indicates the stream flow and gradient are not in equilibrium.

### **Channel Substrate Size and Type**

The surficial geology of the watershed below the North Stamford Reservoir is primarily glacial till and glacio-fluvial deposits, with lesser amounts of alluvial sediments. Broadly, soils throughout the study site are characterized by udorthents and urban land soils (artificially placed fill) throughout the lower reaches of the study area and well-drained soils throughout the middle and upper reaches of the study area. Most naturally placed soils occurring within the Mill River watershed are characterized as well-drained with deep seasonally high water tables (more than 80 inches below ground surface) and low potential for flooding. Because of the sandy, loamy nature of these soils, they are also moderately to highly erodible. Pebble counts showed that, in general, the percent of sand and fine gravel decreased downstream while the percent boulders increases. A healthy habitat generally has an even distribution of various size substrate.

### **Habitat Complexity and Cover**

Generally the habitat is better in the upstream reaches. The following summarizes the various habitats in the Mill River corridor:

- In the downtown-area reaches between Long Island Sound and Scalzi Park, instream physical habitat was rated “relatively poor” to “very poor”.
- The low- to mid- reaches show slight improvement over the downstream-most reaches, and are generally characterized as “suboptimal” or “marginal.”
- Upstream reaches are generally desirable habitat for macroinvertebrate and fish species. Banks in this reach are generally stable with the highest habitat quality at just below the North Stamford Reservoir. At least three of four velocity and depth regimes were present in each reach, enriching the habitat and making it more valuable for aquatic organisms.
- The habitat value of uppermost reach was reduced by elimination of the riparian zone along both banks of the river for commercial use by a gardening center for ornamental plant storage.

A more detailed description of the various habitats along the river corridor is provided in the 2011 Characterization Report.

### Anthropogenic Alterations

Observations of historic USGS Quadrangles and aerial imagery indicate that the Mill River has followed the same general course for more than 100-years; however, straightening and modification to the channel appear to have occurred within nearly all reaches.

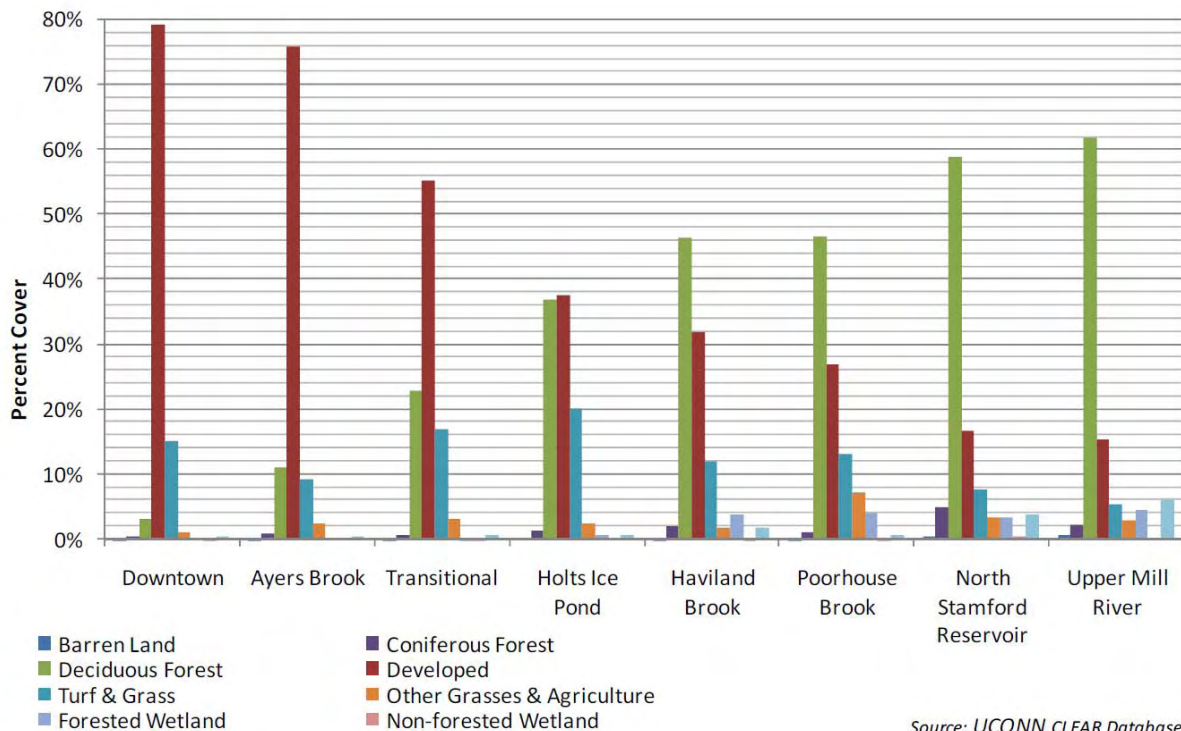
### Channel-Riparian Interaction

Throughout the study area, both of the banks are generally heavily developed within 5- to 25- feet of the river’s mean annual high water line. Undeveloped pockets do occur, but many of these areas appear to be either abandoned agricultural fields or steep slopes not suitable for development. Some of this development is associated with recent commercial/industrial or residential uses. However, the river riparian buffer also reflects historic development associated with agriculture (i.e., stone walls and revetments, drainage ditches, etc.).

The cumulative erosion impact was evaluated for each reach and the majority of reaches were assigned *high* impact ratings because of the extensive bank erosion throughout. Much of the Mill River has high potential for debris jamming and snagging primarily due to aggradation in the lower reaches and restrictions at spans and level controllers (weirs and dams).

### Riparian Vegetation Cover and Substructure

A majority of the corridor land use is characterized as commercial/industrial and residential/commercial in the lower reaches and generally forested and residential above this boundary. It is important to note that much of this forest cover is actually wooded residential lots that are directly adjacent to the brook, obscured by the canopy, thereby giving the false impression that banks are undeveloped. A summary of watershed land cover by subbasin can be found in **Figure 3-1**, and clearly shows the increased development from upstream (right side of chart) to downstream (left side of chart).



Source: UCONN CLEAR Database

**Figure 3-1.** Land Cover by Subbasin within the Mill River Watershed



### 3.3.2 Flow Data

The Mill River has changed as a result of the development and impacts over the last decades. The following summarizes the different stream characteristics relative to flow within the river corridor.

The lower watershed responds very quickly to rain events. This is seen in the rapidly rising hydrographs at the USGS gauge (located just upstream of Toilsome Brook) and in the data from the continuous flow meters installed at culverts of Toilsome Brook and the Mill River drain. Rapid response was also observed by the field teams in the Ayers Brook subwatershed. The rapid response is due to the urbanization of the lower watershed, where 25 to 33% of the land area is developed in the subwatershed south of the Merritt Parkway to Toilsome Brook, and nearly 60% of area is developed in the downtown area. Developed land has more impervious surface than undeveloped land, causing rain to runoff quickly instead of infiltrating into the ground.

The response of the upper watershed to rain events is tempered by the many in-stream ponds along Haviland Brook and Poorhouse Brook. While the Holts Ice Pond subwatershed also has several ponds, it has two to four times the impervious cover of the upstream subwatershed, increasing peak flows but not to the same degree as in the lower subwatersheds.

Rapid response to precipitation is the cause of significant erosion throughout the river. Erosion contributes large volumes of pollutants directly to the river and tributaries, resulting in elevated pollutant concentrations during wet weather events.

#### North Stamford Reservoir

The North Stamford Reservoir contributes a constant flow to the river through a low flow release structure, and discharges water over its dam spillway when the reservoir is at capacity. There is evidence of algal growth and copper sulfate treatment in the reservoir. The reservoir water quality impacts the Mill River by way of the low flow release and the spillway discharge during storm events

#### Tributary Flow

Flow meters were installed in the culvert outfalls of Toilsome Brook and the Washington Boulevard storm drain. The flow meters at these two culverts automatically recorded continuous flow data to the Mill River for a period of 24 weeks. These data were used to characterize these subbasins and quantify pollutant loads during dry weather and wet weather periods.

Staff gages were installed at four tributaries to the river and the low-flow outlet from the North Stamford Dam. The four major tributaries are Poorhouse Brook, Haviland Brook, Holts Ice Pond Brook, and Ayers Brook. Stage measurements were taken at staff gage locations during each full and partial dry weather water quality survey and during wet weather water quality sampling. Recorded velocity measurements were used to compute the stream discharge and develop stage-discharge rating curves at each staff gage location.

#### Flooding

Parts of Stamford are prone to flooding. The Federal Emergency Management Agency (FEMA) completed a Flood Insurance Study (FIS) for the City of Stamford, which was updated in 1993. The following description of the principal flood problems in Stamford was given by FEMA in the FIS:

*“Flooding, triggered by heavy rainfall, occurs in the floodplains and adjacent low areas along the Mianus, Rippowam, and Noroton Rivers. Encroachment into these areas by all types of construction is further aggravating the flood hazard” (16).*

Flood protection measures are described in the FIS as follows:

*“The COE [US Army Corps of Engineers] constructed the hurricane barrier, which protects low-lying development in the south end of the city from flooding caused by hurricanes or severe coastal storms of 500-year recurrence intervals. The City of Stamford has widened the Toilsome Brook channel between Dann Street and Dartley Street, as well as the Bracewood Lane section. Further improvements on Toilsome Brook are in the planning stage.*

*“The reservoirs in the study area were constructed for water supply only, therefore, the reservoirs have no significant effect in the 100- and 500- year floods.*

*“The Stamford Environmental Protection Board and the Connecticut Department of Environmental Protection regulate floodplain encroachment ordinances within the city and establish restrictions in floodprone areas” (16).*

## **Wetlands**

In Connecticut, wetlands are defined strictly by soil type. Wetlands are defined as any land, including submerged land, which consists of any of the soil types designated as poorly drained, very poorly drained, alluvial and floodplain by the National Cooperative Soils Survey of the Natural Resources Conservation Service (NRCS) of the US Department of Agriculture (USDA). Residential and commercial development, encroaching onto the riparian zone of the river, has contributed to the extensive loss of floodplain forests, once thriving along the system. Some small pockets of wetlands, however, can still be found along the middle reaches of the study area, mainly on the left, less developed bank of the river. High-density residential development contributed to the wetland loss along the downstream reaches of the river.

## **3.4 Biological Data**

Physical stream conditions are often an indication of the biological health of a water system. For the Mill River, a geomorphological and ecological assessment study was performed in 2009 to better understand the health of the river. This included use of the EPA benthic macroinvertebrate protocol and the EPA periphyton sampling protocol. When correlated to development, biological data and physical characterization are effective tools for overall restoration planning.

### **3.4.1 Periphyton**

The USEPA field-based rapid periphyton protocol was used at each of the sampling sites as a semi-quantitative assessment of benthic algal biomass and taxonomic composition. Two locations were selected within the same region as the benthic invertebrate sampling locations. The dominant algal species found in the sampling locations indicate nutrient-rich but not eutrophic conditions, and may be linked to the presence of excess phosphorus loading.

### **3.4.2 Benthic Macroinvertebrate**

For each sample location, a benthic macroinvertebrate assessment was conducted using the USEPA Benthic Macroinvertebrates Protocol. The “Single Habitat Approach: 1 Meter Kick Net” method was selected for sample collection. The uppermost reach contained the highest total number of organisms, but a high Family Biotic Index (FBI) indicated fairly poor water quality. The reaches just downstream also



exhibited similar characteristics, with high biodiversity and abundance. Moving further downstream (past the North Stamford Reservoir), the kick-net results showed a lack of biodiversity and eventually very low counts of any living organisms.

### 3.4.3 Fish

Fish populations were not distinctly assessed as part of this study. However, a general physical habitat assessment was conducted to gain a better understanding of the conditions affecting the full spectrum of species within the river system. That data is summarized in Section 3.3.1.

More detailed information and the supporting data relative to the analysis of the watershed are included in the Comprehensive Characterization Report (CDM, 2011).

## 3.5 Impaired Use

According to the CT DEEP, the Mill River is classified as an impaired waterbody habitat for fish, other aquatic life, and wildlife. The stream has not yet been assessed for impairments due to exceedances of pollutant levels above state standards. Based on the findings of the monitoring program and field observations, the likely causes of the aquatic habitat impairment are:

- excess attached algae growth from elevated nutrients
- flow and migration impediments (low head dams)
- erosion and deposition
- metals concentrations
- streambed substrate diversity

The likely causes of impairment listed above are directly linked to observed water quality concerns in the stream. Each can be attributed to increased development in the watershed, which has occurred with little regard to the effect of land use on stream water quality and habitat. Urban and suburban runoff pollutants, increased stream velocities, instream structures, and development in the flood plain lead to the causes of impairment listed above. Though not yet assessed for bacteria, the stream does not meet state water quality standards for bacteria. Elevated bacteria concentrations are also likely due to urban runoff pollution.

The following sections explore the sources of pollutants in greater depth, outline objectives for this plan to improve the health of the Mill River, and identify specific action items that aim to remediate the causes of impairment listed above.

## Section 4 – Pollutant Source and Load Assessment

Evaluating the sources and relative magnitude of pollutant loads to the stream system allow for the development of a targeted management plan. Action items should be aimed at specific problems in specific areas of the watershed where the effect will be most beneficial. The Windshield Survey (Appendix D) performed as part of this project included identification of facilities and land uses that are a potential threat to water quality and opportunities for improved stormwater management within the watershed. The characteristics of the Mill River and watershed reveal that the main contributor of pollutants is stormwater runoff to the river. There are numerous management strategies to control nonpoint source pollution; the following summarizes the pollutant source and loading assessment that was completed prior to developing recommendations for management measures.

### 4.1 Nonpoint Sources

Nonpoint sources (NPS) include any substance or material on a commercial, residential, or public surface or roadway that is collected and transported through overland flow to a body of water. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants. Legally, this represents any sources that cannot be classified as a point source, or anything that is not easily identifiable as the source of contaminant transport to a water body. Often changes to management practices through education and outreach result in an overall reduction of nonpoint source impacts to a water source.

According to the Connecticut Department of Energy and Environmental Protection (CTDEEP), the designated authority on nonpoint source management in the state, the goal of managing nonpoint sources is to “protect public health and the environment from the impacts of nonpoint sources of pollution by promoting practices and adopting controls to reduce nonpoint sources of pollution.” This can be achieved through development and implementation of stormwater best management practices (BMPs), improvements to education and incentives for controlling nonpoint sources at the municipal level, implementation of a stormwater discharge program, and development of a program to implement nonpoint source demonstration projects.

Urban/suburban runoff is the most prominent form of nonpoint source pollution in the Mill river basin. As the majority of the area south of Merritt Parkway is primarily residential with limited forest land, grass and soil, most of the stormwater which falls on these surfaces is conveyed through a stormwater drain system which empties into the Mill River.

#### **Industrial/Commercial Land Usage**

The quality of urban runoff from industrial and commercial sites is often dependent on site use, and can include chemicals, metals, or other hazardous agents. These sites are often fully impervious, creating a greater volume of runoff than suburban or residential areas.

Dirt, oil, and debris collect on the impervious surfaces of commercial and industrial sites, which include parking lots, driveways, roadways, and sidewalks. Commercial establishments, due to the nature of their business, are more likely to regularly maintain these areas in order to avoid debris buildup and unsightly driveways. Industrial establishments may be required to as part of site-wide regulated or voluntary stormwater pollution control measures.

