Appendix A Public meetings: Project Briefing to Neighborhood Groups

On July 31, 2008 the SWPCA in cooperation with the City of Stamford and project consultant CDM Smith met with representatives of the Stamford Partnership, North Stamford Association, Hampton Inn, and Projects for Public Spaces (PPS) to brief them on the Rippowam/Mill River Watershed Management and Infrastructure Program. A PowerPoint presentation summarizing the program goals, current scope of work, major tasks, and related projects was provided.

A discussion with questions and answers followed the presentation. Discussion topics included infrastructure improvements recommended as a result of the program, notification to private abutting properties of river access during sampling events, and improved opportunities for public access and recreation.

Sustainable Gardening Expo

The City of Stamford-sponsored Sustainable Gardening Expo took place on May 21, 2009 at Stamford City Hall to offer citizens more information about how the city leaders, environmental agencies, and professionals are working to improve water quality and reclaim the natural environment downtown. Participants included the Mill River Collaborative, Stamford Nature Center, SWPCA, The Bartlett Arboretum, and local landscaping and tree service companies.

CDM Smith and PPS, in cooperation with SWPCA, developed several posters and provided handouts for participants to encourage and promote stewardship of Stamford watersheds and responsible riverbank lawn management through use of native plants in streamside buffer gardens CDM Smith and PPS also conducted a brief citizen survey to gage local perspectives of stream water quality and stormwater runoff. Results of the survey demonstrated the importance residents hold on returning natural vegetation to the stream banks of the Rippowam River, improving water quality, and making it a usable space where they can appreciate the natural environment, hold public events, and utilize biking and walking trails.

World Water Monitoring Day

On August 19, 2009, representatives of the Stamford Land Use Bureau, SWPCA, and CDM Smith met to discuss World Water Monitoring Day on September 18, 2009. While SWPCA was primarily responsible for working with students to conduct the water quality testing, this meeting allowed various entities to take advantage of the opportunity to coordinate with the ongoing study. This provided an opportunity for students to try water quality sampling through the lens of a professional watershed study in their community.

Workshop at Scalzi Park

On November 12, 2009 CDM Smith and PPS held a public workshop to solicit input on issues and goals surrounding restoration of the Mill River watershed. Approximately 25 local residents and stakeholders were in attendance representing such organizations as Connecticut Department of Energy and Environmental Protection (CT DEEP), the Regional Plan Association, Scalzi Riverwalk Nature Preserve, Long Island Sound Study, Soundwaters, the Mill River Collaborative, and the SWPCA. CDM Smith gave a brief presentation on the current status of extensive field monitoring and data collection efforts, as well as next steps for preparation of a watershed management plan. PPS presented benchmark river development projects from around the world and introduced the format for the breakout groups which served as the forum for public input regarding the watershed. Questionnaires containing the same five questions as those addressed in the breakout group were also distributed to attendees at the workshop.

Breakout group feedback suggested watershed management must focus on improving overall water quality, redesigning the riverbanks so that they more closely resemble the natural habitat, and addressing issues with stormwater management. A combination of education, outreach, and enforcement was targeted as an important part of changing individual practices that are detrimental to the health of the river. In order to effectively address this, the group felt that there was a need for robust partnerships between local stakeholders. The groups also said that they would like to see habitat sensitive amenities that encourage responsible use of the river for activities such as swimming, kayaking, and biking throughout the watershed.

Advisory Committee Meetings

An advisory committee was formed in 2008 to provide opportunity for stakeholder involvement at various decision points, following deliverables, and for project direction. The committee included representatives from the City of Stamford, SWPCA, PPS, and CDM Smith. Advisory committee meetings were held in July 2008, March 2009, and March 2010.

Through the annual meetings, the group was able to highlight opportunities for public outreach and events, keep various stakeholders engaged in the study, and allow for a more informed project direction and management of outcomes.

Mill River Collaborative Coordination Presentation

A presentation on the Mill River Watershed Study was given to the Mill River Collaborative on July 25, 2011. Topics covered in the meeting included the City's 3-pronged approach of dam removal, urban park restoration and greenway development; and the status of the Basin Management Plan being developed for the Mill River.

City of Stamford Briefing

A meeting was held with Mayor Michael Paiva 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. As part of this meeting, a stakeholder group was identified to provide vital feedback on the contents of the Basin Management Plan and potential implementation of the recommendations.

Stakeholder Meeting

The initial meeting of the stakeholders for the Basin Management Plan took place on January 26, 2012. This group consisted of City employees and members of the Mill River Collaborative. The goal of this meeting was to review with all of the members the work that had been completed to date, review the preliminary recommendations included in the Plan and obtain input from the stakeholders relative to the validity and potential implementation of each recommendation. This group will be utilized to review the draft Plan and provide comments prior to finalizing the Plan.

Appendix B Watershed Management Model: Memorandum

To: *Mill River Watershed Study Project Team*

From: *CDM Smith*

Date: *April 4, 2012*

Subject: *Mill River Watershed Management Model Development and Results*

This memo discusses the development of the Watershed Management Model (WMM) for the Mill River basin. This model provides an estimate of the mass loading, to receiving water, of user specified pollutants. WMM is an event mean concentration (EMC) land used based model that can provide an estimate of annual mass loading.

This memo will discuss WMM in general terms, and then discuss the specific set up of the model to represent the Mill River basin. Finally there will be a discussion of the various best management practices (BMP) being considered for pollutant reduction.

The Watershed Management Model

The WMM uses a database platform to estimate annual or seasonal pollutant loads from many sources within a basin. Data required to use the WMM include storm water EMCs for each pollutant type, land use, and average annual precipitation. In addition, the areas served by septic systems identified, annual baseflow and average baseflow concentrations, and point source flows and pollutant concentrations. It is also possible to include average combined sewer overflows (CSOs) and concentrations if applicable. The following summarizes some of the features of the WMM:

- Estimates annual storm water runoff pollution loads and concentrations for nutrients (total phosphorus, dissolved phosphorus, total nitrogen), heavy metals (lead, copper, zinc, cadmium), oxygen demand (BOD_5), sediment (total suspended solids, total dissolved solids), and bacteria (fecal coliforms, *E. coli*) based upon EMCs, land use, percent impervious, and annual rainfall;

- Estimates stormwater runoff pollution load reduction due to partial or full scale implementation of onsite or regional BMPs;

- Estimates annual pollution loads from stream baseflow;

- Estimates point source loads for comparison with relative magnitude of other basin pollution loads;
- Estimates pollution loads from failing septic tanks; and
- Applies a delivery ratio to account for reduction in runoff pollution load due to uptake or removal in stream courses.

Pollution control strategies that may be identified and evaluated using the Watershed Management Model include:

- Nonstructural controls (e.g., land use controls, buffer zones, etc.);
- Low Impact Development (LID) retrofit (e.g., rain garden, tree filters, porous pavement, etc.); and
- Structural controls (e.g., onsite and regional detention basins, grassed swales, dry detention ponds, etc.).

The model provides a basis for planning-level evaluations of the long term (annual or seasonal) basin pollution loads and the relative benefits of pollution management strategies to reduce these loads. The WMM evaluates alternative management strategies (combinations of source and treatment storm water controls) to develop a proposed municipal storm water management plan.

Within a given basin, multiple subbasins can be evaluated. Subbasins are typically subdivided by tributary areas, outfalls, or other receiving water body within a basin. However, subbasins can be delineated based on non-hydrologic boundaries such as jurisdictional limits. This provides decision makers with information regarding the relative contribution of pollution loadings from various areas within a basin which can be used for targeting control measures to those areas which are responsible for generating the majority of the pollutant load.

Basins and Pollution Sources

A basin is the land area which supplies all of the water that eventually flows into downstream receiving water such as a river, lake, or reservoir. The major sources of water in a basin typically include rainfall runoff from the basin surface and seepage into streams from groundwater sources.

The major sources of pollutants in a basin are typically storm water runoff pollution from urban and agricultural areas and discharges from wastewater treatment plants (WWTPs) or industrial facilities. Storm water runoff pollution, traditionally referred to as "nonpoint source pollution" (NPS), discharges into streams at many dispersed points. A WWTP discharge or industrial process wastewater discharge typically referred to as "point source pollution," releases pollution into streams at discrete points.