Industrial sites which regularly conduct work with petroleum products and hazardous degreasing products, such as manufacturing facilities, transportation centers, and gas stations, are generally required to maintain additional on-site precautions to prevent migration of spills. Such precautions are necessary due to the nature of the materials, which are highly soluble and migrate quickly when introduced to water resources, creating a costly situation where environmental remediation is required and losses to aquatic life result. Dry cleaning facilities also have potential for negative environmental impacts due to the highly toxic nature of the chemicals used. While spills of any size legally require reporting to the CTDEEP and remedial investigation, small releases often go unseen and unreported. As a result, it is particularly important to maintain barriers between such industrial and commercial sites and sensitive aquatic habitats.

Regular vehicle parking lots where a number of cars may be garaged or parked for long periods of time will also accumulate some oil, gas, and other hazardous chemicals as a result of the use of vehicles. When possible, such lots are generally required to maintain a site-specific oil/water separator to catch contaminants during a storm when overland flow could otherwise convey the materials to nearby water resources.

### **Residential**

As a general guideline, impervious surfaces are more likely to collect, absorb, and convey pollutants than pervious surfaces. Natural ground cover, grasses, gravel, rock gardens, wooden decks with drainage to grass or dirt, and vegetated gardens are all pervious alternatives. As stormwater runoff travels over impervious surfaces, in addition to collecting pollutants, the relative heat – which is naturally higher in paved surfaces than natural landscape – may increase the temperature of the runoff water, adding additional stress to receiving water aquatic systems in the summer months.

It is important to consider the residential and small scale applicability of chemical hazards resulting from petroleum products. At the household level, vehicles with leaks may introduce petroleum products to the stormwater conveyance system. Regular maintenance of vehicles, such as at-home oil changes, use of engine degreasers, grease, road salts and sands, paints, deicers, and other chemicals must be stored and handled properly to avoid contamination. Household chemicals, including grease, should be stored in well-conditioned containers and kept out of weather.

As with managing agricultural practices, chemicals used in landscaping such as insecticides, pesticides, herbicides, and fungicides can poison receiving water aquatic life and lead to dead zones, where aquatic life is unable to survive. Limiting chemical application frequency and avoiding over-application beyond recommended use will help to mitigate this risk. Additionally, overwatering will increase likelihood of transport.

Yard waste must also be managed to avoid clogging drains with debris, such as tree leaves and grass clippings. Composting and mulching yard waste is recommended whenever possible. Native plants will reduce pests and may require less irrigation or chemical applications than non-native species. When changing the landscape of a property, working with the natural contours will limit sediment transport.

Other best practices include keeping sidewalks, driveways, and parking lots clear of debris and litter, particularly areas around catch basins. Such debris can be collected by the system, transported, and washed into streams. Plastic bags, six-pack rings, bottles, and cigarette butts have been known to choke, suffocate, or disable birds, ducks, fish, turtles, and other aquatic species. Households that are adjacent to waterways should ensure filtration of overland flow by maintaining or allowing natural landscape buffer strips or gardens to divide lawn grass from the waterway.

### **Septic Systems**

Septic systems that are overwhelmed or unmaintained may leak, introducing high concentrations of nutrients and pathogens (bacterial and viral) to nearby waterways through subsurface transport. The result is increased levels of pathogens in the surface water. There are several areas of the Mill River watershed that are not sewered and therefore rely on individual septic systems to handle residential waste. Proper maintenance of these systems is critical to ensuring that the stream meets bacterial standards for recreation.

The United States Environmental Protection Agency (USEPA) recommends that systems are checked once every 3 years, and pumped every 3 to 5 years. Limiting wastewater production by reducing overall water use can extend the life of the septic system. This can be achieved through using low flow shower heads, faucets, and toilets as well as efficiently using dish and clothing washing machines.

### **Sediment**

Site work which involves disturbing the ground surface often leads to silt transport to the stormwater conveyance system. This silt will collect within the system traps, which are designed to prevent silt from clogging conveyance piping. However, some silt will work through the system and end up being deposited in receiving waters, leading to adverse changes to the streambed ecology and aquatic system health. As mentioned previously, silt runoff will also carry chemical contaminants including metals, which build up rather than degrading. Site work should include silt protection by fencing, hay bales, or compost berms and such is required to obtain most construction permits in the state of Connecticut. Catch basins and silt traps within the stormwater conveyance system should also be cleaned and maintained to ensure proper system function.

### **Stream Bank Erosion**

Stream bank erosion in Stamford likely results as development encroaches on the river, limiting natural landscaping and cutting back on the vegetation which would otherwise act to reinforce the shape and limit erosion. Efforts should be made to increase frequency of natural vegetative buffers and avoid continued encroachment towards the river.

New development is anticipated to be minimal along the portion of the river south of the Merritt Parkway, as these reaches are almost fully developed. However, future development projects, particularly those that involve developing previously forested areas, should be particularly sensitive to the impacts to sediment transport and erosion that results from cut back buffers and unstable stream banks.

### **Silviculture**

The upper portion of the watershed, north of the Merritt Parkway, consists primarily of undisturbed forested land and natural landscape. In the event that this area becomes more developed, it is essential for the health and wellbeing of the waterway for best management practices to be followed for site development. Additionally, there are several limited parcels south of the Merritt Parkway, within the

study area, which have been noted as forested land. Development in these areas must take into consideration the impacts to the Mill River in order to prevent further degradation of the waterway.

Improper management of forests, including development of previously forested lands, can be a major contributor of sediment to stream systems. In general, natural systems with forested lands have a natural balance of sediment deposition, production, and compaction. Sediment does not often travel once deposited onto a forest floor because plant roots including trees, bushes, and undergrowth hold the soil in place. When that system is disturbed during construction activities, soil containing a high percentage of organics is often too fine to be reasonably controlled from transport. In order to manage forested lands, trees must be cleared to make room for roadways, undergrowth removed, and generally the system is upset of its natural balance.

When undergrowth is removed, particularly small bushes and border plants along stream banks, the system is deprived of the natural sediment controls that prevent sediment transport. This growth stabilizes stream banks which would otherwise erode without roots to reinforce its strength. The undergrowth also serves to shade the stream and removal of the vegetation leads to higher temperatures which change plant growth and can limit sources of food and shelter for aquatic life.

Whenever possible, it is recommended to avoid disturbing stream bank buffer areas and nearby forested areas. Before construction, the area should be surveyed for sections which require special protection, such as steep slopes and naturally sensitive forest areas, in order to avoid disturbing less stable soils and natural hills reducing the risk of severe erosion. Sensitive rock formations and streamside vegetation should be left undisturbed. Whenever possible, replanting is an essential component to natural resource recovery.

## 4.2 Point Sources

Point sources include direct sources of pollutants which are known to be introducing contaminants into the stream. These discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) permit program under the USEPA, Phase I and Phase II Stormwater Permits, and Concentrated Animal Feeding Operations (CAFO) permits. There are no point source discharges to the Mill River within Stamford.

Illicit connections to storm sewers can act as point sources during dry weather. It was not within the scope of this study to identify stormwater outfalls that may contain illicit connections, but as part of the monitoring and reconnaissance effort field crews identified outfalls with dry weather flow.

## 4.3 Other Potential Pollutant Sources

Other pollutant sources were also considered under this assessment. Such sources include known hazardous waste sites such as those regulated under the USEPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), and registered brownfields properties. Such contamination can be detrimental to surface water resources and lead to environmental consequences including fish kills, severe biological degradation, and high levels of chemical contamination. During a desktop and windshield survey of the watershed, one site was discovered on the USEPA's Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) database; Scofieldtown Road Park. This landfill site is currently under investigation for remediation. Contaminants originating at this site could potentially travel through groundwater and enter the Mill River via baseflow. The monitoring program for this basin management

plan did not focus on determining the extent of contamination caused by the Scofieldtown Road Park landfill.

Underground storage tanks (USTs) can be found in industrial, municipal, and residential properties. When USTs leak, as a result of age or degradation, the contents can escape into nearby soil and eventually groundwater. Major concerns would include large volume containers which contain petroleum products that easily pass through soil to groundwater and can develop large contaminant plumes that feed to surface water sources. During the desktop and windshield survey of the watershed, 200 sites with leaking USTs were identified within the watershed<sup>1</sup>

The desktop review and water quality sampling conducted under this assessment did not suggest any major sources of contamination beyond that of stormwater runoff in the Mill River. Therefore, there are no recommended action items aimed specifically at the remediation of impacts from the landfill or leaking USTs.

## 4.4 Linkage of Pollutant Loads to Water Quality

The results of water quality monitoring on the Mill River show a linkage between water quality issues in the river and known potential sources of the problems. The full water quality monitoring results are presented in the Comprehensive Characterization Report (CDM, 2011). The monitoring discovered widespread elevated levels of bacteria in the river. Table 4-1 lists the locations and times of higher bacteria trends and possible causes of each based on land use and watershed knowledge.

**Table 4-1 Water Quality Trends and Sources - Bacteria**

<b>Elevated Bacteria Trend</b>	<b>Possible Cause/Loading Sources</b>
<b>Higher dry weather concentrations observed:</b> <ul style="list-style-type: none"> <li>• Poorhouse Brook</li> <li>• Immediately downstream of the Merritt Parkway</li> <li>• Ayers Brook</li> <li>• Toilsome Brook</li> </ul>	Illicit connections to storm sewers Direct waterfowl fecal contamination Failing septic systems
<b>Higher summer concentrations throughout the river</b>	Warmer, more friendly conditions for bacteria growth More waterfowl habitat
<b>Higher wet weather concentrations observed:</b> <ul style="list-style-type: none"> <li>• Poorhouse Brook</li> <li>• Lower watershed</li> <li>• Tributaries (as compared to main stem)</li> </ul>	Improper pet waste management General urban runoff Runoff contamination from waterfowl feces

Metals were also observed at levels above the state water quality standards during the monitoring program. The source of metals pollution is generally urban/suburban runoff, particularly from roads and streets. Zinc and lead levels were both greater in stormwater samples (wet weather) and in the lower watershed, where development and impervious surfaces are more widespread. Elevated levels of copper

<sup>1</sup> A fact sheet on the CTDEEP Underground Storage Tank Program is available at [www.dep.state.ct.us/wst/ust/ustregs.htm](http://www.dep.state.ct.us/wst/ust/ustregs.htm). Information on spill reporting and responsibility for remediation of spills is also available at [www.dep.state.ct.us/wst/oilspill/resp.htm](http://www.dep.state.ct.us/wst/oilspill/resp.htm).

could be caused by natural levels within the watershed or by copper sulfate dosing within the North Stamford Reservoir (often performed to control reservoir algal growth). During one sampling event, levels of copper were greater in the reservoir discharge, indicating that it is periodically dosed with copper sulfate to control algal growth.

Nutrients are of concern for the watershed because of the direct drainage to the Long Island Sound, where high levels of nutrients cause hypoxia (lack of oxygen in the water). Observed nutrient and bacteria levels suggest that a cause of elevated contaminants in Ayers Brook and Toilsome Brook is likely sewage either from illicit connections, failing septic systems and urban runoff with pet waste. Nonpoint source runoff, laden with lawn care fertilizers, is also a very likely source in the residential and commercial portions of the watershed. As total phosphorus levels were observed coincidentally with higher suspended solids during wet weather events, they may be caused by sediment resuspension and bank erosion. Evidence of excessive algal growth in ponds was observed throughout the watershed, and the levels of algae (chlorophyll-a) measured in the river during wet weather monitoring suggests that the algae is flushed from the ponds to the streams during rain events.

## 4.5 Estimation of Pollutant Loads

### 4.5.1 Point Sources

There are no permitted point source discharges to the study area reach; however, illicit connections to storm sewers can act as point sources during dry weather. As part of the sampling program, outfalls were sampled for bacteria to identify possible illicit connections. Three outfalls in the lower watershed had observed *E. coli* concentrations above the state water quality standard for streams. The three outfalls are located near the Cold Spring Road crossing, next to Scalzi Park, and near the North Street crossing. It is likely that many more outfalls along the tributaries have dry weather flow with high bacteria counts, based on the instream sampling results in the tributaries. These outfalls were not identified or sampled as part of this study. The results of the outfall sampling are presented in the 2011 Comprehensive Characterization Report.

### 4.5.2 Nonpoint Sources

As part of the Basin Management Plan, a watershed loading model was developed to estimate nonpoint source contributions from the subbasins, based on annual rainfall and land cover statistics. The full model development and results are explained in the 2011 Watershed Modeling Memorandum (Appendix B). Figure 4-1 shows the results of the modeling of existing conditions in the watershed. The chart lists the total annual loading across the top, with each portion of the stacked bars representing the loading from each subbasin. These are estimates of the nonpoint source loading, taking into account failing septics but not illicit connections leaking sewage into the stream. The tributaries with more flow tend to contribute more loading, with the exception of Toilsome Brook (purple) and the Lower (downtown) Direct Drainage (orange). Toilsome Brook contributes disproportionately high amounts of BOD, fecal coliform, TKN, and total phosphorus – typical residential development pollutants. The downtown drainage contributes disproportionately high amounts of metals – typical road runoff pollutants.



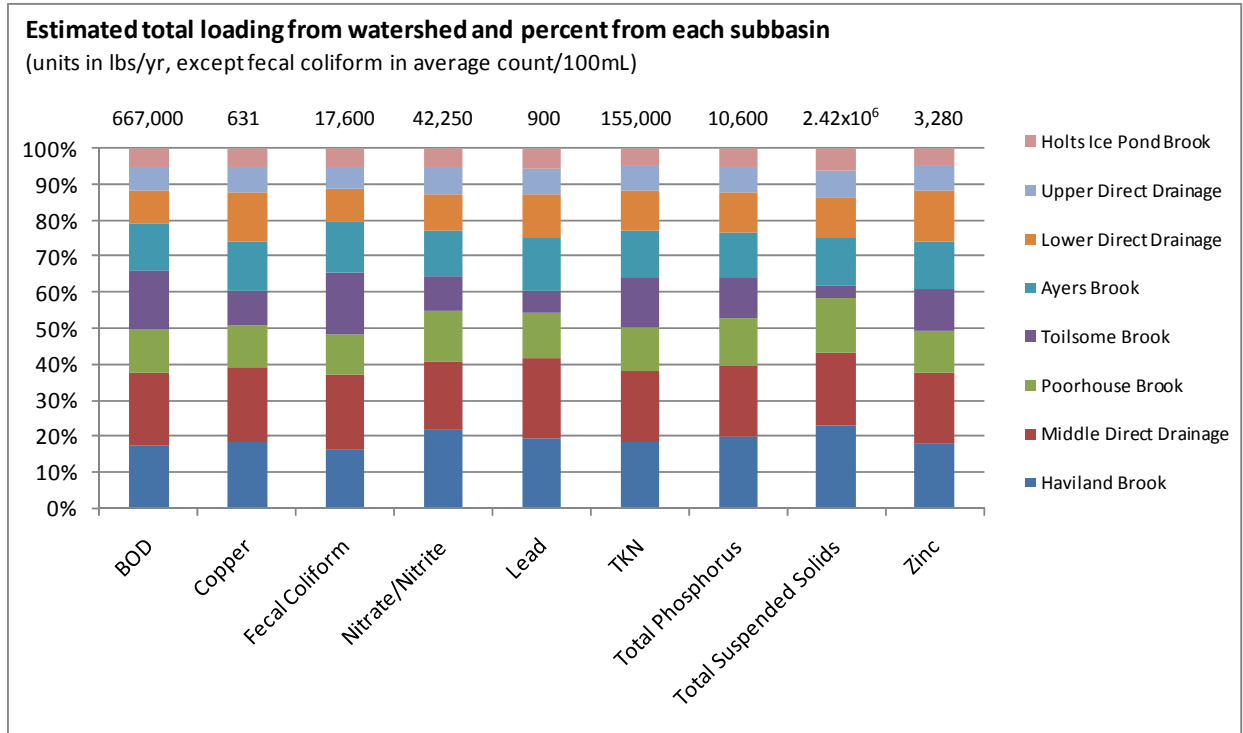


Figure 4-1 Estimated Total Nonpoint Source Loading from Mill River by Subbasin

## 4.6 Areas in Need of Improvement

Based on the monitoring program results and the watershed loading model, the following areas are considered in need of improvement:

Table 4-2 Identification of Areas in Need of Improvement

Identified Area	Bacteria	Metals	Nutrients	BOD	DO	Algae
<b>Downtown drainage</b>	X	X				
<b>Toilsome Brook</b>	X		X	X		
<b>Ayers Brook</b>	X		X			
<b>Poorhouse Brook</b>	X					
<b>Lower subbasins</b>	X		X			
<b>Specific points on mainstem:</b>						
Near Merritt Parkway	X					
Near Scalzi Park	X					
Near Broadway crossing	X					
Downstream of North Stamford Reservoir		X			X	
<b>Upper watershed tributaries and ponds</b>						X



## Section 5 – Watershed Management Objectives

The goal of this basin management plan is to make the Mill River a usable natural space for the community and a healthy habitat for the species which it supports. This can only be achieved through a comprehensive approach to watershed management and pollutant mitigation. Poor stormwater quality, uncontrolled urban runoff volume, direct anthropogenic alterations to the stream, and a general lack of river and watershed stewardship are the driving causes of the current degraded state of the Mill River in Stamford. This section of the plan outlines the management objectives developed through stakeholder input and overall watershed assessment.

The results of stakeholder involvement meetings were compiled to develop eight objectives for the basin management plan. In order to achieve these objectives, several strategies were considered based on the portion of the river which is in need of attention and the actions necessary to improve the conditions. The following section is a list of the plan objectives and broad ideas for where and how they could be achieved. Section 6 provides detailed explanations of the different types of action items and a comprehensive list of recommended action items for the improvement of the Mill River watershed. Section 7 groups the action items into alternatives centered on solving very specific problems (e.g. reducing bacteria concentrations in the river, fostering stewardship of the river and watershed).



### **Objective 1. Increase public awareness, education, and community involvement**

**Location:** Throughout the watershed for the public, North Stamford Reservoir for Aquarion Water Company.

**Specific actions:** Develop a comprehensive awareness, education, and community involvement plan that includes opportunities for involvement and education. Work with Aquarion Water Company to improve water quality.



### **Objective 2. Improve access and connection to the river, including passive and active recreational opportunities**

**Location:** Long Ridge Rd commercial properties, Buckingham Road, Merritt Parkway corridor (near Wire Mill Road and utility substation), Cold Spring Road, wetlands boardwalk.

**Specific actions:** Develop a comprehensive plan for public use areas that are interesting, accessible, provide an activity such as walking or biking, promote connections between the public and the river, link with other access points, and have a consistent identity with each point throughout the length of the river.



### Objective 3. Build a grassroots watershed constituency

**Location:** Throughout the watershed.

**Specific actions:** Inspire members of the community to develop a citizen-driven watershed constituency which acts as a steward of the watershed, initiates community participatory activities such as cleanups and plantings, participates in community activities to create awareness of the watershed, and generally drives the goals laid out in this plan.



### Objective 4. Control and reduce high flows to promote river corridor health and reduce flooding

**Location:** Areas where river can be reconnected to flood plain, North Stamford Reservoir, Ayers Brook subbasin, Toilsome Brook subbasin, middle and lower direct drainage subbasins, parcel-based or neighborhood-based solutions where appropriate.

**Specific actions:** Develop education initiatives which focus on low impact development, explore daylighting in Toilsome Brook, optimize flood storage reservoir operations, use floodplain for temporary storage, use parcel-based solutions in the northern watershed, and use City stormwater solutions on a neighborhood basis.



### Objective 5. Improve water quality, specifically: metals, dissolved oxygen, bacteria, and nutrients

#### Metals

**Location:** Throughout the watershed (in wet weather).

**Specific actions:** High levels of metals can lead to regulatory concerns for the river and overall health of the river. Stormwater controls that filter overland flow from impervious areas to stormwater drains or directly to the river will reduce concentrations of metals in the river.

#### Dissolved Oxygen

**Location:** North Stamford Reservoir low flow outlet and throughout the watershed.

**Specific actions:** Dissolved oxygen (DO) is necessary for healthy aquatic life. The Mill River, being shallow and free-flowing in most reaches, should have adequate capacity to reaerate. The North Stamford Dam low flow outlet is discharging water with low DO to the upper reach of the study area. Additionally, nutrient abundance in the water column results in excess algal growth in slow moving sections (ponds); algal decay consumes DO. Remediation of the low DO in the North Stamford dam outlet and stormwater runoff controls and best practices to limit nutrient runoff will improve the DO levels throughout the river.

#### Bacteria

**Location:** Ayers and Toilsome Brook subbasin in dry weather; throughout the watershed in wet weather.

**Specific actions:** Reduction in bacteria levels will improve opportunities for recreation on the Mill River. To reduce the levels of bacteria within the river, efforts should be made to reduce the prevalence of

waterfowl and develop an education and outreach campaign which focuses on pet waste management. The City should implement an illicit detection discharge and elimination (IDDE) program to uncover sources of bacteria in the storm drain system. Septic system status should be assessed throughout the watershed, with particular emphasis on properties adjacent to the river and tributaries, to ensure all systems are in working order.

### Nutrients

**Location:** North Stamford Reservoir, northern watersheds, garden centers, and throughout the watershed in wet weather.

**Specific actions:** Work with local garden centers and the public as part of a focused education and outreach campaign to reduce nutrient inputs into the river during wet weather. Nitrogen reduction is important for the health of Long Island Sound. Phosphorus is important to limit algal growth within the stream. As with metals, street sweeping and regular catch basin cleanout will also help to reduce excessive nutrient loads to the river.



### Objective 6. Restore instream and riparian habitat

**Location:** Instream at structures, floodplain, wetland restoration, and specific erosion problem areas.

**Specific actions:** Potential actions include installing fish ladders, removing low-head dams, creating pools and riffles, restoring riparian buffers, stabilizing banks and implementing erosion control measures.



### Objective 7. Ensure sufficient low flows for habitat and aesthetics of river

**Location:** North Stamford Reservoir low flow release, garden center intakes, other private intakes, watershed stormwater infiltration, instream structures (rock weirs, etc).

**Specific actions:** Implement best management practices and low impact development techniques; work with Aquarion Water Company to increase releases from the North Stamford Reservoir; and address private water intakes, particularly at commercial garden centers.



### Objective 8. Promote the City of Stamford's sustainability mission

**Location:** Throughout the watershed.

**Specific actions:** Install rain gardens, work with the Mill River Collaborative and Keep Stamford Beautiful, employ educational programs on low impact development techniques, enforce code, develop ordinances, and acquire easements.

## Section 6 - Watershed Management Strategies

Watershed management strategies are the programs, physical controls, and regulatory mechanisms that support meeting the management objectives of this plan. Strategies may be as simple as increasing the frequency of catch basin cleanouts in high density urban areas or as complex as developing a municipal authority for comprehensive management of a municipal stormwater network. For the City of Stamford, a combination of action items were developed that will address the objectives of this basin management plan.

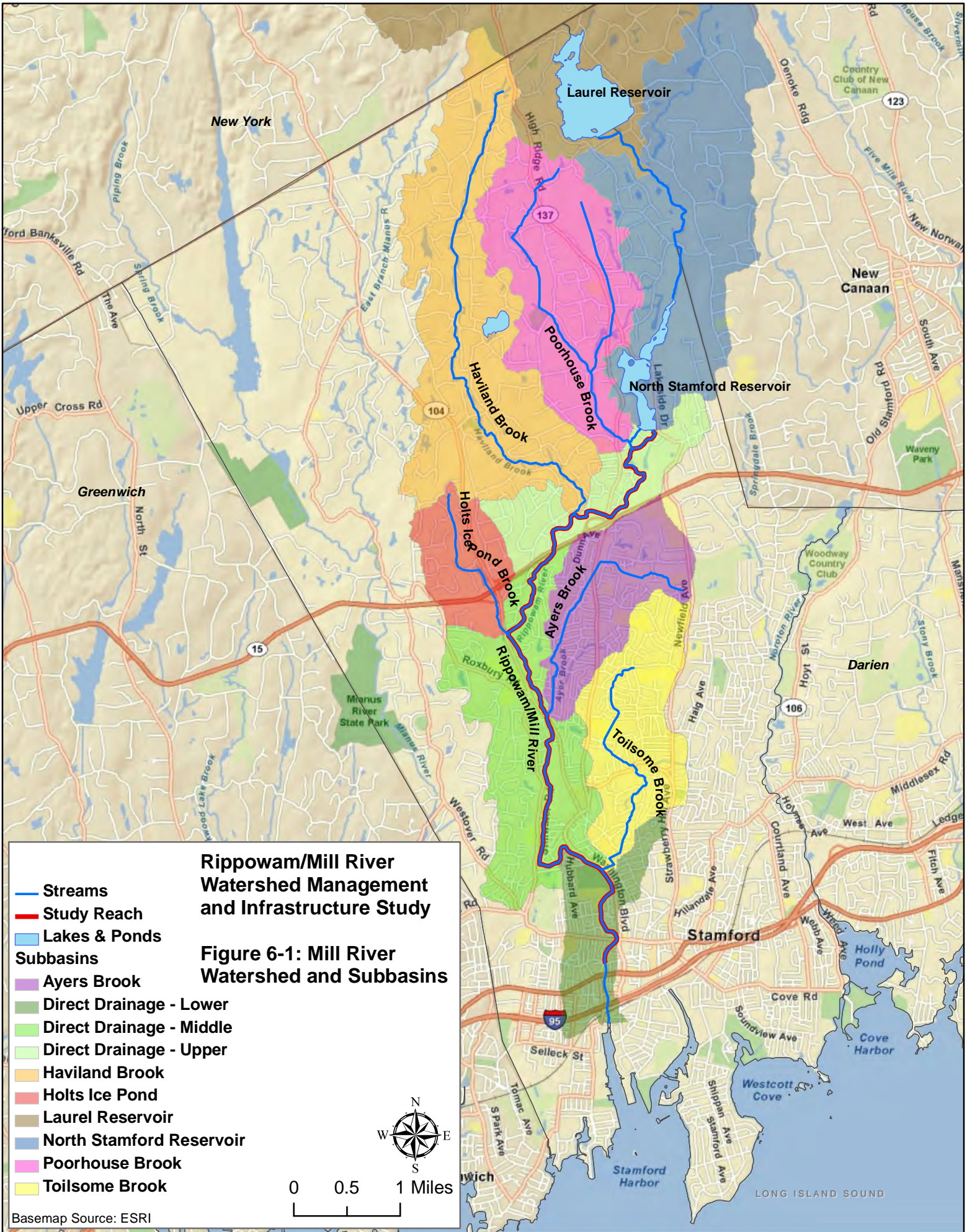
The selection of the action items were based on the pollutants of concern, which consist of nutrients, metal, and bacteria, and the following objectives described in Section 5:

1. Increase public awareness, educations, and community involvement
2. Improve access and connection to the river, including passive and active recreational opportunities
3. Build a grassroots watershed constituency
4. Control and reduce high flows to promote river corridor health and reduce flooding
5. Improve water quality, specifically: metals, dissolved, oxygen, bacteria, and nutrients
6. Restore instream and riparian habitat
7. Ensure sufficient low flows for habitat and aesthetics of river
8. Promote the City of Stamford's sustainability mission

In order to determine the most appropriate action items for the Mill River watershed, a comprehensive survey was conducted to identify all possible best management practices, low impact development technologies, and ordinances. Once all possibilities were identified, an assessment of each category was conducted to determine feasibility and appropriateness for the City of Stamford, based on the needs of the watershed. When possible, the action items were modeled using the Watershed Management Model (WMM) developed for the Mill River basin.

A total of 29 action items were identified for the Basin Management Plan. The action items are listed below and described in the following section according to the nature of the action item, under the categories of structural controls, nonstructural controls, and programmatic approaches. Several of the action item descriptions reference subbasins within the Mill River watershed. Subbasins are shown on Figure 6-1.





**Rippowam/Mill River  
Watershed Management  
and Infrastructure Study**

**Figure 6-1: Mill River  
Watershed and Subbasins**

- Streams
- Study Reach
- Lakes & Ponds
- Subbasins**
- Ayers Brook
- Direct Drainage - Lower
- Direct Drainage - Middle
- Direct Drainage - Upper
- Haviland Brook
- Holts Ice Pond
- Laurel Reservoir
- North Stamford Reservoir
- Poorhouse Brook
- Toilsome Brook



0 0.5 1 Miles

Basemap Source: ESRI



***Structural Controls:***

- Rain garden/bioretention area
- Tree filter/street Planter
- Porous pavement
- Green roof
- Sand filter

***Nonstructural Controls:***

- Removal of low head dams
- Modify North Stamford Reservoir low flow
- Holts Ice Pond remediation
- River bank restoration
- Riparian buffer improvements
- Removal of invasive plants
- Instream restoration
- Public access points
- Designate wildlife protection and viewing areas

***Programmatic/Regulatory Mechanisms:***

- Waterfowl reduction program
- Pet waste reduction program
- Community participation events
- Reduce improper yard waste dumping
- Website for public education and information
- Educational signage
- Mark stormwater grates with educational message
- Promote better commercial property stormwater practices
- Promote better residential property stormwater practices
- Bacteria source tracking
- Increase street sweeping and catch basin cleaning
- Illicit discharge detection and elimination
- Address private water intakes
- Create Mill River Watershed Association
- Regular monitoring program

## 6.1 Structural Controls

Structural controls are physical features installed in urban and suburban environments designed to manage stormwater runoff to surface water resources. During rain events, stormwater collects on impervious surfaces such as concrete sidewalks, paved roadways, driveways, parking lots, and building rooftops. Impervious surfaces prevent water from infiltrating into the underlying soil. Water accumulates quickly and must be conveyed from the impervious surfaces to a receiving water body or storage area where it travels in natural waterways or infiltrates into the subsurface.

Surface contaminants which accumulate through daily use of impervious surfaces, such as car oil in parking lots or sand and salt on roadways, are collected by stormwater and deposited in receiving catch basins, outlets, and receiving surface water resources. Over time, surface contaminant deposits accumulate to the detriment of natural habitats and water resources. Structural controls can address the concentration and incidence of surface contaminants introduced to surface water resources by capturing and filtering stormwater before it enters the storm drain system. An array of various structural controls impact different pollutants of concern.

Application of structural controls typically occurs in developed areas where surfaces would otherwise be impervious. For this reason, structural controls may also provide a portion of pervious surface where stormwater may naturally infiltrate into the subsurface. This reduces total flow to the storm drain system, thus reducing the peak flow rate and total output to surface water resources. Overall stormwater volume reduction also exacts less demand on stormwater infrastructure, which results in reduced flooding incidents.