Rainfall/Runoff Relationships

Nonpoint pollution loading factors (lbs/acre/year) for different land use categories are based upon annual runoff volumes and event mean concentrations (EMCs) for different pollutants. The EMC is defined as the average of individual measurements of storm pollutant mass loading divided by the storm runoff volume. One of the keys to effective transfer of literature values for nonpoint pollution loading factors to a particular study area is to make adjustments for actual runoff volumes in the basin under study. In order to calculate annual runoff volumes for each subbasin, the pervious and impervious fractions of each land use category are used as the basis for determining rainfall/runoff relationships. For rural/agricultural (nonurban) land uses, pervious land represents the major source of runoff or stream flow, while impervious areas are the predominant contributors for most urban land uses.

Annual Runoff Volume

WMM calculates annual runoff volumes for the pervious/impervious areas in each land use category by multiplying the average annual rainfall volume by a runoff coefficient. A runoff coefficient of 0.9 is typically used for impervious areas (i.e., 90% of the rainfall is assumed to be converted to runoff from the impervious fraction of each land use). A pervious area runoff coefficient of 0.10 is typically used. The total average annual surface runoff from land use L is calculated by weighting the impervious and pervious area runoff factors for each land use category as follows:

$$R_L = [C_P + (C_I - C_P)\, IMP_L] * I \quad \textit{(Equation 1)}$$

Where:

R_L = total average annual surface runoff from land use L (in/yr);
IMP_L = fractional imperviousness of land use L;
I = long-term average annual precipitation (in/yr);
C_P = pervious area runoff coefficient; and
C_I = impervious area runoff coefficient.
Total runoff in a basin is the area-weighted sum of R_L for all land uses.

Nonpoint Pollution Event Mean Concentrations

The Watershed Management Model estimates loads from pollutants which are most frequently associated with nonpoint pollution sources, including, but not limited to:

- Oxygen Demand
  - Biochemical Oxygen Demand (BOD_5)
- Sediment
  - Total Suspended Solids (TSS)
  - Total Dissolved Solids (TDS)
- Nutrients
  - Total Phosphorus (TP)
  - Dissolved Phosphorus (DP)
  - Total Kjeldahl Nitrogen (TKN)
  - Nitrate + Nitrite (NO3 +NO2)
- Heavy Metals
  - Lead (Pb)
  - Copper (Cu)
  - Zinc (Zn)
  - Cadmium (Cd)
- Bacteria
  - Fecal Coliform (F-Coli)
  - *E. coli*

These pollutants and their impacts on water quality and aquatic habitat are described below.

Oxygen Demand: Biochemical Oxygen Demand (BOD_5) is caused by the decomposition of organic material in storm water which depletes dissolved oxygen (DO) levels in slower moving receiving waters such as lakes and estuaries. Low dissolved oxygen is often the cause of fish kills in streams and reservoirs. The degree of DO depletion is measured by the BOD_5 test that expresses the amount of easily oxidized organic matter present in water.

Sediment: Sediment from nonpoint sources is the most common pollutant of surface waters. Many other toxic contaminants adsorb to sediment particles or solids suspended in the water column. Excessive sediment can lead to the destruction of habitat for fish and aquatic life.

Total suspended solids (TSS) is a laboratory measurement of the amount of sediment particles suspended in the water column. Excessive sediment pollution is primarily associated with poor erosion and sediment controls at construction sites in developing areas or unstable channels throughout river systems.

Nutrients: Nutrients (phosphorus and nitrogen) are essential for plant growth. Within a water supply reservoir, impoundment, lake, or other receiving water, high concentrations of nutrients can result in overproduction of algae and other aquatic vegetation. Excessive levels of algae present in a receiving water is called an algal bloom. Algal blooms typically occur during the summer when sunlight and water temperature are ideal for algal growth. Water quality problems associated with algal blooms range from simple nuisance or unaesthetic conditions, to noxious taste and odor problems, oxygen depletion in the water column, and fish kills. In addition, algal blooms are positively related to the levels of trihalomethanes (a suspected carcinogen) in drinking water. Collectively, the problems associated with excessive levels of nutrients in a receiving water are referred to as eutrophication impacts. Control of nutrients discharged to streams can severely limit algal productivity and minimize the water quality problems associated with anthropogenic eutrophication.

Heavy Metals: Heavy metals are toxic to humans and are subject to State and Federal drinking water quality standards. Heavy metals are also toxic to aquatic life and may bioaccumulate in fish. Lead, copper, zinc and cadmium are heavy metals which typically exhibit higher nonpoint pollutant loadings than other metals found in urban runoff. The presence of these heavy metals in streams and reservoirs in the basin may also be indicative of problems with a wide range of other toxic chemicals, like synthetic organics, that have been identified in previous field monitoring studies of urban runoff pollution (USEPA,1983b).

Bacteria: Bacteria occurring in stormwater runoff is a cause for concern as it can possibly pose a health risk. Typically an indicator organism, such as fecal coliform is used to estimate the presence of bacteria. The source of bacteria in runoff can either be naturally occurring in runoff or can be anthropogenic in origin. As an example, water fowl and wildlife can be the cause of naturally occurring bacteria; combined sewer overflows or contamination from inadequately maintained septic systems can be the cause of anthropogenic sources.

Event Mean Concentrations

Over the past 30 years, nonpoint pollution monitoring studies throughout the U.S. have shown that annual "per acre" discharges of urban storm water pollution (e.g., nutrients, metals, BOD_5) are positively related to the amount of imperviousness in the land use (i.e., the more imperviousness the greater the nonpoint pollution load) and that the EMC is fairly consistent for a given land use. The EMC is a flow-weighted average concentration for a storm event and is defined as the sum of individual measurements of storm water pollution loads divided by the storm runoff volume. The EMC is widely used as the primary statistic for evaluations of storm water quality data and as the storm water pollutant loading factor in analyses of pollutant loadings to receiving waters.

Nonpoint pollution loading analyses typically consist of applying land use specific storm water pollution loading factors to land use scenarios in the basin under study. Runoff volumes are computed for each land use category based on the percent impervious of the land use and the annual rainfall. These runoff volumes are multiplied by land use specific mean EMC load factors (mg/L) to obtain nonpoint pollution loads by land use category. This analysis can be performed on a subarea or basin-wide basis, and the results can be used for performing load allocations or analyzing pollution control alternatives, or for input into a riverine water quality model.

Selection of nonpoint pollution loading factors depends upon the availability and accuracy of local monitoring data as well as the effective transfer of literature values for nonpoint pollution loading factors to a particular study area.

EMC monitoring data collected by the USEPA's Nationwide Urban Runoff Program (NURP) and the Federal Highway Administration (FHWA) were determined to be log normally (base e) distributed. The log normal distribution allows the EMC data to be described by two parameters, the mean or median which is a measure of central tendency, and the standard deviation or coefficient of variation (standard deviation divided by the mean) which is a measure of the dispersion or spread of the data. The median value should be used for comparisons between EMCs for individual sites or groups of sites because it is less influenced by a small number of large values which is typical of lognormally distributed data. For computations of annual mass loads, it is more appropriate to use the mean value since large infrequent events can comprise a significant portion of the annual pollutant loads.

To estimate annual pollutant loads discharged to receiving waters from a municipality, median EMCs are converted to mean values (USEPA, 1983b; Novotny, 1992) by the following relationship:

$$M = T * ((1 + CV^2))^{1/2} \qquad \textit{(Equation 2)}$$

where:

M = arithmetic mean;
T = median; and
CV= coefficient of variation = standard deviation/mean.

Nonpoint Pollution Loading Factors

WMM estimates pollutant loadings based upon nonpoint pollution loading factors (expressed as lbs/ac/yr) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor M_L is computed for each land use L by the following equation:

$M_L = EMC_L * R_L * K$ (Equation 3)

where:

M_L = loading factor for land use L (lbs/ac/yr);
EMC_L = event mean concentration of runoff from land use L (mg/l); EMC_L varies by land use and by pollutant;
R_L = total average annual surface runoff from land use L computed from Equation 4-1 (in/yr); and
K = 0.2266, a unit conversion constant.

By multiplying the pollutant loading factor by the acreage in each land use and summing for all land uses, the total annual pollution load from a subbasin can be computed. The EMC coverage is typically not changed for various land use scenarios within a given study basin, but any number of land use data sets can be created to examine and compare different land use scenarios (e.g., existing versus future) or land use management scenarios.

BMP Pollutant Removal Efficiencies

The Watershed Management Model applies a constant removal efficiency for each pollutant to all land use types to simulate treatment BMPs. These removal efficiencies are often the result of comparing manufacturer's estimates with independent studies. It is also necessary to make some accounting of the percent coverage of a particular BMP.

Calculation of Pollutant Loading Reduction from BMPs

The effectiveness of BMPs in reducing nonpoint source loads is computed for each land use in each subbasin. Up to five BMPs per land use can be specified. The percent reduction in nonpoint pollution per pollutant type in each subbasin of the basin is calculated as:

$$P_{L,SB} = (AC_{1,SB}(REM_1) + (AC_{2,SB}(REM_2) + (AC_{3,SB}(REM_3) + (AC_{4,SB}(REM_4) + (AC_{5,SB}(REM_5)$$ (Equation 4)

where:

$P_{L,SB}$ = percent of annual nonpoint pollution load captured in subbasin SB by application of the five BMP types on land use L;

$AC_{1,SB}$; $AC_{2,SB}$;
$AC_{3,SB}$; $AC_{4,SB}$; = fractional area coverage of BMP types 1 through 5 on subbasin SB; $AC_{5,SB}$

REM_1; REM_2 = REM_3; REM_4; REM_5	removal efficiency of BMP types 1 through 5 respectively; REM; varies by pollutant type but not by land use or subbasin.

Equation 4 enables the user to examine the effectiveness of various BMPs and the degree of BMP coverage within a basin. Coverage might vary depending upon whether the BMP is applied to new development only, existing plus new development, etc. Also, topography may limit the areal coverage of some BMPs.

The nonpoint pollution load from a basin is thus computed by combining Equations 3 and 4 and summing over all land uses and all subbasins, i.e.

$$MASS = \sum_{SB=1}^{N} \sum_{L=1}^{15} M_{L,SB} (1 - P_{L,SB}) \qquad (Equation\ 5)$$

where:

MASS = annual nonpoint pollution load washed off the basin in lbs/yr.

The resultant model is a very versatile yet simple algorithm for examining and comparing nonpoint pollution management alternatives for effectiveness in reducing nonpoint pollution.

Failing Septic Tank Impacts

Many of the residential developments within the U.S. rely on household septic tanks and soil absorption fields for wastewater treatment and disposal. The nonpoint pollution loading factors for low density residential areas, which are typically served by septic tank systems, are based on test basin conditions where the septic systems were in good working order and made no significant contribution to the monitored nonpoint pollution loads. In fact, septic tank systems typically have a limited useful life expectancy and failures are known to occur, causing localized water quality impacts. This section presents a method for estimating average annual septic tank failure rates and the additional nonpoint pollution loadings from failing septic systems.

To estimate an average annual failure rate, the time series approach proposed by the 1986 USEPA report Forecasting Onsite Soil Absorption System Failure Rates was used. This approach considers an annual failure rate (percent per year of operation), future population growth estimates, and system replacement rate to forecast future overall failure rates. Annual septic tank failure rates reported for areas across the U.S. range from about 1% to 3%. For average annual conditions, it is conservative to assume that septic tank systems failures would be unnoticed or ignored for five years before repair or replacement occurred.

Therefore, during an average year, 5% to 15% of the septic tanks systems in the basin are assumed to be failing.

This is consistent with the results of a survey conducted in Jacksonville, Florida, by the Department of Health and Rehabilitative Services. Of more than 800 site inspections, about 90 violations had been detected. Types of violations detected were typically: (1) drain field located below groundwater table, (2) direct connections between the tile field and a stream, and (3) structural failures. The violation rate of 11% is consistent with the average year septic tank failure rate and period of failure before discovery/remediation. The "impact zone" or the "zone of influence" for failing septic tanks can be assumed to be all residential areas that are not served by public sewer.

Pollutant loading rates for failing septic systems were developed from a review of septic tank leachate monitoring studies. The range of concentrations of total-P and total-N based upon literature values are as follows:

	Total-P	Total-N
Low	1.0 mg/L	7.5 mg/L
Medium	2.0 mg/L	15.0 mg/L
High	4.0 mg/L	30.0 mg/L

Annual "per acre" loading rates for septic tank failures from low density residential land uses were then estimated assuming 50 gallons per capita per day wastewater flows. The loading rates can be applied to the percentage of all non-sewered residential land uses with failing septic tanks. The septic tank loading factors are included in the runoff pollution loading factors. The range of percent increases in annual per acre loadings attributed to failing septic tanks is:

	Total-P	Total-N
Low	130%-180%	120%-150%
Medium	160%-250%	140%-200%
High	220%-400%	180%-310%

To assess the increase in surface runoff load due to failing septic tanks, WMM considers a multiplication factor. This multiplication factor is applied to the phosphorus (dissolved P, total P) and nitrogen (TKN, NO_2+NO_3-N) parameters.

Consequently, the load from a residential area with failing septic tanks is:

(surface runoff load without failing septic tanks) x

((multiplication factor) x (% of area with failing septic tanks/100%) + (1 - (% of area with failing septic tanks)/100%))

Despite the large increase in annual loading rates, septic tank failures typically have only a limited impact on overall nonpoint pollution discharges. This is because the increased annual loading rates are applied only to the fraction of non-sewered residential development that are predicted to have a failing septic tank system during an average year. Based upon this methodology, failing septic tank systems typically would contribute less than 10% of total nonpoint loadings.

Model Limitations

The WMM was developed to estimate the relative changes in nonpoint source pollutant loads (average annual or seasonal) due to changes in land use or from the cumulative effects of alternative basin management decisions (e.g. treatment BMPs). The models should be applied to appropriate spatial (basin wide) and temporal (average annual or seasonal) scales. It is not appropriate to use these input/output models for analysis of short-term (i.e., daily, weekly) water quality impacts. It is also not appropriate to use WMM to estimate absolute loads for a given outfall system without specific monitoring data for that system.

WMM Data Analysis

There are eight major subbasins in the Mill River Basin as shown in **Figure 1**. These subbasins range in size from approximately 580 to 2,500 acres in total area. The following sections describe how land use, BMP, septic tank, and other data was obtained and processed to perform the pollution loading analysis.

Land Use

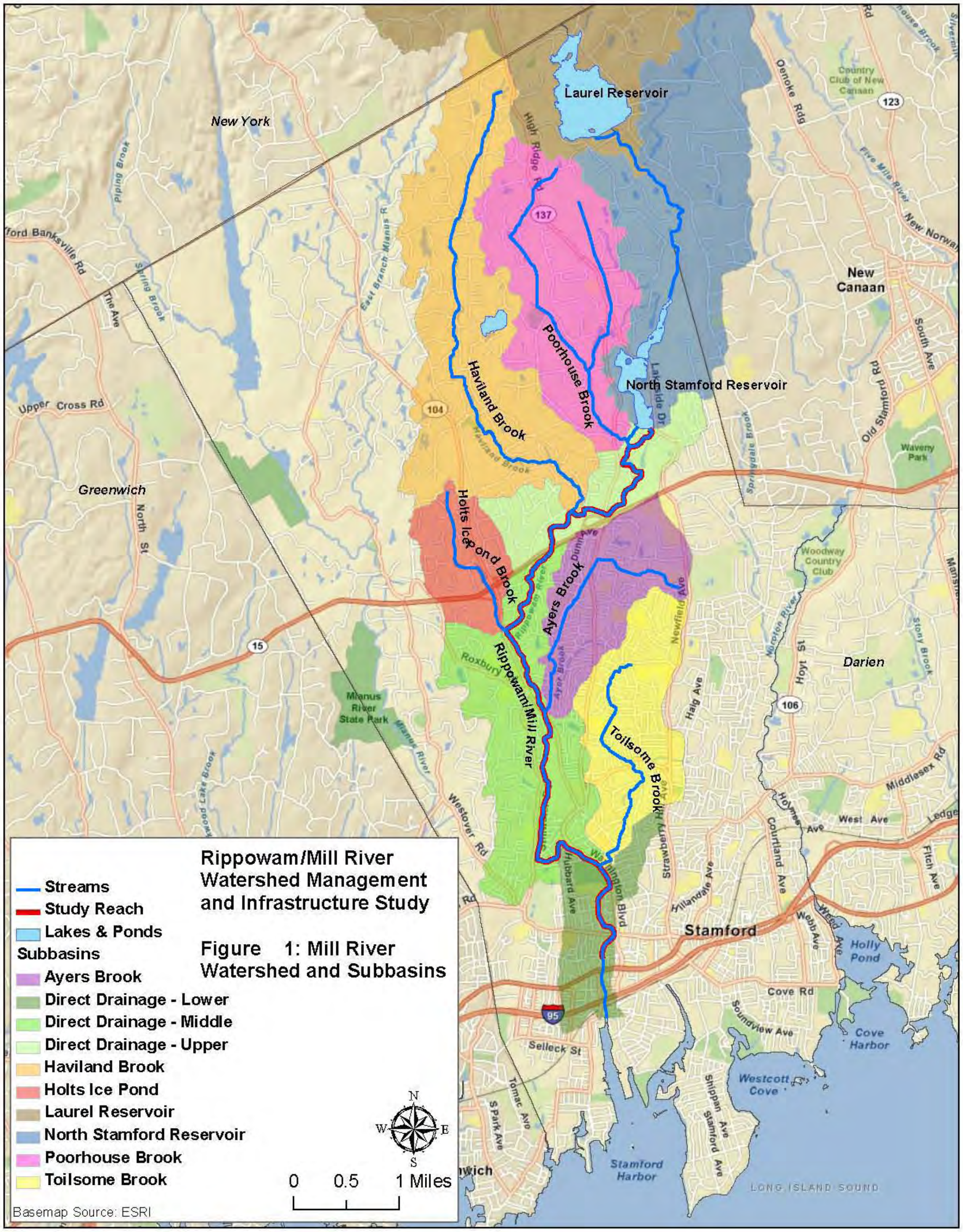
Land use shape files were obtained from the City and imported into the GIS software package Arcview Version 9.3©. Subbasin (which were delineated for a previous effort) shape files were combined with the land use shape files to determine the land use distribution by subbasin.