The following section describes the recommended structural controls for the City of Stamford under this plan.

### 6.1.1 Rain Garden/Bioretention Area

A rain garden or bioretention area is a stormwater management practice that uses soils, plants, and microbes to treat stormwater before it infiltrates into soil or is discharged. In areas where stormwater accumulates quickly and in large volumes, rain gardens capture and collect water that would otherwise be directed to storm drains, accumulate in puddles, or filter downhill onto roadways. Common applications include large impervious areas, such as parking lots and urban centers, where the rain gardens replace landscaped areas.

Rain gardens are constructed as shallow, depressed areas that consist of dense native plants and soils. When rainfall occurs, directed runoff will accumulate around the organics, creating a temporary pond. Pollutants carried by stormwater are absorbed through the natural biological process of the biota. Once through the system, runoff may be discharged to an engineered drainage system or left to naturally infiltrate into groundwater.

Rain gardens are frequently used in Low Impact Development design as an efficient method of removing total suspended solids (TSS) and other pollutants that accumulate on impervious areas.

The overall pollutant load reduction that can be expected in the Mill River watershed from rain garden implementation was estimated using the WMM. It was assumed that through education programs the city may expect to capture 10% of runoff through on-site rain garden bioretention. The modeling also assumed that all runoff from Stamford Hospital (8 acres) and half of the city-owned property downtown (5 acres) could be routed through bioretention. **Table 6-1** shows the estimated basin-wide pollutant loading reductions that could be achieved by implementing rain gardens.



**Figure 6-2.** Rain garden in an urbanized area.  
Source: Portland River Renaissance Initiative



**Figure 6-3.** Vegetated bioretention area in Stamford (photo taken October 2009)



**Figure 6-4.** Descriptive educational sign posted at a rain garden in front of the City of Cambridge Department of Public Works Headquarters, Cambridge, Massachusetts.



**Table 6-1. Modeled Pollutant Loading Reduction from Rain Gardens**

Pollutant	Estimated Basin-Wide Percent Reduction in Loading
Biological Oxygen Demand	7%
Metals	4 – 7%
Fecal Bacteria	8%
Nutrients	2 – 4%
Sediment	7%

Costs vary significantly depending on the size and capture area of the rain garden. An average cost range of \$25,000-\$51,000 per acre of tributary area, combined with the modeling assumptions described above, yields a total cost estimate of \$7.4 to \$15.1 million to achieve the reductions listed in Table 6-1 (CRWA, 2010; CWP, 2007). It is important to consider that this cost would be shouldered by various entities to build the individual rain gardens, including commercial property owners, residential homeowners, and the City for municipal projects.

### 6.1.2 Tree Filter/ Street Planter

Tree filters and street planters are a stormwater management practice that captures and treats stormwater runoff in urban areas. Similar to rain gardens, this is accomplished by using urban tree plantings, or vegetated curb plantings, as an opportunity to install a subsurface treatment system. Runoff from streets and sidewalks is directed to a subsurface pre-treatment device such as baffle box (a square, sectioned chamber connected to a storm drain) at the edge of a roadway where grit and oil from stormwater are removed. From this device, water flows to infiltration planters which typically contain bioretention filter media. The treated water then infiltrates into the ground or discharges to the storm drain system.

A less sophisticated version of this would be an urban tree or mini-planter system. Trees are typically installed along sidewalks for aesthetic reasons, but may also function as small rain gardens and treat stormwater through filtration. Artificial filters and/or infiltration basins, as described above, may be used to add additional stormwater runoff capture and treatment.

The overall pollutant load reduction that can be expected in the Mill River watershed from tree filter implementation was estimated using the WMM. It was assumed that the city may expect to capture 25% of runoff from impervious/urban land cover in the Ayers Brook subbasin and 6% of the runoff from impervious/urban land cover in the downtown subbasin. **Table 6-2** shows the estimated basin-wide pollutant loading reductions that could be achieved by implementing tree filters.



**Figure 6-5.** Extensive street planter along roadway in urban space. *Source:* CDM Smith Harvard University project

**Table 6-2 Modeled Pollutant Loading Reduction from Tree Filters**

Pollutant	Estimated Percent Reduction in Loading	
	Ayers Brook Basin	Downtown Basin
Biological Oxygen Demand	2%	2%
Metals	0 – 2%	0 – 2%
Fecal Bacteria	<1%	<1%
Nutrients	0 – 2%	1 – 2%
Sediment	2%	2%

Costs vary significantly depending on the size and capture area of the tree filter. An average cost range of \$152,000 to \$178,000 per acre of tributary area, combined with the modeling assumptions described above, yields a total cost estimate of \$3.0 to \$3.6 million to achieve the reductions listed in Table 6-2 (CRWA, 2010; CWP, 2007).

### 6.1.3 Porous Pavement

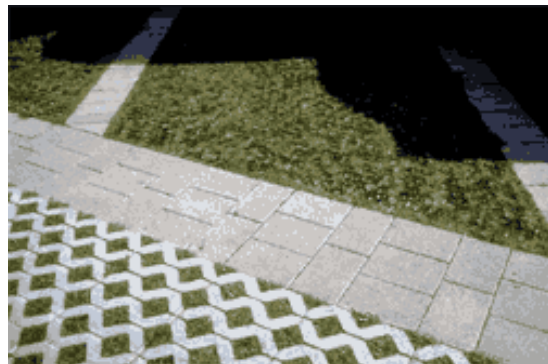
Porous pavement is an effective stormwater management practice that provides water quality treatment and water quantity control in otherwise largely impervious areas. On most paved surfaces, large volumes of rainwater collect particulates which accumulate on the paved surface while being diverted to a storm drain system, and eventually empty into natural water systems. When rain falls on porous pavement, it drains directly through the pavement and infiltrates into the subsurface, preventing large volumes of rain and particulates from entering natural systems.

Rainfall drains through porous pavement and aggregate layers where small particulates are filtered out. Some designs also include an infiltration reservoir comprised of larger media to allow additional treatment and storage prior to discharging to an overflow inlet, catch basin, or infiltrated directly into subsoil. In areas where infiltration is not permitted, in the case of sensitivity to pollutants or high groundwater, the system may be lined and outfitted with subdrains and conveyance to storm drains.

Typical uses of porous pavement include parking lots, low-use roadways, sidewalks, and commercial developments. Similarly designed systems may include porous asphalt or block modular and grid pavers, where water infiltrates in areas between blocks composed of



**Figure 6-6.** Porous pavement parking lot constructed as part of the CDM Smith Hartford Green Capitals Project



**Figure 6-7.** Various examples of permeable pavers or pavement brick orientation schemes. Photo courtesy of CDM Smith.

concrete, porous concrete, brick, stone, or recycled plastic. These systems and their usage are highly variable and depend on the aesthetic, structural, or budgetary limitations of a project. However, all types of permeable paving must be used in areas with low vehicle volumes and low speed, making them ideal for parking lots, sidewalks, and bike paths.

The overall pollutant load reduction that can be expected in the Mill River watershed from porous pavement implementation was estimated using the WMM. It was assumed that the city could apply porous pavement to 10% of parking lots within commercial and high-density residential land covers within the watershed. **Table 6-3** shows the estimated basin-wide pollutant loading reductions that could be achieved by implementing porous pavement.

**Table 6-3. Modeled Pollutant Loading Reduction from Porous Pavement**

Pollutant	Estimated Basin-Wide Percent Reduction in Loading
Biological Oxygen Demand	4%
Metals	1 – 3%
Fecal Bacteria	<1%
Nutrients	0 – 3%
Sediment	3%

Costs vary significant depending on the size and designated use of the pavement. An average cost range of \$192,000-\$715,000 per acre of pavement, combined with the modeling assumptions described above, yields a total cost estimate of \$20.8 to \$77.3 million to achieve the reductions listed in Table 6-3 (CWP, 2007; Tetra Tech, 2009; UNH, 2009). It is important to consider that this cost would be shouldered by various entities to build the individual porous pavement lots, including commercial property owners, residential homeowners, and the City for municipal projects. These costs should also be compared to the cost of traditional resurfacing of the same areas.

#### 6.1.4 Green Roof

A vegetated roof cover, or green roof, is a plant system installed on an otherwise impervious area that is designed to divert or delay stormwater runoff, and insulate commercial, industrial, or residential roof structures. These systems are made of hardy varieties of drought tolerant succulent plants, such as sedum, installed in planters on urban roofs.

When rain falls, water is absorbed by plants and retained within the roof structure. Excess water is released through evaporation, reducing overall peak rate and volume of stormwater runoff from the roof. The biological, physical, and chemical processes found in the plant and soil complex reduce overall impact to the urban storm drain system.



**Figure 6-8.** Green Roof at the Children's Museum in Boston, Massachusetts. *Source:* Photo provided by laurenmetter.com

As a secondary benefit, green roofs and rooftop gardens, may serve as an aesthetic and culturally appealing aspect of highly urban environments and are often used in public settings to increase awareness and education of stormwater needs.

The overall pollutant load reduction that can be expected in the Mill River watershed from green roof implementation was estimated using the WMM. As shown in table 6-4, the overall pollution reduction potential of green roofs in the city is small. However, the public awareness and education aspect of these features may compensate for the shortcoming in overall coverage. A fairly aggressive assumption was made in the model that every building in the city with a footprint greater than 10,000 square feet would have a green roof. **Table 6-4** shows the estimated basin-wide pollutant loading reductions that could be achieved by implementing the green roofs.

**Table 6-4. Modeled Pollutant Loading Reduction from Green Roofs**

Pollutant	Estimated Basin-Wide Percent Reduction in Loading
Biological Oxygen Demand	1 – 2%
Metals	1%
Fecal Bacteria	1%
Nutrients	1%
Sediment	1 – 2%

Costs of green roofs vary significantly depending on the size and type of application. An average cost range of \$240,000 to \$1.3 million per acre of roof, combined with the modeling assumptions described above, yields a total cost estimate of \$6.0 to \$34.0 million to achieve the reductions listed in Table 6-4 (CWP, 2007). It is important to consider that this cost would be shouldered by various entities to build the green roofs, including private building owners for commercial projects and the city for municipal projects.

### 6.1.5 Sand Filter

Similar in structure and size to small detention ponds, sand filters are designed to direct stormwater to a location where it infiltrates into the subsurface or into a pre-filter for a storm drain system. Typical applications include urban areas where limited space is available for stormwater management infrastructure, in areas with a high groundwater table, or where soils are relatively impermeable. Sand filters are also effective in removing oil and grease often collected in runoff from vehicle storage or parking areas.

Basic sand filter design consists of an upper gravel or rock layer underlain by coarse to medium sand. However, more sophisticated or engineered structures are available. In areas where storage is necessary, pretreatment occurs in a subsurface settling chamber where large debris settles to the bottom of the tank. A second chamber containing a sand filter further removes smaller particles before



**Figure 6-9.** Sand Filter in an urban park. *Source:* Unknown.



water is either discharged to the existing drainage system or infiltrates into the soil.

Use of sand filters improves both stormwater quality and reduces runoff volumes through filtration of particulates and diversion or delay of peak flow. These improvements not only reduce the incidence of backups, but also reduce the pollutant load on receiving streams, ponds, and other water resources where stormwater is discharged.

The overall pollutant load reduction that can be expected in the Mill River watershed from sand filter implementation was estimated using the WMM. It was assumed that the city could capture 25% of the runoff from the High Ridge Rd commercial area in Ayers Brook Basin and 5% of runoff from impervious surface downtown through sand filters. **Table 6-5** shows the estimated basin-wide pollutant loading reductions that could be achieved by implementing sand filters.

**Table 6-5. Modeled Pollutant Loading Reduction from Sand Filters**

Pollutant	Estimated Basin-Wide Percent Reduction in Loading
Biological Oxygen Demand	4%
Metals	1 – 3%
Fecal Bacteria	2%
Nutrients	0 – 2%
Sediment	3 – 4%

Costs vary significant depending on the size and capture area of the sand filter. An average cost of \$91,000 per acre of tributary area, combined with the modeling assumptions described above, yields a total cost estimate of \$1.8 million to achieve the reductions listed in Table 6-5 (CWP, 2007). It is important to consider that this cost would be shouldered by various entities to build the individual sand filters, including commercial property owners and the City for municipal projects.

## 6.2 Nonstructural Controls

Nonstructural controls are programs which address management issues related to human activities that affect the water quality of the Mill River and its surrounding watershed. Programs may include maintenance to the river, citizen participation, adjustments to municipal services, and/or cooperation with private industrial property owners to address activities or conditions which negatively affect the river. Program-level controls and participatory activities are long-term development opportunities which will improve water quality over time.

Examples of program improvements include removal of low head dams, municipal and industrial maintenance and operations programs, illicit discharge detection and elimination (IDDE), identification and removal of private water intakes, and regular water quality monitoring. Citizen action can be utilized for organized management activities that require volunteer support, such as limited river bank restoration activities, removal of invasive plants, river cleanups, and limited instream restoration activities. Education and outreach positively influence stormwater improvements by focusing on pet waste reduction, yard waste management, and riparian buffer improvements on residential properties. Waterfowl reduction, educational signage near rivers, and improvements to public access also support

continued resident involvement and ownership of urban surface water resources. If possible, developing a citizen-based watershed association would provide an authority with which to drive such programs.

The following section summarizes the nonstructural control action items recommended under this plan and outline cost considerations for implementation. Refer to Section 6.4 for cost estimates.

### 6.2.1 Removal of Low Head Dams

Uninterrupted flow within a river is crucial to sustaining healthy habitats, maintaining consistent temperatures, and preserving fish and benthic population migration patterns. Barriers that limit natural flow negatively affect the river by impeding sediment flushing, limiting aquatic species migration, and increasing aeration, all of which are detrimental to maintaining healthy aquatic habitat.

Since development along the Mill River in the 17<sup>th</sup> century, several low head dams have been constructed to provide water as a resource for industrial activities. Over time, the industrial entities have closed down while several low head dams remain in place.

A low-head dam removal program could improve the water quality and aquatic habitat within the river, increase sediment flushing, and allow reestablishment of migration patterns. Such a program could involve a study to assess removal options and anticipated cost of each option, design, sediment removal including physical removal, treatment, and disposal, water quality and sediment monitoring, and riparian buffer improvements.

Figure 6-11 shows the locations and adjacent land parcels for the low-head dams within the study area that are candidates for removal.



**Figure 6-10.** Low head dam on the Mill River

### 6.2.2 Modify North Stamford Reservoir Low Flow Outlet

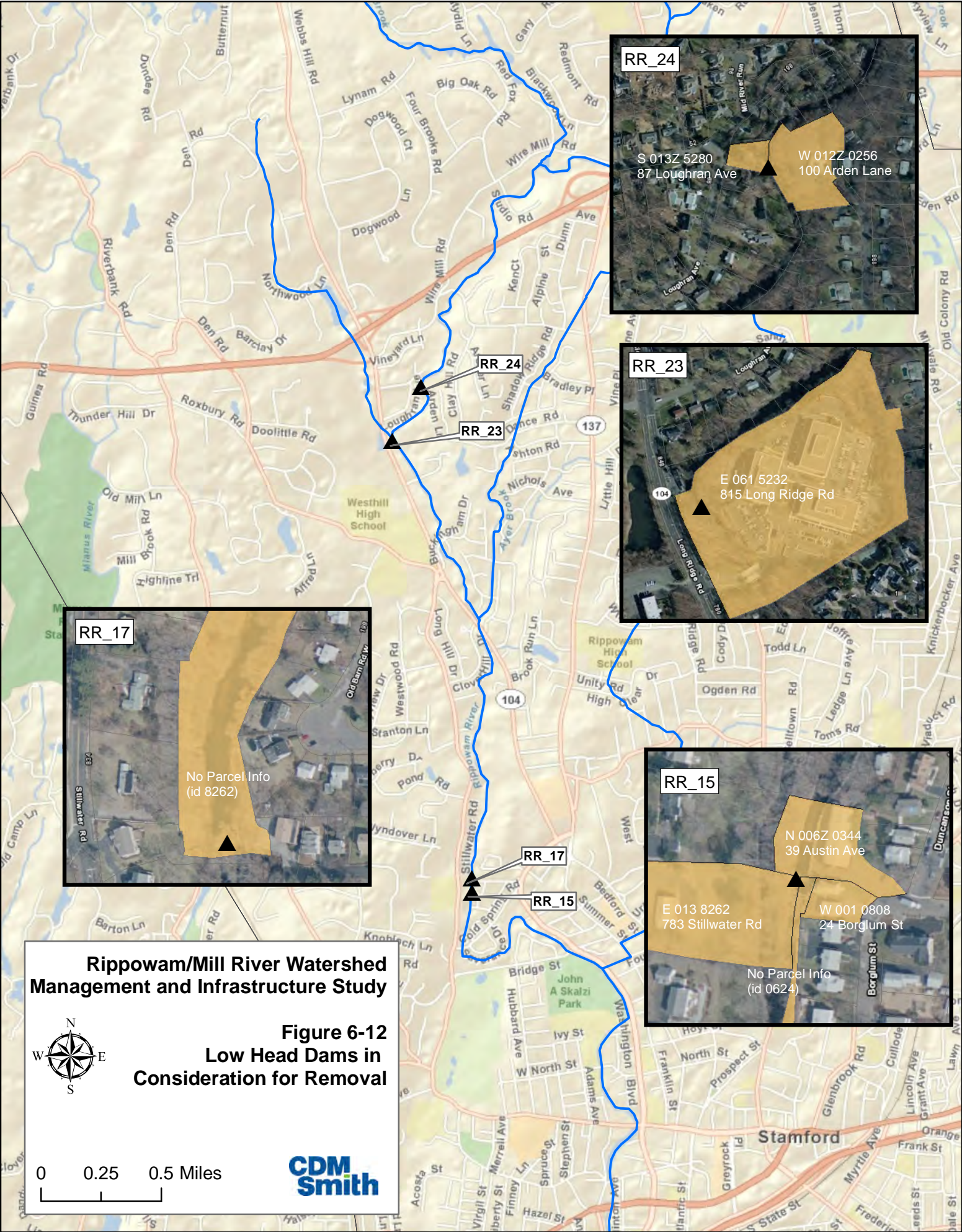


**Figure 6-11.** North Stamford Dam low flow outlet

The current low flow outlet from the North Stamford Reservoir discharges water at a few cubic feet per second directly to the Mill River. The outlet flow often has very low dissolved oxygen, especially in the summer months when the reservoir is likely stratified and the discharge is released from the hypolimnion (lower zone of cold, oxygen-depleted water). The low flow outlet discharge is aerated fairly quickly within the Mill River to more acceptable levels of dissolved oxygen under the current low flow release. However, should the release be increased, the low dissolved oxygen would cause habitat degradation.

There are two options for increasing the dissolved oxygen in the low flow discharge: 1) relocating the take point to a higher elevation within the reservoir or 2) introducing oxygen to the water after discharge. Relocating the take point would likely be more costly than designing post-discharge aeration. Either strategy will require an active management strategy





**RR\_24**

S 013Z 5280  
87 Loughran Ave

W 012Z 0256  
100 Arden Lane

**RR\_23**

E 061 5232  
815 Long Ridge Rd

**RR\_17**

No Parcel Info  
(id 8262)

**RR\_15**

N 006Z 0344  
39 Austin Ave

E 013 8262  
783 Stillwater Rd

W 001 0808  
24 Borglum St

No Parcel Info  
(id 0624)

**Rippowam/Mill River Watershed  
Management and Infrastructure Study**

**Figure 6-12  
Low Head Dams in  
Consideration for Removal**

0 0.25 0.5 Miles



between the City of Stamford and Aquarion Water Company, the owner and operator of the reservoir. An additional study should be done to assess current conditions, characterize the impact of the discharge on the immediate and further downstream reaches, and identify strategies that can be employed to improve flow and water quality conditions for the benefit of the Mill River. Cost for either option would involve a study, design, and construction. Construction for option 1, which would relocate the discharge outlet, would be significant in comparison to option 2, which would incorporate aeration mechanisms within the stream, downstream of the outlet.

### 6.2.3 Holts Ice Pond Remediation

Holts Ice Pond was identified as an excessively impacted water resource in need of pollutant mitigation. The pond is eutrophic, meaning that excessive nutrient loads have resulted in excess algal growth. The excess algae prevent the pond from supporting a healthy ecosystem. The pond also discharges excess nutrients and algae to the mainstem Mill River during storm events. Uncontrolled nonpoint source loading and a long residence time within the pond are the causes of the pond eutrophication.

Remediation programs can be focused and basic, with limited benefits, or complex and far-reaching, for maximum benefits. Such a program should include consideration for downstream affects of Holts Ice Pond on the Mill River along with current and future use of abutting properties. Planning should be done to collaborate with adjacent property owners to reduce the affects of land use, including applications of fertilizers and other chemical treatments, on the Mill River.

There are two options to address the Holts Ice Pond impact on the Mill River. The first option is source control, which would include remediation of the entire pond, including removal of excessive sedimentation, through a comprehensive study, design, and construction/ implementation with buffer improvements. The second option is to address the discharge from the pond, rather than attempt to control the nonpoint sources and improve the pond itself. Under this option, the City could work with land owners along the channel that carries water from the pond to the Mill River to install constructed wetlands. Wetlands would provide nutrient uptake and mitigate high flows from the pond during storm events.



**Figure 6-13 and Figure 6-14.** Holts Ice Pond Extreme Algal Growth in Summer

### 6.2.4 River Bank Restoration

Unstable river banks are detrimental to the habitat, ecology, water quality, and natural geomorphology of a river. Bank instability is caused by land development, high intensity storm flows, and channel modifications. Unstable banks can release large volumes of soil and sediment during wet weather events. As soil saturation increases during a rain storm, bank stability decreases. Erosion of the bank results in sediment being carried downstream, where it will settle and degrade habitat. Bank erosion is dynamic

and armoring the edges of one river reach will cause erosion elsewhere. Erosion results in water quality degradation, habitat loss, and property loss.

River bank restoration can include easing steep slopes and armored banks and increasing rooted plants to reinforce the embankment strength. This will decrease erosion and deposition, which will improve benthic and aquatic habitats, and improve the overall water quality in the river. Riparian buffer improvements, in addition to bank restoration, will increase the longevity of repairs. To implement such a program, overall cost is dependent on the height of the stream bank, the severity of armoring or erosion, and the method used to stabilize the stream bank. In general, the cost to repair river banks along the Mill



**Figure 6-15.** Eroded stream bank along Mill River

River could range from \$350 to \$1000 per linear foot.

Visual surveys of the study reach concluded that approximately 50% of the stream banks, on both sides, are armored. This is an indication of extensive need for bank restoration. The cost range for restoring 10% of the banks of the Mill River, based on linear feet of restoration and considering both sides of the river, would be \$2.8 to \$7.9 million.

### 6.2.5 Riparian Buffer Improvements

Riparian buffers provide filtration for sediments and particulates, add structural reinforcement to river banks, and reduce and delay the peak flow in the river. When development such as residential homes, streets, bridges, buildings, and parking lots encroach on a river, riparian buffers are often diminished.



**Figure 6-16.** Healthy riparian buffer and shaded stream area in Mill River



**Figure 6-17.** Lack of riparian buffer showing bank erosion in Mill River

A healthy riparian buffer includes a mix of native grasses, shrubbery, and trees. Vegetation helps to more evenly distribute overland runoff flow, absorb nutrients and excess water, and control concentrated runoff. Trees aid in stabilizing river banks and provide shade, reducing water temperature and providing a more suitable habitat for aquatic animal and plant species. Incorporating these elements into public

land areas and encouraging residents to do the same will make a substantial difference in the quality and quantity of stormwater inputs the Mill River receives. Overall cost for this program is estimated to be minimal as cost would be voluntarily incurred by informed residents, the City, and proactive commercial land owners along the river. Cost per property and maintenance is also estimated to be minimal if native grasses, shrubbery, and trees are planted.

### 6.2.6 Removal of Invasive Plants

Removal of invasive plant species is essential to river habitat restoration. Non-native species endanger the environments they invade by displacing native species within the same ecological niche. This causes a ripple effect up the ecological food chain, a lack of biodiversity in the area, and alterations to the physical and chemical properties of the river.

The invasive species known as Japanese Knotweed (*Polygonum cuspidatum*) was found in abundance along the Mill River. This invasive species is commonly found in areas along stream banks and roadways which are not regularly maintained. It was originally introduced in the United States for erosion control because of the species' ability to grow in a variety of soil conditions and thick underground root system which will grow back even after the plant has been cut down.



**Figure 6-18.** Japanese Knotweed in bloom  
Source: University of Connecticut Eastern Forest Environmental Threat Assessment Center

The Japanese knotweed can grow to 10-feet in height and can inhabit a variety of adverse conditions including full shade, high temperatures, high salinity, and drought. Japanese knotweed poses a significant threat to riparian areas, where it can survive severe floods and rapidly colonize scoured shores and islands. Once established, populations are extremely persistent.

In the Mill River basin, this species poses a threat because it spreads quickly, takes over entire areas, impedes access to the river, and chokes out other natural species necessary to maintain a healthy habitat. Removing these plants will make room for native plants to reestablish themselves. Currently, the City organizes annual volunteer cleanup events which remove this invasive species along the river. The cost for continuing this program is based on maintaining supplies, educating volunteers, and transporting and disposing of the plants and is estimated to be minimal.

### 6.2.7 Instream Restoration

Instream restoration is a broad category of improvements which may be made to enhance the quality of a stream by improving the hydrologic, geomorphic, and ecological processes of a degraded watershed system and/or replacing compromised elements of the natural river system.

In areas where fish habitat has been compromised, the habitat can be enhanced by placing materials, such as large pieces of wood or boulders, into the stream channel to increase pooling and change the



**Figure 6-19.** Excessive large and small debris jamming Mill River



hydrologic cycle of a specific area. Other instream restoration techniques include increasing tree plantings along the riparian zone to offer shade to otherwise exposed river areas. Or the channel itself could be dredged or manipulated in order to address specific processes which connect and sustain fish and aquatic life habitats, as appropriate, to meet the specific habitat needs of native aquatic life populations.

Within the Mill River, high sedimentation and excessive debris dumping has caused buildup throughout the stream bed, choked benthic animal and aquatic plant life populations, and altered the hydrology of the river. Debris removal should be the first step in a stream restoration program for the Mill River. The river will respond to changes in flow patterns, seeking equilibrium in its new geometry. Therefore, it is not advisable to produce major changes within the channel without a detailed geomorphological assessment of the expected outcome.

The cost for improving instream habitat is comparable to that of river bank restoration and will require minor site-specific study (to supplement results from the geomorphology study completed in 2010), design, and construction. Construction costs could include equipment access pathways, and replanting, to the river, structural reinforcement, biological plantings, and removal of trash and debris.

### 6.2.8 Public Access Points

Recreational activities provide residents with an opportunity to utilize all of the benefits that local resources have to offer. Public access to the water resource is an essential component to establishing the community relationship with a local water source. Access points for canoes, kayaks, and fishing will provide the community with an added incentive to maintain, preserve, and protect the river.



**Figure 6-20.** Public amenities along the Charles River in Boston, MA

Public access points could be installed in park areas or along the river in locations where there is enough space to park multiple vehicles and transport personal watercraft to the river using a clearly designated, spacious pathway. Signage should designate the parking area, the boat access point, and list any local ordinances and use limitations, such as limited motorized watercraft and operation hours. The new downtown Mill River Park (the former Mill Pond area) would be an excellent site for river access, particularly fishing and wading. There is a potential access point that could be developed off Buckingham Road in the middle watershed. An existing access point from the road to the floodplain at this location could be better maintained and a small boat launch may be possible. Cost of site selection and procurement, study, design, and construction of an individual public access points is highly variable and dependent on the cost of property.

### 6.2.9 Designate Wildlife Protection and Viewing Areas

Designated wildlife viewing areas offer an opportunity for members of the community to participate and engage in the well being of their local water resource. Such designated viewing spots could be installed along walking pathways, bike trails, parks, and other water access points. In general, wildlife viewing points require little site preparation and little infrastructure to complete. They can be as simple as a park bench and small sign in a park and incur a minimal investment to develop.

Wildlife protection areas are designated parcels of land that are intentionally preserved and undeveloped to benefit local wildlife populations. Local wildlife in Stamford includes many species of birds, small mammals, reptiles, invertebrates, amphibians, and deer. Protection areas could be designated with support from local property owners and the CT DEEP. Cost of siting and installation of basic signage and seating areas for viewing areas is generally estimated to be minimal.



**Figure 6-21.** Bird watching is a passive recreational activity that promotes habitat protection and watershed stewardship. Photo courtesy of CDM Smith.

## 6.3 Programmatic and Regulatory Mechanisms

Program-scale improvements are long-term opportunities to address water quality in Mill River and associated tributaries. These recommendations include program ideas that will improve the overall watershed health or address specific areas of concern. They are driven both from the top down and from the bottom up. The city can develop ordinances to enforce some programs, but others should be grass-roots efforts initiated by conscientious citizens of the watershed. Estimated costs associated with these programs are anticipated to be incorporated within current municipal costs. Refer to Table 6-6.

### 6.3.1 Waterfowl Reduction Program

Canada geese and ducks are common throughout the region during warm weather and throughout the year. Flocks congregate along surface water sources including streams, rivers, and ponds to hunt, nest, and graze. While they can be perceived as a pleasant sight in populated areas where contact with wildlife is limited, large groups of waterfowl can overpopulate a limited area and pose a threat to native species and residents, and can severely affect water quality in the boundary water resource. In addition, Canada Geese are not historically native to the northeast and have been introduced in the last hundred years as a result of a defunct hunting and repopulation program.

When waterfowl congregate in large populations, particularly in parks which are free of natural predators, water is available, and residents choose to feed them, they tend to overtake an area and build residence. Over time, they can become territorial, particularly when goslings are young. Because food is plentiful and there are no natural predators, there is no control for the population and it continues to expand to the point of overpopulation.



**Figure 6-22.** Canadian Geese along the Mill River



The largest threat to the Mill River is the large amount of waste produced by the large waterfowl populations. Waste is washed by rainfall runoff from grassed areas to the river, substantially increasing nutrient and bacteria levels, promoting algal growth, and severely degrading the resource. The monitoring program discovered high levels of bacteria within the Mill River, and waterfowl are a likely contributor.

Waterfowl overpopulation is a common problem in areas throughout the country, and particularly in the northeast. A great amount of work has been done by municipalities to identify and mandate programs which manage these populations. A common partner organization to municipalities and watershed groups is GeesePeace, which is a 501(c3) non-profit corporation. Examples of municipal programs include stakeholder involvement, property owner engagement, training seminars, population stabilization, site aversion through use of a trained canine, mandated no feeding regulations, community outreach and education, advertising, public service announcements, educational videos, and posted signage.