Table 1 presents the acreages of each of the eight land use categories in the major basins for present land use conditions. Generally these land uses are fairly standard with the exception of commercial/high density residential and impervious/urban. These land uses represent the urbanized portion of the study area. **Figure 1** shows the locations of the subbasins.

Table 1: Land Use in Mill River Basin (acres)

Subbasin	Commercial/HD Residential	Forest	Impervious/ Urban	MD Residential	Open Land	Road	Water	Wetland	Total
Ayers	168	157	36	396	38	162	7	9	972
Haviland	312	1,376	0	367	62	251	61	105	2,534
Holts Ice Pond	45	232	3	154	53	77	8	5	577
Mainstem1	135	10	184	104	53	139	19	5	648
Mainstem2	256	266	31	590	143	273	26	10	1,595
Mainstem3	133	354	1	130	20	101	17	6	762
Poorhouse	130	855	3	332	138	168	21	67	1,714
Toilsome	172	82	39	533	103	181	0	6	1,116
Total	1,351	3,332	296	2,607	610	1,352	158	212	9,918

Runoff coefficients for pervious and impervious areas were universally defined to be 0.9 for impervious areas and 0.1 for pervious areas. The refinement in the volume of runoff associated with each basin was due to the weighted value of the percent impervious determined for each basin as a function of that basin's land use.


Rippowam/Mill River
Watershed Management
and Infrastructure Study
Figure 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
Laurel Reservoir
North Stamford Reservoir
Haviland Brook
Poorhouse Brook
Holts Ice Pond Brook
Ayers Brook
Rippowam/Mill River
Toilsome Brook
New York
Greenwich
New Canaan
Darien
Stamford
Stamford Harbor
Westcott Cove
Cove Harbor
Holly Pond
LONG ISLAND SOUND

Percent Directly Connected Imperviousness

The percent directly connected impervious (DCIA) for each land use was also a parameter that required some consideration. The US Environmental Protection Agency (EPA) developed guidance to estimate the percent DCIA based upon impervious areas for New Hampshire small MS4 Permits. As the geographic locations are similar, this guidance was used to estimate the DCIA in the Mill River basin.

The guidance provides an estimate of the total imperviousness for standard land uses as well there are a number of relationships that can modify the total imperviousness based upon the degree of connectedness. These relationships were first documented in Sutherland, 2000. These relationships estimate the DCIA as a function of the total imperviousness and the degree of connectivity of the total imperviousness to the collection system. **Table 2** presents these relationships.

Table 2: Sutherland Relationships between Impervious Area and DCIA

Watershed Selection Criteria	Assumed Land Use	Equation (where IA(%) ≥ 1.0)
Average - Mostly storm sewered with curb and gutter, no dry wells or infiltration, residential rooftops not directly connected.	Commercial, Industrial, Institutional/Urban public, Open land, and Medium density residential.	$DCIA = 0.1(I.A.)^{1.5}$
Highly connected - Same as above, but residential rooftops connected.	High density residential	$DCIA = 0.4(I.A.)^{1.2}$
Totally connected - 100% storm sewered with all IA connected.	---	DCIA = IA
Somewhat connected - 50% not storm sewered, but open section roads, grassy swales, residential rooftops not connected, some infiltration.	Low density residential	$DCIA = 0.04(I.A.)^{1.7}$
Mostly disconnected - Small percentage of urban area is storm sewered, or 70% or more infiltration/disconnected.	Agricultural, forested	$DCIA = 0.01(I.A.)^{2.0}$

* adapted from EPA 2011

Making use of these relationships and impervious areas noted in the EPA 2011, **Table 3** presents the DCIA values used in the WMM.

Table 3: Land Use Impervious Area Assumption

Land Use	Watershed Selection Criteria	DCIA
Forest/Rural Open	Mostly disconnected	1.0
Urban Open	Mostly disconnected	1.2
Medium Density Residential	Average	23.4
Highways	Totally connected	50.0
Water/Wetland	Totally connected	95.0
Impervious/Urban	Highly connected	55.5
Commercial/High Density Residential	Highly connected	58.3

Pollution Removal Efficiencies

The intent of this project is to include and quantify the impact of low impact development (LID) best management practices (BMP) on the existing mass loading to the Mill River. LID BMPs include the following: rain gardens, tree filters, porous pavement, green roofs, sand filter, street sweeping, catch basin cleaning, and public education. In general there are two types of benefits to be realized by these types of BMPs: 1) a reduction of the volume of stormwater runoff generated, and 2) reduction of concentration of the various pollutants.

A component of many LID BMPs is to mimic predevelopment hydrology, i.e. the development of spatially distributed incremental storage/treatment facilities as opposed to centralized wet ponds. In this manner, runoff is captured locally, often at its source. This allows for a decentralized treatment model, also the subsequent infiltration, if possible, proceeds in a more diffuse manner. Depending upon the level of implementation, this component of the BMPs may result in a significant reduction in the post development runoff volume/rate. It is noted that a direct implication of a reduction in runoff volume is provides a proportional reduction in pollutant mass loading. Examples of BMPs that exhibit this component are pervious pavement and rain gardens.

The other component of LID BMPs is the actual pollutant concentration reduction. This often proceeds via vegetation uptake, biochemical conversion, or settling of solids (with or without associated constituents). The effectiveness of pollutant reduction is a direct function of the configuration of the BMP. Examples of this type of BMP are tree filters and rain gardens. The reduction in pollutant concentration is often a function of many factors including, but not limited to: incoming pollutant concentration, type of vegetation present in the BMP, and residence time of the runoff entering the BMP. Often the manufacturer will provide estimates of pollutant load reduction.

Another important consideration is the relative level of treatment being provided. As an example, one could imagine that a single rain garden may be quite effective when treating the runoff from a single lot, or perhaps, several lots. The effect of this single rain garden would likely be inconsequential if it sought to treat the runoff from several city blocks. It is necessary to design and implement an adequate number of facilities to provide pollutant reduction indicated by the manufacturer's estimates.

In order to estimate the reduction in runoff volume, the Sutherland Equations were used with three land uses that are likely to be retrofitted with LID BMPs. These three land uses are: medium density residential (MDR), commercial/high density residential, and impervious/urban. It was assumed that the watershed selection criteria would shift from average (MDR), and highly connected (commercial/high density, and impervious/urban) to somewhat connected. This would result in a reduction of DCIA to 19.4, 46.4, and 43.4 percent respectively. Currently, only this component is used in quantification of the reduction in pollutant loading in the model.

A literature search was done to quantify the pollutant concentration reduction from implementing LID BMPs, these pollutant load reduction efficiencies will be used in the final version of the analysis. These values are presented in **Table 4**.

Table 4: Pollutant Concentration Reductions from Management Practices

Management Option	Total Phosphorus	Total Nitrogen	TSS	Copper	Other Metals (Pb, Zn, Cd)	Bacteria
Rain Garden/Bioretention	50%	50%	85%	75%	75%	70%
Tree Filter	70%	70%	90%	80%	80%	0%
Porous Pavement	65%	40%	85%	85%	65%	0%
Sand Filter	50%	30%	80%	55%	80%	37%
Green Roof	45-60% reduction in runoff from roofs					

Note: Percent reductions apply to runoff going through BMP

Event Mean Concentration Values

For this study, the EMC values were obtained from three general sources. CDM maintains a database of EMC values for the entire country. Periodically additional values are included in this database, and regional extractions are created. Recently, as a part of a CDM research and development project, Wolosoff and Greene 2010, estimated EMC values for 6 regions of the Country. Region 1 corresponds to the northeast. The values provided in this memo were used as available. An internet search resulted in a table of EMC values that were used in the Niantic River Watershed Protection Plan. As this river is located in Connecticut, these values were used. The remainder values were the default values from WMM. These values for the seven land use categories are presented in **Table 5**. The source is indicated on this table.

Table 5: Event Mean Concentrations Used in Mill River Watershed Model

Land Use	Pollutant Event Mean Concentration										
	BOD (mg/l)	TSS (mg/l)	TP (mg/l)	DP (mg/l)	TKN (mg/l)	NOx (mg/l)	Pb (mg/l)	Cu (mg/l)	Zn (mg/l)	Cd (mg/l)	F-Coli[1]
Commercial/HDR	29.5	77.75	0.41	0.13	1.3	0.55	0.038	0.026	0.141	0.003	1.21E+11
Forest/Rural Open	3.0	51.0	0.11	0.03	0.9	0.80	0.000	0.000	0.000	0.000	1.36E+09
Highways	3.1	25.7	0.18	0.22	1.5	0.25	0.049	0.037	0.156	0.003	2.72E+09
Impervious/Urban	24.3	72.0	0.37	0.12	1.2	0.47	0.037	0.037	0.213	0.004	9.04E+10
Medium Density Residential	11.5	54.5	0.26	0.27	1.5	0.53	0.040	0.023	0.121	0.004	1.86E+11
Urban Open	3.0	51.0	0.11	0.03	0.9	0.80	0.014	0.000	0.040	0.001	2.27E+10
Water/Wetlands	4.0	6.0	0.08	0.04	0.8	0.59	0.011	0.007	0.030	0.001	1.36E+09

Notes: 1 - units are #/100mL * conversion factor (4.535e6) to result in #/year in WMM results

Wolosoff's memo

WMM default

Niantic River Watershed Protection Plan

Rainfall Data

Rainfall data for the Mill River basin was obtained from the long term average for US Historical Climatology Network Station #067970 (Stamford, CT). The long term average was determined from 104 years of data (1905 to 2009). The long term average was 47.5 inches.

Septic Tank Usage

Septic tanks are used in many areas of the Mill River Basin for sewage disposal, primarily in older residential areas. The estimated percentage of each major subbasin served by septic tanks is presented in **Table 6**. Sewer service coverage maps were provided to CDM by the Stamford Water Pollution Control Authority. These maps, coupled with city parcel data, led to the values presented below.

Table 6: Percentage of Mill River Basin on Septic Systems

Land Use Type	Ayers	Haviland	Holts Ice Pond	Mainstem1	Mainstem2	Mainstem3	Poorhouse	Toilsome
Commercial/HD Residential								
Area (acres)	6.9	312.3	41.7	0.0	15.5	112.9	129.5	1.4
% Of Area:	4%	100%	93%	0%	6%	85%	99%	1%
MD Residential								
Area (acres)	8.2	366.9	122.7	0.0	88.2	121.2	328.4	2.6
% Of Area:	2%	100%	80%	0%	15%	93%	99%	0%

For existing land use conditions, septic tank impacts were estimated for medium density residential and commercial/high density residential land uses (i.e., only the residential land uses were considered to be served by septic tanks. The WMM assesses the impact of failing septic tank by applying a multiplication factor to the surface runoff load. This multiplication factor was calculated as the ratio of the annual unit loading rate (i.e. lbs/ac/year) of the estimated septic tank failure loading compared to the stormwater runoff annual unit loading. This multiplication factor was applied only to the total phosphorus, nitrogen (TKN, NO_2+NO_3), BOD, and F-Coli parameters.

The factor used for total phosphorus was 3.2 for MDR and 3.9 for commercial/HDR. The factor used for the nitrogen was 1.8 for MDR and 1.9 for commercial/HDR. The factor used for the BOD was 1.8 for MDR and 3.0 for commercial/HDR. Finally, the factor for F-Coli was 10.0 for MDR and 17.4 for commercial/HDR.

To assess the increase in runoff load due to failing septic tanks, WMM considers the multiplication factor (discussed above), the percent septic tank coverage, and the percent failure rate. The percent failure rate assumed for this study was 10%.

Baseflow Volume and Pollutant Concentrations

In addition to calculating runoff loading from subwatersheds, the WMM takes into account the baseflow volume and concentration in the stream. It is important to accurately estimate the baseflow contributions to flow and pollutant loading to bound the level of improvement that can be expected from stormwater management options. The field program for the Mill River study provided ample data in the form of pollutant concentrations to estimate baseflow loads. The program included six dry weather sampling events: one event in each of the four seasons targeting low flow, dry weather conditions, and two pre-wet weather event sampling rounds. The average of all dry weather samples for each parameter was used as the baseflow concentration in the model; the values are shown in Table 7. In the WMM, the baseflow represents all flow not originating as rainfall in one of the study subwatersheds. This includes natural stream baseflow as well as the flow from the upstream boundary, the North Stamford Dam. The baseflow was estimated using a standard baseflow separation technique with the USGS gage data.

Table 7: Estimated Baseflow Values

Parameter	Units	Estimated Value for Model
Flow	(ac-ft/yr)	9,535
BOD	lbs/yr	41,517
Copper	lbs/yr	286
Dissolved Phosphorus	lbs/yr	569
Fecal Coliform	counts/yr	1.09E+07
Nitrates	lbs/yr	20,519
Lead	lbs/yr	99
TKN	lbs/yr	12,651
Total Phosphorus	lbs/yr	1,182
Total Suspended Solids	lbs/yr	116,583
Zinc	lbs/yr	357

WMM Results

The final output from the WMM for the purposes of assessing management options for the Mill River watershed are the loadings from each subbasin. **Figure 2** shows the fraction of loading from each subbasin, for each parameter, used as the baseline existing conditions for the analysis.

The WMM was used to evaluate the expected pollutant loading reductions resulting from structural BMPs presented in the Watershed Management Plan. The levels of implementation of the BMPs (listed in Table 4 of this memorandum) were projected based on a consolidation of knowledge about the watershed, key focus areas, and land use patterns. A wide variety of implementation options were evaluated in the model; the most comprehensive were selected for inclusion in the Watershed Management Plan. These pollutant loading reduction results may be used by the city to select BMPs targeted at a specific pollutant of concern or targeted at a particular area of the watershed. The results may also assist the city in evaluating the benefit of implementing BMPs.

Section 6 of the Watershed Management Plan includes a description of all action items included in this study. For each modeled structural BMP action item, there is a description of the representation of the BMP in the WMM and a summary of the pollutant loading reduction. **Tables 8a through 8e** also show the percent reductions.