**Figure 6-23.** Informative sign posted along the Charles River in Boston, Massachusetts

In addition to waterfowl population reduction tactics, site work can be employed to limit the effects of excessive waste to a water body. Planting native grasses and other low-lying plants in an open space, particularly along the shore of a river or pond, will provide a buffer which catches and filters waste before it enters a water body. Such plantings also limit direct access to the water and can make waterfowl nervous, since the grass provides a cover for potential predators. Implementation of such a program is estimated to be minimal, but could be more costly depending on the level of effort required to improve signage and limit waterfowl access.

### 6.3.2 Pet Waste Reduction Program

Unmanaged pet waste can accumulate on the ground surface and wash off in rainfall runoff, leading to increased levels of bacteria in receiving waters following a storm event. Pet wastes may also introduce viruses and parasites to receiving water bodies, threatening public health. Pet waste is also unsightly and can deter use of public space.

Active municipal management for pet waste reduction is a two-fold process which involves education and outreach in addition to local ordinance development and enforcement. The first step is to develop an awareness campaign that champions proper pet waste removal. Education and outreach could involve informative handouts, signage, directed mailings for licensed owners, participation in community events, establishment of a local dog owners club, and presentations to local community groups and schools that stress the importance of proper pet waste disposal.

In addition to awareness and education, designating spaces for pet walking, pet curbing, and pet socializing will encourage pet owners to maintain shared public pet spaces. Such spaces could offer water, waste



**Figure 6-24.** Pet waste advisory sign and free pick-up bags in Stamford

pickup bags, and trash containers in commonly visited public spaces such as parks and city-owned grassed areas. Over time, such spaces in other cities have been known to provide a physical space for local pet owners to congregate and develop connections with their neighbors, increasing pride and connection to their community.

The second aspect of pet waste reduction is development and enforcement of local ordinances that punish pet owners who do not properly dispose of pet waste. The level of investment is highly dependent on the severity of the issue and the level of impact pet waste has on local water resources. Fines can range from \$25 for first time and up to \$500 for repeat offenders. However, enforcement is highly dependent on witnessed incidents, which can be difficult and costly to regulate. Cost for implementation of a pet waste reduction program will include cost for bags, signage, waste receptacles, and enforcement. A portion of these costs could be offset through noncompliance fines.

### 6.3.3 Community Participation Events

Annual river cleanups sponsored by local watershed groups have been effective in many communities throughout the country as an activity that not only benefits water quality, but also improves the connection residents have to their local water resources. These cleanups incur a minimal cost for basic supplies – such as trash bags, rakes, and temporary signage - and provide regular maintenance to an extent beyond what could be accomplished by municipal employees alone. Coordination and setup is also minimal, and can generally be done on a volunteer basis.

Annual cleanups also provide an opportunity for community members to meet one another, develop a connection with the river, and increase pride in their community. River cleanups engage local schools in waste pickup, increase awareness of littering, and inspire neighborhood groups to team up and represent their organizations. Such an event could also engage local business owners through sponsorship opportunities and designated company team cleanup areas, providing an opportunity for social engagement, collaboration among employees, and increased presence of the business within the community.

In addition to cleanup events, it is important for residents to also establish a positive long-term relationship with the Mill River. Opportunities for hands-on participatory activities that improve the landscape, such as native species plantings or park renovations, allow residents to provide long-lasting impressions on the watershed. Such activities could be coordinated with local schools to provide an avenue for students to develop stewardship over the well being of the natural environment. Costs to conduct such programs are minimal and rely heavily on volunteers and donated supplies.



**Figure 6-25.** CDM Smith employees clean up the Potomac River in Virginia as part of an annual volunteer cleanup event

### 6.3.4 Reduce Improper Yard Waste Dumping

Yard waste is composed of leaves, grass, brush, weeds, and organic trimmings pulled from plants on residential properties. In Stamford, yard waste is accepted at the Scofield Town landfill. The service is free for residents who arrive in their personal vehicle and at the cost of approximately \$80 per ton for commercial vehicles. In the fall, leaves are picked up by the city starting in the second week of November. Specific dates for city-wide pickup are posted on the city website and in the *Stamford Advocate* starting in early November.



**Figure 6-26.** Grass clipping disposal along banks of Mill River

Connecticut law requires all residential, commercial, and public/private agencies, including institutions such as schools and hospitals, to compost leaves. In most cases, this requires the entity to hire a private hauler. Residents, however, can choose to utilize city services which often include free pickup during peak leaf season or may choose to compost leaves on their property. Grass clippings can be left in place on the lawn or brought to an accepting recycling center.

However, residents often do not properly care for their yard waste. This is particularly evident in rural areas or areas along river banks where leaf piles are common. Improper yard waste dumping along river banks is against state law and it is harmful to the health of the local water resource.

Improper yard waste dumping along river banks introduces excess organic waste material and sediment to the water body. As deposited leaves decay, the process consumes dissolved oxygen in the water, creating a habitat unsuitable for aquatic species. The decomposition process also releases nitrogen and phosphorus which promote algal growth in water.

In addition to water quality concerns, sediment and erosion as a result of improper yard waste disposal can have a detrimental effect on water resources. When yard waste accumulates due to dumping, it can prevent natural vegetation from growing. This leads to unstable embankments, inhibits drainage, and promotes erosion.

Improper disposal is not limited to border properties along stream banks; leaves and yard waste should not enter storm drains. Yard waste piles left uncontained on the curb will wash to storm drains during rain events and clog the system. This leads to increased maintenance costs for the city and water quality degradation due to decreased drain system functionality.



**Figure 6-27.** Leaves discarded along roadway drainage route in Mill River watershed



To address improper dumping of yard waste, the City should educate residents of the detrimental effects of poor disposal practices on water resources and their property boundaries. Proper embankment management, consisting of native tree and brush plantings and maintenance, should also be part of a local education and outreach campaign. If necessary, local enforcement of state law is also an option. Cost for implementing such a program is based on developing local ordinances and setting up enforcement strategies, and may be offset through fines.

### 6.3.5 Develop Website for Public Education and Information

Websites are an invaluable resource for the public to learn more about local initiatives related to watershed management, best practices, education, and outreach campaigns. Developing a web presence in some capacity is an essential component of any citizen campaign, particularly for campaigns that are complex or require some level of participant training. Websites also provide legitimacy to an outreach program, particularly when managed by a volunteer organization, by offering more information on group affiliations and how the organization is structured.

The website could be developed specifically by a Mill River watershed association or a webpage could be incorporated into the existing city of Stamford website. In both cases, there are a variety of companies that specialize in environmental communications and campaigns that could assist with the development of these resources. In addition to a webpage, live updates in the form of a blog, Twitter account, Facebook page, or general interest electronic mailing list could be another resource to connect watershed constituents to the mission of improving the river.

The cost for developing a website is dependent on where the website will be hosted. If the website is hosted through the City website (this is considered option 1) the cost will be minimal and may be shared with typical web hosting costs that the City incurs on an annual basis. If, however, the website is hosted separately from the City webpage, costs could be more substantial, as shown for option 2 in Table 6-6.

### 6.3.6 Educational Signage



**Figure 6-28.** Example of educational signage from Charles River reservation in Boston, Massachusetts

Educational signage in public spaces along the river provides an opportunity for community members who use access points, recreational walking or biking paths, or park areas to learn more about their local natural resources. Such signage could include a map of the park trails, photographs of park development or historical use, a description of the history of the local area, or information on local animal or plant species. Signs can also be used to designate protected species areas or to educate citizens on local regulations such as picking up pet waste or not feeding waterfowl.

However they are used, signs are an opportunity to communicate with the public who use natural spaces and

could be applied in a variety of locations and conditions to maximize resident cooperation with resource protection. Cost for designing, siting, and installing signs could be covered by the watershed association donations and sponsors.



### 6.3.7 Mark Stormwater Grates with Educational Message

In many cities throughout the northeastern United States, storm drains convey wet weather runoff from urban developed areas to surface water resources. Storm drains within the Mill River watershed carry stormwater to tributary streams or directly to the main stem river, which ultimately empties into the Long Island Sound. Many pollutants in stormwater originate far from the catch basin on lawns, streets, and sidewalks. However, depositing substances directly into the drains also pollutes the water. Potential direct pollutants include pet waste (bacteria), volatile compounds from paints and solvents, metals and oil from vehicles, leaf or yard waste, phosphorus from detergents, and litter. Citizens often confuse storm drains with sanitary sewers, thinking that what goes down a storm drain ends up in the same place as what goes down the toilet or sink drain. In Stamford, where these systems are separate, outreach is needed to educate citizens on how the city's infrastructure functions.

By marking stormwater grates with educational messages that communicate the end output of the drain system, citizens' awareness of the potential pollution route increases. Generally, this decreases improper storm drain disposals, but more importantly it reminds people that everyone lives and works within a watershed, which is the first step to fostering stewardship for community water resources.

In Stamford, Boy Scouts have volunteered to mark catch basin grates that drain to the Long Island Sound. A broader campaign, involving additional volunteer groups, would expand this beneficial pollution mitigation and public education endeavor for a minimal cost. The City may also choose to install permanent signs in concrete sidewalk areas downtown where higher pedestrian traffic provides more visibility for educational signage and aesthetics are more important.



**Figure 6-29.** Example of storm drain stencil. Source: Unknown

### 6.3.8 Promote Better Commercial Property Stormwater Practices

Commercial property owners could play a large role in stewardship of the Mill River by adopting low impact development strategies which offset the negative effects of an impervious developed area. This can be done by combining several strategies and making those strategies visible to the public.



**Figure 6-30.** Stormwater detention site with educational signage at City of Cambridge, Massachusetts Department of Public Works building



**Figure 6-31.** Large commercial parking lot in Stamford: a good opportunity for stormwater best management practices

Depending on the use of a commercial site, improved stormwater practices could include: porous pavement, porous pavers, rain gardens, a green roof or roof garden, tree planters, and buffer gardens.

The City of Stamford, in partnership with community groups and/or the Mill River watershed group, should work in partnership with local commercial property owners to connect them with resources and information necessary for the development of improved stormwater practices at commercial sites. The City can also adopt ordinances and incentives for commercial developers to use low impact development techniques. Cost for such improvements would be incurred by commercial property owners.

### 6.3.9 Promote Better Residential Property Stormwater Practices

Stamford is primarily a residential community and improved management of stormwater runoff from residential properties is an important component of this plan. Residential stormwater best practices could include low impact development strategies and best management practices, such as green roofs or rooftop gardens, incorporation of porous materials in driveways and paved property areas, incorporating rain gardens at roof leader outlets, planting natural buffer areas between manicured lawns and river embankments, properly managing leaf and yard waste, minimizing use of fertilizers and pesticides, and developing a general awareness of how household practices could affect river water quality.

Improving residential stormwater practices will require collaboration between the City of Stamford and the local watershed constituency. Education and outreach materials, events, presentations, web-based information resources, and participatory workshops will be necessary to spread awareness and understanding of best management practices, available resources, and connections with local professionals. While not all residents will actively participate in such a program, targeted engagement of boundary homes along the Mill River and its tributaries could provide a significant improvement to stormwater practices. The City may also consider developing incentives and rebate programs to assist residents with the financial burden of implementing best management practices and low impact development techniques.

Similar to other voluntary programs, costs for promoting an education and awareness-based campaign is minimal and will likely be incurred by residential property owners. Additional funding could be provided by the city to provide subsidies or reward incentives on an annual basis.

### 6.3.10 Bacterial Source Tracking

Bacterial source tracking is a scientific method used to determine the origin of bacterial pollution found in surface water resources. Samples collected from the stream are analyzed to determine if the fecal bacteria was produced by a human, wildlife, agriculture, or domestic pet. The technology is well-proven, but generally very expensive.

This information, while expensive, could allow the city to take corrective action against illicit connections and develop a more targeted management approach. For example, knowing that waterfowl are a much larger source of bacteria than dogs would allow the city to target management strategies toward waterfowl control and not expend resources on pet waste programs. Bacteria source tracking results can also provide focus for a city-wide Illicit Discharge Detection and Elimination program. Such a program is costly, but costs are projected to decline as such programs become more commercially viable.

### 6.3.11 Increase Street Sweeping and Catch Basin Cleaning

Street sweeping and catch basin cleaning have tremendous benefits to receiving surface water sources by preventing sand, salt, litter, metals, volatile organic compounds, oils, fertilizers, pesticides, and other hazardous materials from being introduced to the surface water resource. Proper street sweeping involves vacuum removal of the surface material followed by appropriate disposal.



**Figure 6-32.** Debris on Stamford residential street that would be removed by street sweeping



**Figure 6-33.** Poorly maintained catch basin grate in downtown Stamford

Maintaining storm drain catch basins, which can become laden with sediment and debris despite the very best street sweeping efforts, is imperative to ensuring proper functioning of the system. Debris clogging storm drainage routes can cause flooding and can result in higher sediment loads to the river during large storms. Cost for increased street sweeping would be incurred through an increase in current road maintenance budgets.

### 6.3.12 Illicit Discharge Detection and Elimination

As part of the Phase II MS4 requirements, Stamford is required to develop an illicit discharge detection and elimination (IDDE) program. Currently the City does not have a comprehensive IDDE program. The following is excerpted from EPA's NPDES website<sup>1</sup>, giving an explanation of illicit discharges and sources of additional information.

*Illicit discharges are generally any discharge into a storm drain system this is not composed entirely of stormwater. The exceptions include water from fire fighting activities and discharges from facilities already under an NPDES permit. Illicit discharges are a problem because, unlike wastewater which flows to a wastewater treatment plant, stormwater generally flows to waterways without any additional treatment. Illicit discharges often include pathogens, nutrients, surfactants, and various toxic pollutants.*

*Phase II MS4s are required to develop a program to detect and eliminate these illicit discharges. This primarily includes developing:*



**Figure 6-34.** Wash water from a commercial car wash discharging down a storm drain is an example of an illicit discharge. Source: EPA

<sup>1</sup> [http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min\\_measure&min\\_measure\\_id=3](http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=3)



- a storm sewer system map,
- an ordinance prohibiting illicit discharges,
- a plan to detect and address these illicit discharges, and
- an education program on the hazards associated with illicit discharges.

An effective illicit discharge program needs to be both reactive and proactive. The program is reactive in addressing spills and other illicit discharges to the storm drain system that are found. The program must also be proactive in preventing and eliminating illicit discharges through education, training and enforcement.

Additional information on this minimum measure, including the stormwater Phase II regulatory requirements<sup>2</sup> for IDDE and a fact sheet on the IDDE minimum measure<sup>3</sup> is also available.

### 6.3.13 Address Private Water Intakes



**Figure 6-35.** Private water intake on the Mill River (May 2009)

In an effort to preserve the already-diminished baseflow in the Mill River, the city could implement a program to seek out and regulate these private withdrawals. The costs associated with such a program would include associated staffing and administrative costs.

An often-overlooked negative impact that land development in a watershed can have on the associated streams is decreased base flow. Increased impervious surfaces reduce the amount of stormwater that infiltrates into the shallow groundwater, therefore decreasing the groundwater-fed base flow in streams. Low flows during dry summer months are natural for a stream, but further decreases in low flows – due to any factor - can be detrimental. The developed watershed of the Mill River causes decreased summer base flows. Private, unregulated withdrawals from the river can decrease these flows further. During field visits and sampling events, staff observed mobile units withdrawing large volumes of water from the river as well as private, permanent intakes along the stream banks.

### 6.3.14 Create Mill River Watershed Association

Many of the topics outlined in this section have discussed the formation of a local watershed association. Watershed associations have proven to be very effective in promoting major cleanup actions and water quality improvements in urban watersheds throughout New England. In order to implement many of the nonstructural controls outlined in this section, the City should consider working in partnership with local community groups to help inspire a community-driven volunteer watershed association for the Mill River.



**Figure 6-36.** Example of educational signage and park development as part of the outreach/education campaign by Charles River Watershed Association in Boston, Massachusetts.

<sup>2</sup> [http://cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp\\_regulatory.cfm#minmeasure3](http://cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_regulatory.cfm#minmeasure3)

<sup>3</sup> <http://www.epa.gov/npdes/pubs/fact2-5.pdf>



The Mill River watershed association could be responsible for working with the city to: develop web resources, manage outreach and education campaigns, organize river cleanup events, and organize other events, initiatives, and development strategies that would increase water quality and improve the river for the benefit of the community. Development improvements that the watershed association could propose include increased visibility of the river, increased community use and participation along the river through bike paths, walking paths, dog parks, wildlife viewing areas, recreational access points, educational signage, and other long-term strategies that benefit the overall health of the Mill River.

### 6.3.15 Regular Monitoring Program

A regular monitoring program should be established to gauge the short- and long-term benefits of the action items recommended in this plan. The program should include targeted monitoring of problem areas identified in the Comprehensive Characterization Report and Section 4 of this plan. The monitoring should also include regular collection of water quality samples from throughout the river system to periodically assess the conditions and compare to the baseline established by this study.

A volunteer monitoring program, with adequate training of field personnel, is a cost-effective approach to this task. Overall annual cost could include equipment (sampling bottles, labels, storage, and monitoring equipment), transportation, sample analysis (which could be supported by the City wastewater treatment facility), and training. In addition, a one-time or occasional routine review of the sampling program could be supported by a consulting firm to provide feedback on water quality, sample locations, and continued advancement of the watershed management program.



**Figure 6-37.** Winter sample collection on a Mill River tributary

## 6.4 Summary of Action Items

Costs ranges associated with each action item are listed in **Table 6-6** below. Each of the action items described above is summarized in **Table 6-7**. This table lists the relevant report section, the action item name, a short description of the benefits, the category, locations where the action item may be applicable, the parties likely involved in implementation, the activities involved (e.g. design, construction), the plan objectives addressed by the action item, and the relative cost. Several of the action items refer to particular reach numbers of the study area stream where the action item could be implemented; **Figure 6-38** is a map of the reach numbers. The relative costs are presented in ranges as follow:

**Table 6-6. Cost Range Explanation for Implementation of Action Items**

Cost Range	Explanation
\$	No cost or minimal cost to the city (other parties involved would bear the cost, or the action item would fit in with existing programs)
\$\$	Up to \$100,000
\$\$\$	Up to \$500,000
\$\$\$\$	Greater than \$500,000

The cost estimates provided in this document are planning-level estimates; the actual cost of each action item will depend upon many factors outside the scope of this planning effort.

In addition to Table 6-7, Appendix E contains a fact sheet for each action item. These sheets may be useful for public communication, quick reference, or compiling applications for funding (grants and loans).

**City of Stamford**  
**Rippowam/Mill River Watershed Study**  
**Table 6-7. Summary of Action Items, Benefits, and Project Objectives**

Report Section	Action Item	Benefits <sup>1</sup>	Category <sup>2,3</sup>	Applicability <sup>4</sup>	Parties Involved <sup>5</sup>				Engineering/Design	Construction	Related Objectives <sup>6</sup>	Relative Cost <sup>7</sup>	Unit
					City of Stamford	Private Entities	Volunteers	Watershed Constituency					
6.1.1	Rain garden/bioretenion area	Filter and reduce total runoff and pollutants	Structural BMP	Mall, Hospital, Commercial, Residential and Municipal Properties	X	X			X	X	4, 5, 6, 7, 8	\$\$-\$\$\$\$	Per model assumptions
6.1.2	Tree filter/street Planter	Filter and reduce total runoff and pollutants	Structural BMP	High Ridge Road, Long Ridge Road, Hubbard Area, Mall, Commercial areas, General		X			X	X	4, 5, 6, 7, 8	\$\$\$\$	Per model assumptions
6.1.3	Porous pavement	Filter and reduce total runoff and pollutants	Structural BMP	Mall (Long Ridge Rd), Scalzi Park, Commercial/ Residential/ Municipal Properties with impervious surface	X	X			X	X	4, 5, 6, 7, 8	\$\$\$-\$\$\$\$	Per model assumptions
6.1.4	Green roof	Filter and reduce total runoff and pollutants	Structural BMP	Mall (Long Ridge Rd), Commercial properties, General	X	X			X	X	4, 5, 6, 8	\$\$\$-\$\$\$\$	Per model assumptions
6.1.5	Sand filter	Filter and reduce total runoff and pollutants	Structural BMP	Commercial/ Municipal Properties with impervious surface	X	X			X	X	4, 5, 6, 7, 8	\$\$\$\$	Per model assumptions
6.2.1	Removal of low head dams	Removes barriers, allowing species migration and river flow to follow natural patterns	Nonstructural Control	Specific structures identified throughout river	X				X	X	2, 6	\$\$\$	Per Dam Removed
6.2.2	North Stamford Reservoir - modify location of low flow outlet	Higher oxygen content in water flowing to river from North Stamford Reservoir	Nonstructural Control	North Stamford Reservoir Outlet	X	X			X	X	5, 6	\$\$\$\$	Total - move outlet
	Downstream of Outlet			\$\$\$								Total - reaeration	
6.2.3	Holts Ice Pond - source control and pond remediation	Improvements to the hydraulics and water quality of the Holts Ice Pond discharge would reduce its negative impacts on the main river.	Nonstructural Control	Holts Ice Pond	X	X			X	X	4, 5, 6	\$\$\$\$	Option 1 - pond remediation
	Downstream of Pond			\$								Option 2 - discharge remediation	
6.2.4	River bank restoration	Prevents excessive sedimentation and maintains structural borders	Nonstructural Control	General Location			X	X	X	X	5, 6	\$\$\$	Total
6.2.5	Riparian buffer improvements	Buffers mitigate negative effects of stormwater runoff by reducing flow velocity and sequestering pollutants.	Nonstructural Control	Education, Ordinance, General			X	X	X	X	4, 5, 6	\$	Annual
6.2.6	Removal of invasive plants	Restores ecological health of river corridor and watershed.	Nonstructural Control	Ayers Brook, Reaches 3-7, Reach 9, General Location			X	X			6	\$	Annual
6.2.7	Instream restoration	Restores natural functions of stream.	Nonstructural Control	Reaches 1-2, 3-8, General Location			X	X	X	X	4, 6	\$\$\$	Total
6.2.8	Public access points	Improve public accessibility and awareness though park areas, boat launches, and walking pathways.	Nonstructural Control	Reach 10, Scalzi Park, General	X			X	X	X	1, 2	\$\$	Annual
6.2.9	Designate wildlife protection and viewing areas	Improves public accessibility and awareness.	Nonstructural Control	Reach 18, Scalzi Park, General	X			X			1, 2, 3, 6	\$	Annual
6.3.1	Waterfowl reduction program	Reduces source of bacteria pollution.	Programmatic/Regulatory	Education, Reach 1, Scalzi Park, General Location	X		X	X			1, 2, 5	\$	Annual
6.3.2	Pet waste reduction program	Reduces source of bacteria pollution.	Programmatic/Regulatory	Education, Ordinance, Scalzi Park, General	X		X	X			1, 2, 5	\$	Annual
6.3.3	Community participation events	Improve aesthetics and river ecology through cleanup events, plantings, and other programs	Programmatic/Regulatory	River Clean Up Day, Signage, Education			X	X			1, 2, 6	\$	Annual
6.3.4	Reduce improper yard waste dumping	Reduces source of nutrients and solids pollution.	Programmatic/Regulatory	Education, Signage	X	X		X			1, 5, 6	\$	Annual
6.3.5	Website for public education and information	Improves public accessibility and awareness.	Programmatic/Regulatory	Within City webpage	X			X	X		1, 2, 3	\$	Annual
				Separate webpage								\$\$	Total

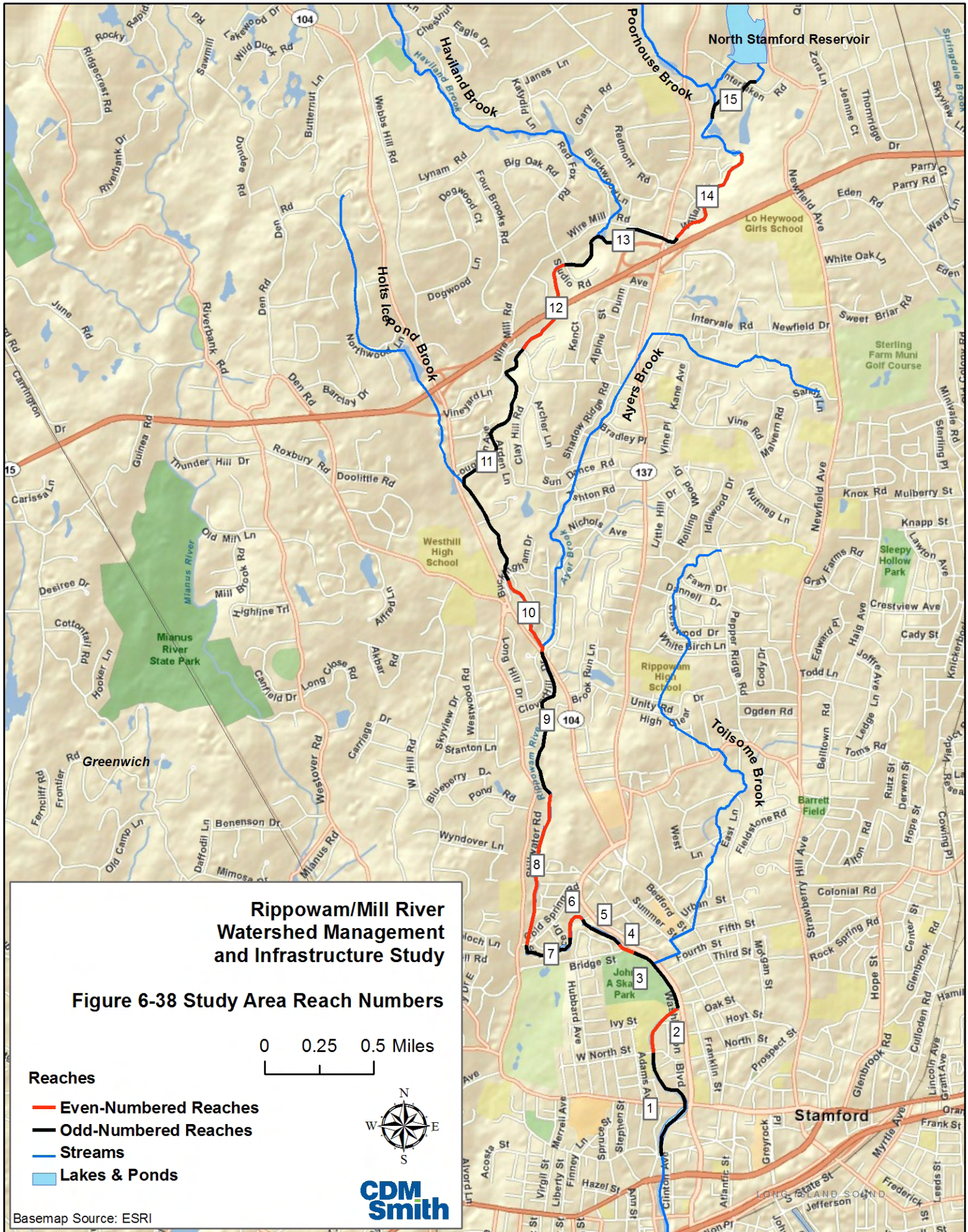
**City of Stamford**  
**Rippowam/Mill River Watershed Study**  
**Table 6-7. Summary of Action Items, Benefits, and Project Objectives**

Report Section	Action Item	Benefits <sup>1</sup>	Category <sup>2,3</sup>	Applicability <sup>4</sup>	Parties Involved <sup>5</sup>				Engineering/Design	Construction	Related Objectives <sup>6</sup>	Relative Cost <sup>7</sup>	Unit
					City of Stamford	Private Entities	Volunteers	Watershed Constituency					
6.3.6	Educational signage	Improves public accessibility and awareness.	Programmatic/Regulatory	Education	X			X			1, 2, 3	\$	Annual
6.3.7	Mark stormwater grates with educational message	Improves public awareness and reduces pollution.	Programmatic/Regulatory	Install permanent signs into concrete near storm drains	X						1, 5, 6	\$\$ - \$\$\$	Option 1
				Spray paint message								\$	Option 2
6.3.8	Promote better commercial property stormwater practices	Reduces source of solids pollution.	Programmatic/Regulatory	Ordinance, BMP Enforcement, Education	X	X		X	X		5, 6	\$	Annual
6.3.9	Promote better residential property stormwater practices	Reduces source of solids, bacteria, and nutrients pollution.	Programmatic/Regulatory	Ordinance, BMP Enforcement, Education, Subsidies	X	X		X	X		1, 5, 6, 8	\$\$\$\$	Annual
6.3.10	Bacteria source tracking	Step towards reducing sources of bacteria pollution.	Programmatic/Regulatory	Toilsome and Ayers Brooks, Program	X				X		5	\$\$\$\$	Total
6.3.11	Increase street sweeping and catch basin cleaning	Reduces source of solids and metals pollution.	Programmatic/Regulatory	General Location	X						5, 6	\$	Annual
6.3.12	Illicit discharge detection and elimination	Step towards reducing sources of bacteria pollution.	Programmatic/Regulatory	Program	X				X	X	5, 6	\$\$\$\$	Total
6.3.13	Address private water intakes	Restores natural river flows.	Programmatic/Regulatory	Existing Permit, Ordinance, Garden Center at Reservoir	X	X					1, 7	\$\$	Annual
6.3.14	Create Mill River Watershed Association	Establishes venue for action, improves public accessibility and awareness.	Programmatic/Regulatory	Program	X			X			1, 3	\$	Total
6.3.15	Regular monitoring program	Evaluates progress toward Basin Management Plan goals, and assesses health of river.	Programmatic/Regulatory	Program	X			X	X		5, 8	\$\$	Annual

**Notes**

- (1) Benefits description is general and not comprehensive. Refer to relevant text within the Basin Management for further description.
- (2) Structural BMPs are well-known best management practices often considered for retrofit to existing stormwater conveyance or for new, low-impact development (LID)
- (3) Nonstructural controls may be programs or physical changes that are not considered structural BMPs, but have a direct and physical positive impact on the river
- (4) Applicability refers to the general area within the Mill River Watershed where known issues determined during Phase I could be remedied; other areas may also be candidates for the action item
- (5) Parties involved are generally assigned based on the nature of the action item and suggested as a guideline
- (6) Objectives are as follows:
1. Increase public awareness, education, and community involvement
  2. Improve access and connection to the river (including passive and active recreation opportunities)
  3. Build a grassroots watershed constituency
  4. Control and reduce high flows to promote river corridor health and reduce flooding
  5. Improve water quality, specifically: metals, dissolved oxygen, bacteria, and nutrients
  6. Restore instream and riparian habitat
  7. Ensure sufficient low flows for habitat and aesthetics of river
  8. Promote the City of Stamford's sustainability mission
- (7) Opinion of Probable Cost per item is general and relative; not directly comparable across Action Items; costs will be quantified and evaluated in detail for final Plan
- \$ no cost or minimal cost to the city
- \$\$ up to \$100,000
- \$\$\$ up to \$500,000
- \$\$\$\$ greater than \$500,000
- n/a = cost estimate not available at this time; too many variables to provide reasonable estimate before final Plan is developed







## References

Charles River Watershed Association (CRWA) for Franklin, Massachusetts. “Stormwater Management Plan for Spruce Pond Brook Subwatershed”, 2010.