Figure 2: Pollutant Loading by Subbasin

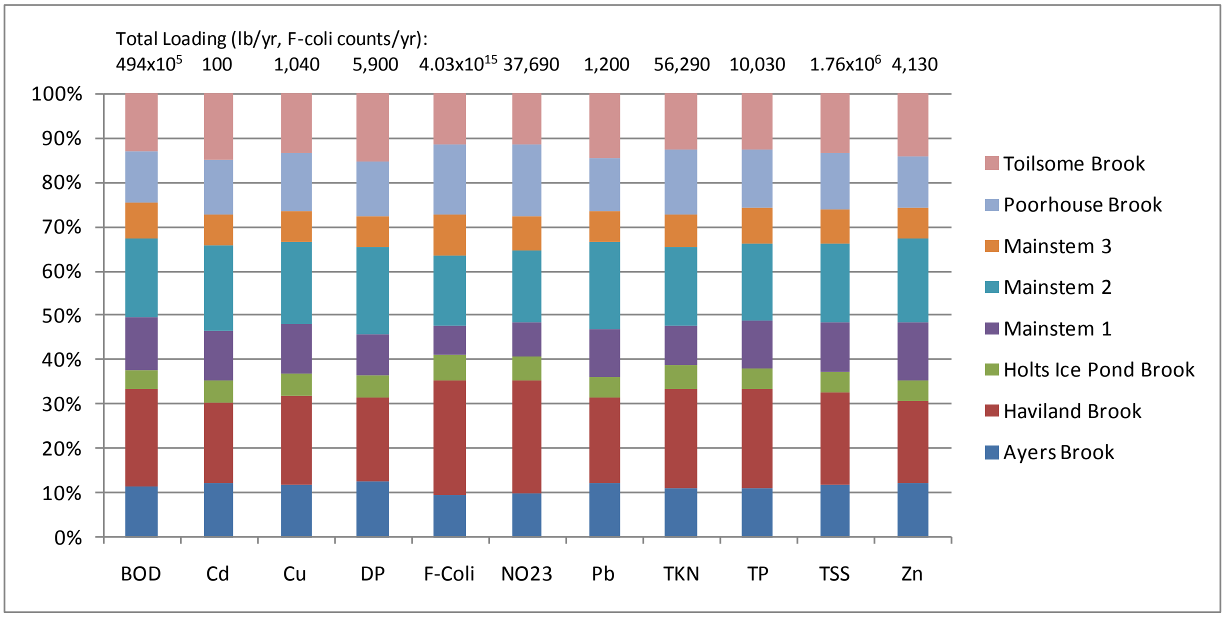


Table 8a: Estimated Pollutant Loading Reduction from Rain Gardens

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

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 8b: Estimated Pollutant Loading Reduction from Tree Filters

Pollutant	Estimated % 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%

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 8c: Estimated Pollutant Loading Reduction from Porous Pavement

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

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 8d: Estimated Pollutant Loading Reduction from Green Roofs

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

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. 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.

Table 8e: Estimated Pollutant Loading Reduction from Sand Filters

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

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.

References

Sutherland, 2000. *Methods for Estimating Effective Impervious Cover*. Article 32 in the Practice of Watershed Protection, Center for Watershed Protection, Elliot City, MD.

USEPA, April 2011, *Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for New Hampshire Small MS4 Permit*, EPA, Washington, DC.

Wolosoff, S. and A. Greene, *Compilation of a National Storm Event Mean Concentration (EMC) Database*, Internal CDM R&D Memo, 2010.

Appendix C: 9 Element Watershed Based Plan Component Checklist for CWA Grant Funding[1]
Watershed Management Plan Title:
Waterbody ID, Hydrologic Unit Code, Watershed Boundary Data Set, or Hydrologic Response Unit:
River Basin:
County(ies):
Title of TMDL: a) A TMDL for This Watershed is ("X" as applicable): ( ) Approved ( ) In Draft b) No TMDL Has Been Developed to Date: ( )
Comments:

[1]In order to be eligible for CWA Section 319 incremental* grant (watershed protection) funding - or to submit a Section 319 grant proposal - a copy of the EPA approved 9 element watershed based plan and this completed checklist must be on file with the Connecticut Department of Environmental Protection's Bureau of Water Protection and Land Reuse. Components and formatting of this checklist may change in response to federal grant funding, grant guideline revisions, or other program initiatives or purposes as deemed appropriate by EPA/CT-DEP. Note that preparation or submittal of an EPA 9 Element watershed based plan, or this checklist, does not obligate the EPA or CT DEP to partially or fully fund any part of a watershed based plan or recommended implementation project.

* Incremental grant background: Congress enacted Section 319 of the Clean Water Act in 1987, establishing a national program to control nonpoint sources of water pollution. During the last several years EPA has been working with the States to strengthen its support for watershed-based environmental protection by encouraging
local stakeholders to work together to develop and implement watershed-based plans appropriate for the particular conditions found within their communities. In particular, EPA and the States have focused attention on waterbodies listed by States as impaired under Section 303(d) of the Clean Water Act. Toward this end States must use $100 million ($1 million for Connecticut) of Section 319 funds (referred to as "incremental funds") to develop watershed-based plans that address nonpoint source impairments in watersheds that contain Section 303(d)-listed waters and implement recommendations incorporated in these plans.

Component (A) **Identification of Pollutant Causes and Sources**	**Yes**	**No**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan identifies the pollutant *causes* and *sources* <u>or</u> groups of similar sources that will need to be managed to achieve the load reductions identified in this watershed based plan or a TMDL, including page number where load reductions are found in this plan.) <u>Comments</u>:				

Component (B) **Pollutant Load Reduction Estimates**	**Yes**	**No**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan provides estimates of load reductions needed to delist water bodies identified in the watershed based plan. <u>This is a requirement of the Watershed Based Plan.</u> <u>Comments</u>:				
II. The plan provides *estimates* of potential load reductions for each pollutant cause or source, or groups of similar sources that need to be managed. (If "No" or "N/A" provide comments below.) <u>Comments</u>:				
III. A model (as outlined in Attachment B.IV.) is used to *estimate* pollutant load reductions (assumptions and limitations should be stated). <u>Comments:</u>				

Component (C) **Best Management Practices**	**Yes**	**No**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan provides locations where *potential* BMPs may be implemented. Comments				
II. The plan identifies *potential* BMPs to be installed in "critical" areas. Comments: This is a requirement of the Watershed Based Plan				

Component (D) **Financial and Technical Assistance**	**Yes**	**No**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I: The plan provides estimates of the financial and technical assistance that will be needed to implement the plan. This is a requirement of the Watershed Based Plan. Comments: This section will include BOTH estimates and potential funding sources for project implementation costs AND Annual maintenance costs of the project.				
II: The plan identifies sources and authorities that will be relied upon to implement the plan. Comments:				

Component (E) **Education and Outreach**	**Yes**	**No**	**Chapter, Section, Table, List, etc.**	**Page No.(s)**
I. The plan provides an information/education component that will enhance public understanding of the plan and encourage their early and continued participation in project development. Note: This education and outreach component must link the information to model demonstration or pilot projects that stakeholders can implement post WBP development.				

Component (F) Plan Implementation Schedule	Yes	No	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan provides a schedule for implementing management measures. (Applicant should base implementation timetable on BMPs in "Component C" above.) Comments:				

Component (G) Interim Milestones	Yes	No	Chapter, Section, Table, List, etc.	Page No.(s)
I. The plan provides a list or description of interim milestones for determining whether NPS management measures are being implemented.				

Component (H) Monitoring and Assessment	Yes	No	Chapter, Section, Table, List, etc.	Page No.(s)
I. A set of criteria that can be used to determine whether loading reductions are being achieved over time and progress is being made towards attaining water quality standards. Comments:				

Component (I) Plan Implementation Effectiveness	Yes	No	Chapter, Section, Table, List, etc.	Page No.(s)
I. A monitoring component to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item (H). Comments: The WBP must note that revisions will be made to improve the effectiveness of implementation efforts if monitoring shows no improvement post BMP efforts.				

Watershed Management Plan Component Checklist
for CWA Grant Funding*
Acknowledgment

I/we, the undersigned, believe that the watershed plan addresses Elements "a-i" of the EPA approved watershed based plan model elements - particularly those elements pertaining to broadly estimating pollutant load reductions that may result from implementation of best management practices - as presented in the, "*Nonpoint Source Program and Grants Guidelines for States and Territories*. Federal Register. October 23, 2003. (Volume 68, Number 205. pp. 60658-60660). http://www.epa.gov/fedrgstr/EPA-WATER/2003/October/Day-23/w26755.htm

I/we acknowledge that information provided by this checklist is based on a dynamic watershed based plan. Certain components of the 9 element watershed based plan (and this checklist) may need to be updated as data and information improves.

The signatory(ies) below are under no obligation to partially or fully fund or implement a watershed based plan, or any part thereof, unless funded by an EPA/CT-DEP approved Section 319 grant in accordance with an approved Section 319 workplan.

This checklist is submitted for CWA Section 319/CT-DEP Nonpoint Source Program grant program purposes by:

____ ________________
Signature/Title Date

____ ________________
Signature/Title Date

*This CWA Grant Funding Source includes, but is not limited to, CWA Section 319 grant funding.

- Attachment -
9 Element Watershed Based Plan Component Checklist
Helpful Notes and Examples

Component (A): Identification of Pollutant Causes and Sources

I. Causes *may* include low dissolved oxygen, organic enrichment, nutrients, ammonia, pathogens, siltation, pH, metals, habitat alteration, turbidity, pesticides, priority organics, etc.

Sources or "groups of similar sources" *may* include agriculture (pasture grazing; animal feeding operations; crop production, irrigation, etc.), urban/construction (stormwater runoff; industrial/municipal discharges, impervious surfaces, etc.), silviculture (forest planting/harvesting), land disposal (illegal dump; littering, septic tanks/septage disposal, etc.), resource extraction (surface mining); flow regulation/modification; etc.

Component (B): Pollutant Load Reduction Estimates

I. The load reduction estimates needed to delist water bodies identified in the watershed based plan may be incorporated from a previously approved CT TMDL or TMDL currently being drafted by DEP. TMDL parameters may include organic enrichment/dissolved oxygen (OE/DO), pathogens, nutrients (Total Nitrogen (TN) / Total phosphorus (TP), siltation, pH, metals, etc., and should be expressed as pounds/yr, tons/yr, percent, etc. Load reduction data may be descriptive or in tabular/list format.

II. Load reduction *Estimates* of each pollutant load reduction *to be targeted* by the plan should be included. For Section 319 funding purposes, pre-implementation BMP estimates of nitrogen, phosphorus, and sediment load reductions must be provided, if applicable. Estimates should be expressed as *number, pounds, tons, acres, miles, etc*.

Estimates are *predicted* load reductions expected from pre-implementation BMPs for a particular *cause* (e.g., siltation, nutrients) and/or *source* (e.g., agriculture, pasture grazing)
Example:

Pollutant:	Unit	Pre-BMP	Post-BMP	% Reduction Estimate
Sediment	tons/acre	12.69	6.8	47
Organic N	pounds/acre	14.8	11.46	23
Nitrate (NO_3)	pounds/acre	2.22	1.75	47
Organic P	pounds/acre	2.44	1.30	11
Soluble P	pounds/acre	0.19	0.08	57

III. Load reduction *estimates* may be determined using models (e.g., EPA Region 5, Step L, SWAT, IPSI, RUSLE, etc), technical/research references, or WQ monitoring and assessment data. Model assumptions and limitations should be stated.

Note: Pollutant load reductions for most on-the-ground management measures can usually be estimated using desktop models or water quality monitoring data for BMPs such as stream bank restoration, cover crops, buffers, nutrient management, seeding and mulching, etc. Estimates of load reduction associated with education and outreach (public involvement; behavior/attitudes changes), technical assistance, land-use ordinances, habitat/biological responses, etc., may not be easily discernable. *However, demonstration projects and pilot projects would have pollutant load reduction models for stakeholders to follow.*

Note: Pre- and post-BMP implementation nitrogen, phosphorus, and sediment load reduction estimates, *as applicable to the project*, are *required* for Section 319 grant funding.

Component (C): Best Management Practices

I. Location of Potential BMPs: This section refers to the *anticipated* locations, if known (pre-BMP implementation). *Potential* sites should be identified using a narrative description; photos, land use/topographic map, etc. Lat/Long and GPS coordinates should also be included, if BMP sites are obvious and definite.

Example:

TMDL Causes: Siltation, Nutrients
TMDL Sources: Agriculture, Pasture Grazing
BMP Location: Farmland Approx. *(X)* Miles (*direction*) of (*Town*), *Tributary to* (*Name)* River.

II. Description of Potential BMPs: The plan should provide a management practice description; numbers, types, etc. in Critical Areas of Concern in the Watershed

Example:

Problem: Approx. 75 head of beef cattle with unrestricted access to the (*name of impaired waterbody*), grazing on 30 acres of unimproved pasture land.
Solution: Install NRCS Conservation Practice Standard 914. Livestock Fencing: 6,680 feet.

Note: Because some “best” management practices may involve the establishment of committees, hiring coordinators, planning, monitoring/assessments, developing local ordinances, regulation/enforcement, providing technical assistance, establishing citizen volunteers, conducting outreach/training, Load Reductions Estimates as a result of these types of measures may be difficult to quantify. It is acknowledged that BMPs are *estimates* and *may* need to be modified over time as new information is derived, land use’s change, and as the watershed plan is implemented. CT-DEP supports 319 grant outreach and education projects that include demonstration projects and pilot projects for stakeholders to more fully understand the process of NPS implementation.

Component (D): Financial and Technical Assistance

I. Estimates of the financial and technical assistance

Example 1:

Technical Assistance: Riparian buffers for erosion and sedimentation control to the stream. Project total cost = $10,000.

Financial Assistance:

A. Section 319 Grant Funding (60% of total cost)

a. Riparian Plants (detailed listing, count, description and costs of plantings by Applicant included) $4,000.00

b. Design of Buffered area to ensure long-term maintenance $2,000.00

B. In Kind Services: (40% of total cost)

a. Staff to plant riparian buffer on conservation property $2,500.00

b. Staff to educate residents about importance of riparian buffers to NPS improvements and distribute state brochures on LID $1,500.00

Example 2:

Technical Assistance: Three Rain Gardens for stormwater quality and quantity management at three primary municipal facilities in watershed towns.

Project total cost = $20,000

Financial Assistance:

A. Section 319 Grant Funding (60% of total cost)

a. Rain garden plantings (detailed listing, count, description and costs of plants by Applicant attached to application) $10,000.00

b. Design of Rain Garden to ensure plants will thrive in specific soils and location. Design will also ensure long-term maintenance of the rain garden. $2000.00

B. Municipal Cash Match (40% of total cost)

a. Additional rain garden plantings and materials to install rain garden (detailed listing of plants and additional materials attached to application) $6,000.00

b. Workshop for town residents to educate on benefits of rain gardens and proper long term care for these types of gardens. $2,000.00

II. Watershed plan stakeholders should be identified, and roles and responsibilities defined. *A source* refers to a federal, state, or local agency; or landowners/landusers, citizen volunteers, foundations/grants/loans/donations, etc., that will provide watershed plan implementation services/funding.

Authorities include bur are not limited to laws, rules, regulations, grant/loan programs, etc., that may be necessary to implement the watershed plan,

Component (E): Education and Outreach
Education and Outreach may be "*watershed-scale*" in scope and include, "Partnership" meetings and conferences; school/civic club/service organization presentations; news articles/feature stories; displays, fairs/festivals; tours/field days; agency/citizen cooperation in selection, design, and implementation of management measures, conservation practice "sign-ups" etc.

Implementation Efforts may also be more "*site specific focused*" or "*small-scale*". These projects may include "pilot projects" to encourage additional, larger projects within a specific community, "small scale projects" to address a portion of a larger project site, or "site specific/mini-watershed projects" to address a focused watershed in the larger scale Watershed Based Plan.

Component (F): Plan Implementation Schedule
An implementation schedule refers to tasks that ensure that the watershed plan's goals and objectives will be achieved in an expeditious manner.
Example A:
Milestone 1: Stakeholder will hire a Watershed Project Coordinator by date.
Milestone 2: *10,000 Rain Gardens* will be installed by the Stakeholder by date.

Example B: Management measures in "**F**" and "Interim" milestones in "**G**" below may be combined into a "Milestone Table" or List, as presented below:

No.	Activities and Interim Practices to Assure that Project Implementation is Timely and Reasonable	Milestone Schedule	Responsible Entity
1. 1a. 1b. 1c.	Milestone: Conduct an area-wide watershed project outreach campaign to inform citizens about the project, its benefits, to encourage enthusiasm and input, and to build and sustain project support for the duration of the project period Interim Measure: Develop a stakeholder "contact list" to provide quarterly communication via telephone, e-mail, website, personal contact, meetings, etc. Interim Measure: Document all correspondence with stakeholders, citizen info. request, and records of meetings for the duration of the project period Interim Measure. Coordinate the development and distribution of newsletter articles, brochures, etc, with the Watershed Project Steering Committee	Begin: MM/DD/YY End: MM/DD/YY Begin: MM/DD/YYEnd: MM/DD/YY Begin: MM/DD/YY End: MM/DD/YY Begin: MM/DD/YY End: MM/DD/YY	FRWA with DEP support FRWA/Subcontractor FRWA FRWA
2.	Etc.		
2a.	Etc.		