Center for Watershed Protection (CWP). “Urban Stormwater Retrofit Practices”, Manual 3 of Urban Subwatershed Restoration Manual Series, August 2007.

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## Section 7 - Watershed Management Plan

### 7.1 Basin Management Plan Framework

The scope of this management plan is to identify problems within the Mill River watershed and stream network and recommend a set of action items that will address those issues. Due to cost, construction and other obstacles, the ability to implement each action item varies. The keystone of this plan is the formation of a Mill River Watershed Association that would relieve the City of Stamford of the burden of organizing activities that are best accomplished from a grassroots approach. The following section describes five alternatives that are designed to focus a set of action items on targeted goals. The lists are not prioritized within the alternatives; the action items were chosen as the group that would best address the stated mission of the alternative. The alternatives themselves are also not prioritized; it is to be the decision of the city and other future planning organizations how to best focus efforts in the watershed, knowing the issues described in this plan and in previous Mill River Program deliverables.

### 7.2 Action Plan

#### Planning Alternatives

This Basin Management Plan identifies more than 30 action items aimed at meeting the following 8 core objectives that were developed by project stakeholders:

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
3. Build a grass roots watershed constituency
4. Control and reduce high flows to promote river corridor health and reduce flooding
5. Improve water quality, specifically: metals, dissolved oxygen, bacteria, and nutrients
6. Restore instream and riparian habitat
7. Ensure sufficient low flows for habitat and aesthetics of the river
8. Promote the City of Stamford's sustainability mission

In many cases a single action item aims at meeting multiple objectives. While this plan does not rank the importance of the 8 objectives explicitly, the implementability of the plan depends on identifying specific action items aimed at smaller-scaled alternatives. The following sections identify action items that are targeted to improve individual issues within the watershed. The alternatives for which action items are identified are:

1. Reduce bacteria concentrations in the main stem Mill River
2. Reduce nutrient loading from the Mill River watershed
3. Reduce metals loading from the Mill River watershed
4. Improve physical river habitat
5. Foster watershed and river stewardship within the community

The subsequent sections briefly describe each alternative and provide a concise tabulation of the expected benefits and estimated costs of action items targeted toward the alternative theme. Each action item is fully explained in Section 6 of this plan and corresponds with each fact sheet in Appendix E.

### Alternative 1: Reduce Bacteria Concentrations in Mill River

Elevated bacteria levels are a human health concern. Citizens can come into contact with waterborn pathogens by touching or accidentally ingesting river water, or by consuming plants and animals from the river environment. The sources of bacteria pollution in the Mill River are direct and indirect (runoff), including illicit storm drain connections, failing septic systems, unmanaged pet waste, waterfowl, and generally unmanaged urban runoff. The action items listed in Table 7-1 are targeted toward reducing bacteria levels in the Mill River.

**Table 7-1: Action Items Aimed at Reducing Bacteria in Mill River**

Action Item	Expected Benefits	Parties Involved
<b>Rain Garden/ Bioretention</b>	Estimated basin-wide reduction of bacteria load: 8%	City of Stamford, Land owners
<b>Sand Filter</b>	Estimated basin-wide reduction of bacteria load: 2%	City of Stamford, Land owners
<b>Green Roof</b>	Estimated basin-wide reduction of bacteria load: 1%	City of Stamford, Land owners
<b>Waterfowl Reduction Program</b>	Lower bacteria levels in river	City of Stamford, Watershed constituency
<b>Pet Waste Reduction Program</b>	Lower bacteria levels in river	Watershed constituency, Pet owners
<b>Reduce illicit yard waste dumping</b>	Reduced nutrient pollution to streams	City of Stamford, Residents, Landscapers
<b>Bacteria/DNA Source Tracking</b>	Knowledge of effective solutions	City of Stamford
<b>Increase Street Sweeping and Catch Basin Cleaning</b>	Estimated basin-wide reduction of bacteria load: 5%	City of Stamford
<b>Illicit Discharge Detection and Elimination</b>	MS4 requirement, lower bacteria levels in river	City of Stamford



## Alternative 2: Reduce Nutrient Loading from Mill River Watershed

High nutrient loading to the Mill River has two negative effects: 1) nutrient enrichment in the stream impedes habitat through excess algal growth and related dissolved oxygen sag, and 2) excess nutrient loading to the Long Island Sound is the cause of hypoxia and is the focus of federal and state regulation. Nutrients enter the stream system from watershed runoff and, to a lesser extent, illicit connections to the storm drains. The action items listed in Table 7-2 are targeted toward reducing nutrient loading to streams from the Mill River watershed.

**Table 7-2: Action Items Aimed at Reducing Nutrient Loading from Watershed**

Action Item	Expected Benefits	Parties Involved
<b>Holts Ice Pond Remediation</b>	Local improved pond conditions, less pollutant loading to main stem river	City of Stamford, Land owners
<b>Rain Garden/ Bioretention</b>	Estimated basin-wide reduction of nutrient load: 2-4%	City of Stamford, Land owners
<b>Tree Filter</b>	Estimated reduction of nutrient load: <ul style="list-style-type: none"> <li>• Ayers Basin 0-2%</li> <li>• Downtown Basin 1-2%</li> </ul>	City of Stamford, Land owners
<b>Porous Pavement</b>	Estimated basin-wide reduction of nutrient load: 0-3%	City of Stamford, Land owners
<b>Sand Filter</b>	Estimated basin-wide reduction of nutrient load: 0-2%	City of Stamford, Land owners
<b>Green Roof</b>	Estimated basin-wide reduction of nutrient load: 1%	City of Stamford, Land owners
<b>Riparian Buffer Improvements</b>	Reduced nutrient pollution to streams	Watershed constituency, City of Stamford
<b>Reduce illicit yard waste dumping</b>	Reduced nutrient pollution to streams	City of Stamford, Residents, Landscapers
<b>Improve commercial and residential stormwater practices</b>	Reduced nutrient pollution to streams	Watershed constituency, Residents, Business owners
<b>Subsidies or reward incentives for residential LID</b>	Reduced nutrient pollution to streams	City of Stamford, Residents
<b>City ordinances for new development LID</b>	Reduced nutrient pollution to streams	City of Stamford, Land developers

### Alternative 3: Reduce Metals Loading from Mill River Watershed

Metals in the aquatic environment at levels greater than naturally occurring are toxic to fish and other organisms. Metals will bioaccumulate in the food chain, resulting in higher levels in organisms near the top. Water quality samples from the Mill River have shown levels of copper, lead, and zinc above the Connecticut state water quality standards. Copper can be naturally occurring in high levels in the watershed. Lead and zinc are common urban and street runoff pollutants. The action items listed in Table 7-3 are targeted toward reducing metals loading to streams in the Mill River watershed.

**Table 7-3: Action Items Aimed at Reducing Metals Loading from Watershed**

Action Item	Expected Benefits	Parties Involved
<b>Rain Garden/ Bioretention</b>	Estimated basin-wide reduction of metals load: 4-7%	City of Stamford, Land owners
<b>Tree Filter</b>	Estimated basin-wide reduction of metals load: Ayers Basin 0-2% Downtown Basin 0-2%	City of Stamford, Land owners
<b>Porous Pavement</b>	Estimated basin-wide reduction of metals load: 1-3%	City of Stamford, Land owners
<b>Sand Filter</b>	Estimated basin-wide reduction of metals load: 1-3%	City of Stamford, Land owners
<b>Green Roof</b>	Estimated basin-wide reduction of metals load: 1%	City of Stamford, Land owners
<b>Improve commercial stormwater practices</b>	Reduce metals pollutant loading to streams	City of Stamford, Business owners, Property managers
<b>Increase Street Sweeping and Catch Basin Cleaning</b>	Estimated basin-wide reduction of metals load: 2-5%	City of Stamford

## Alternative 4: Improve Physical River Habitat

In addition to marginal water quality, the Mill River's physical habitat condition impairs its ecological health. Much of the stream has been altered anthropogenically; bank armoring, low head dams, culverting, and unnatural diversions are common throughout the watershed. The watershed and river corridor are significantly developed, and bringing them back to unmodified habitats is not possible. However, there are options for improving the existing habitat conditions to promote growth and encourage native flora and fauna to flourish. The action items in Table 7-4 are targeted toward improving the physical habitat of the Mill River.

**Table 7-4: Action Items Aimed at Improving the Mill River's Physical Habitat**

Action Item	Expected Benefits	Parties Involved
<b>Removal of low-head dams</b>	Improved fish passage and natural stream processes	City of Stamford, Land owners
<b>Change location of reservoir low flow outlet</b>	Increased dissolved oxygen levels downstream of reservoir	Aquarion water Company, City of Stamford
<b>River bank restoration</b>	Reduce sediment erosion, restore natural stream processes	City of Stamford, Land owners
<b>Removal of invasive plants</b>	Improve habitat for native species	Watershed constituency, Land owners
<b>Instream restoration</b>	Creation and improvement of aquatic habitat	City of Stamford, Watershed constituency
<b>Annual river cleanup</b>	Improve physical habitat marred by trash and debris	City of Stamford, Watershed constituency
<b>Designate wildlife protection and viewing areas</b>	Protect wildlife habitat	City of Stamford, Watershed constituency
<b>Address private water intakes</b>	Preserve streamflow for aquatic species	City of Stamford

## Alternative 5: Foster Stewardship within the Community

For decades, the Mill River has been overlooked by the residents of the City of Stamford, at times used for irrigation water or as a place to dispose of lawn waste. Many residents of the community have not had a reason to give much thought to the river in its current state. River and watershed stewardship is the keystone to a successful watershed improvement program. Watershed associations and volunteer groups can organize river cleanups, educate others in the community, and garner support for initiatives to change the behavior and attitude towards the river. The action items in Table 7-5 are targeted toward fostering stewardship for the watershed and river within the community.

**Table 7-5: Action Items Aimed at Fostering Watershed Stewardship**

Action Item	Expected Benefits	Parties Involved
<b>Annual river cleanup</b>	Improve habitat and water quality, connect residents with river	City of Stamford, Watershed constituency
<b>Develop website for public education and information</b>	Disseminate information, rally volunteers, and garner financial support	City of Stamford, Watershed constituency
<b>Mark stormwater grates with educational message</b>	Reduce illegal dumping, remind residents of river	City of Stamford, Watershed constituency
<b>Public river access</b>	Connect residents with river	City of Stamford, Watershed constituency
<b>Designate wildlife protection and viewing areas</b>	Improve habitat, connect residents with river	City of Stamford, Watershed constituency
<b>Create Mill River Watershed Association</b>	Organize river and watershed improvements	City of Stamford, Watershed constituency

## 7.3 Success Tracking and Evaluation

The City of Stamford, or its designee, should publish regular reports on the status of watershed improvements resulting from the implementation of this plan. A vital component in evaluating the success of many of the recommended action items is a regular and comprehensive monitoring program. The monitoring program should be comprised of two basic components: 1) targeted assessments of problem areas, and 2) overall basin-wide assessments.

Targeted assessments should be designed to track the progress of specific areas in the watershed and stream where problems have been identified. These studies may include, but are not limited to, the following:

- Sampling for bacteria within Toilsome Brook and Ayers Brook to discover hot-spots and target management activities
- Wet and dry-weather sampling of stormwater outfalls to identify cross-contamination and characterize runoff
- Main stem nutrient sampling bracketing suspected nonpoint source hot-spots (garden centers, landscaped communities and commercial developments)



A program to track the overall progress of the basin may include a weekly or monthly sample collection effort at targeted locations within the watershed. A large database (spanning both time and location) of water quality data from the Mill River and tributaries would aid in identifying successful programs and other problem areas outside the scope of the Mill River Program. Volunteer monitoring programs are commonly used for this type of effort.

## 7.4 Potential Funding Sources

The City of Stamford is eligible for several federal and state grants that fund the types of improvements recommended for the Mill River Watershed. These programs are applied for on an annual basis and are geared towards projects that emphasize stewardship and environmental protection. Table 7-6 provides a description of each program and its applicability to potential improvement activities within the Mill River Watershed.

**Table 7-6. Potential Funding Sources**

Details		Description
<b>Grant Program</b>	<b>Nonpoint Source Management Grant Program</b>	
<b>Description</b>	CT DEEP	Under this program, CT DEEP accepts proposals for the prevention, control and/or abatement of nonpoint source pollution. Under Section 319 of the Clean Water Act (§319 C.W.A.), the U.S. EPA awards a grant annually to the CT DEEP to fund eligible projects that support the implementation of the Connecticut's Nonpoint Source Management Program. These funds are limited and a competitive bid process is used to ensure that the most appropriate projects are selected for funding.
<b>Applicable Projects</b>	Stormwater	
<b>Grant Program</b>	<b>Transportation Enhancement (TE) Activities</b>	
<b>Description</b>	U.S. Department of Transportation	TE activities offer funding opportunities to help expand transportation choices and enhance the transportation experience through 12 eligible TE activities related to surface transportation, including pedestrian and bicycle infrastructure and safety programs, scenic and historic highway programs, landscaping and scenic beautification, historic preservation, and environmental mitigation.
<b>Applicable Projects</b>	Stormwater, Recreation	
<b>Grant Program</b>	<b>Sustainable Communities Regional Planning (SCRP) Grants</b>	
<b>Description</b>	U.S. Dept. of Housing and Urban Development	SCRP Grants support metropolitan planning efforts that integrate housing, land use, economic and workforce development, transportation, and infrastructure investment. Emphasis is placed on investing in partnerships that integrate separate disciplines into a multi-dimensional project.
<b>Applicable Projects</b>	Community Development	
<b>Grant Program</b>	<b>Land &amp; Water Conservation Fund (LWCF)</b>	
<b>Description</b>	National Park Service	The LWCF Program provides matching grants to States and local governments for the acquisition and development of public outdoor recreation areas and facilities. The program is intended to create and

Details		Description
<b>Applicable Projects</b>	Recreation	maintain a nationwide legacy of high quality recreation areas and facilities and to stimulate non-federal investments in the protection and maintenance of recreation resources across the United States.
<b>Grant Program</b>	<b>Recreational Trails Program (RTP)</b>	
<b>Description</b>	U.S. Dept. of Transportation, CT DEEP	The RTP provides funds to the States to develop and maintain recreational trails and trail-related facilities for both nonmotorized and motorized recreational trail uses. This program provides funding to the CT DEEP, which will forward applications to the Park and Recreation Directors or the First Elected Officials of each municipality for consideration. Funding ratios are 80 percent federal and 20 percent local.
<b>Applicable Projects</b>	Recreation	