Component (G): Interim Milestones
Interim refer to step-wise or intervening measures that ensure the implementation schedule ("F" above) will be achieved, and may include: **RFPs/contracts executed**; hiring a coordinator, to coordinate specific types/number/dates management practices are to be installed, to identify specific BMP sites/site preparation; various stakeholder coordination/information delivery approaches; monitoring/assessments; outreach/training materials to be produced/distributed; etc.

Examples:
Interim Milestone 1: The FRWA will issue an RFP to hire a Watershed Project Coordinator by date.
Interim Milestone 2: The Stakeholder will execute a contract to install 10,000 rain gardens by date.
Interim Milestone 3: The Stakeholder will conduct coordinated *semi-annual* site visits with DEP to ensure BMPs are properly maintained.

Note: Interim Measure(s) may be combined in a tabular format as per *Example "B"* under Component "**F**" above.

Component (H): Monitoring and Assessment
Note: The following items are examples of a watershed monitoring and assessment component. One or more may apply to any particular watershed plan.

a) Water quality samples and stream assessments to assess load reductions will be collected post-BMP implementation (monthly*, quarterly, semiannually, etc,*) by (*agency/cooperator name*).
b) Water quality samples and stream assessments for the *watershed/impaired waterbody name* will be collected post-BMP implementation on or before *date* by (*agency/cooperator name*).
c) Post-BMP implementation data may be compared with any previously collected water quality data and watershed information to determine if pollutant load reductions have been achieved. If no water quality improvements are noted, the watershed plan may be revised, and/or the types, numbers, locations, etc, of BMPs modified by stakeholders.
d) Post-BMP implementation data may be compared with any previously collected water quality data and watershed information to determine the scope of pollutant loadings. If non-impaired waters are threatened, the watershed plan may be revised, and/or the types, numbers, locations, etc, of BMPs modified by stakeholders to protect against further degradation.
e) Post-BMP water quality monitoring data may be compared with NPS TMDL targets to determine if NPS pollutant load reductions have been achieved. If no load reductions have been achieved, the TMDL may be reassessed, as needed.
f) Information collected from CT-DEP 5-year rotational basin assessments, as well as trend, reservoir, or other water quality monitoring programs - may be used to assess basin-wide and targeted watershed pollutant loading. This data may be used to determine if load reductions are being achieved over time as a result of BMPs installed. If water quality standards are not being met during the 5-year period for a targeted 303(d) listed impaired

water, stakeholders may re-evaluate management practice targeting and effectiveness and/or whether the TMDL should be revised.

g) The development of load reduction success indicators (to include meeting water quality standards) will be a collaborative effort among watershed stakeholders. Evaluation criteria developed by stakeholders may be reviewed (*semiannually/annually*) as BMPs are installed.

h) Establishment and implementation of monitoring activities will be coordinated with watershed project partners pre- and post-BMP implementation. Load reduction success may be based on an evaluation of available data and information collected over time. If load reduction criteria are not progressing as expected, stakeholders may revise and re-distribute the watershed plan within (*X*) months of the evaluation.

i) If monitoring indicates load reduction expectations are not being achieved incrementally for the resources available/expended, watershed stakeholders may investigate the effectiveness of selected BMP practices, and may revise the watershed plan.

Note: All plans/proposals that include an environmental monitoring component and submitted for 319 grant funding, must have an approved Quality Assurance Plan before Clean Water Act funding (including but not limited to Section 319 funding) can be expended.

Component (I): Plan Implementation Effectiveness

I. Effectiveness monitoring "over time" may include on-site visits (citizens/resource agency/professional BMP installation or site assessments), documentation of BMP types/numbers/sites; cooperative stakeholder reviews of watershed plan/TMDLs; installation of new/innovative/improved BMPs not proposed in the original plan; water quality monitoring scheme presented in "H" above, etc.

Notes: A process for Revisions to the WBP must be added included in this section to explain how planning efforts will be revised if implementation is not as effective as originally calculated.

Appendix D: Memorandum

To: *Jeanette Brown, Stamford WPCA*

From: *Karen Kelley and Jamie Lefkowitz*

Date: *December 8, 2009*

Subject: *Mill River Watershed Study – Windshield Survey*

As part of the effort to develop a basin management plan for the Mill River Watershed in Stamford, CT, CDM has conducted a desktop/windshield survey of the lower watershed. The purpose of this activity is to summarize the potential threats to water quality within the watershed. This survey focuses on the watershed south (downstream) of the North Stamford Reservoir. The northern portions of the watershed were similarly surveyed in 2003 as part of Connecticut's Source Water Assessment Program. This memorandum includes a summary of the following, accompanied by photographs and maps from the desktop/windshield survey:

- Facilities identified as potential threats to water quality
- Land use trends throughout the southern watershed
- Opportunities for improved stormwater management in the southern watershed

Potential Threats to Water Quality

The following lists identify businesses and facilities within the watershed that may directly impact water quality. Extensive reconnaissance has not been conducted at each site to evaluate if and how the potential threats may be causing water quality problems. The facilities listed below are shown in Figures 1 and 2.

Animal Farms/Petting Zoos

Potential water quality problems can arise at these locations from improper control of stormwater runoff and direct bacterial pollution to surface waters by free-ranging animals.

- Runabout Farm – 46 Acre View Drive – This is a private business, housing typical petting zoo animals (goats, chickens, rabbits, cats, etc) as well as ponies and horses. The farm is approximately one acre.

- Stamford Museum and Nature Center – 39 Scofieldtown Rd – The museum and nature center is home to farm animals and exotic animals, housed in buildings and outdoors. The Museum and Nature Center occupies approximately 84 acres surrounding Bendels Pond, which is part of Poorhouse Brook. The pond is home to numerous swans and other waterfowl – wild and domesticated. Water exits Bendels Pond over a spillway and seepage channel, flows under High Ridge Rd, through another impounded area, and meets with the mainstem Mill River. The primary purpose of the facility is education.

Solid Waste Facilities/Landfills

Uncontrolled solid waste and landfill facilities pose a threat to groundwater, surface water, and soil contamination.

- Scofieldtown Road Park – Scofieldtown Rd and Rock Rimmon Rd – This park is the site of a former city landfill. The unlined landfill opened in the 1930s as a residential dump for household waste, and in 1949 began accepting industrial waste. The landfill was nominally closed in 1968, and capped with soil in 1974 and converted to a park and recycling and leaf composting facility. The landfill does not have an impermeable cap. At the recycling center, an above-ground storage tank was used to store sodium chlorite solution used for winter road maintenance activities, and a salt shed was used to store road salt.

  According to the December 2008 Final Site Reassessment Report issued by USEPA (USEPA, 2008), numerous complaints were filed in the late 1960s by local residents about the park concerning exposed refuse, rat infestation, refuse in an adjacent unnamed stream and wetland area that feeds Poorhouse Brook, and a dump fire. The site was listed in the Comprehensive Environmental Response Compensation Liability Information System (CERCLIS) database in May 1986 (CERCLIS No. CTD981214299). Between 1980 and the present, the Connecticut Department of Environmental Protection, City of Stamford, and EPA have conducted numerous environmental investigations of the property.

  In 1988, CT DEP observed hundreds of tires and several rusted drums, some of which contained resins, paint-like materials, and other waste materials. In 1996, a study performed on behalf of EPA found rusted drums and leachate discharging to an unnamed stream that becomes Poorhouse Brook east of Scofieldtown Road.

  The City recently closed the Scofieldtown Road Park, after groundwater and soil contamination was found above the state limit. The landfill is estimated to be between 10 and 18 acres with a waste depth of 10 to 30 feet.

  Since February 1997, water quality sampling at nearby residential wells has revealed pesticide levels above state drinking water action levels, including dieldrin and chlordane. Residential well testing is ongoing at this time.

Gas Stations and Auto Repair Shops

There are numerous gas stations and auto repair shops within the Mill River watershed. Facilities are continually opening, closing, and undergoing construction. These facilities can impact groundwater, surface water, and soil in a variety of ways, including improper disposal of chemicals, uncontrolled stormwater runoff, and leaky underground storage tanks. Figure 1 shows the approximate location of the gas stations and auto repair shops identified through desktop and windshield surveys in September 2009.

Dry Cleaners

Dry cleaners that perform, or once performed, onsite laundering could be a threat to water quality due to the potential for improper disposal of dry cleaning chemicals. The dry cleaning facilities shown in Figure 1 have not been identified as facilities that have or have had onsite dry cleaning operations, nor has any reconnaissance been done to evaluate their chemical disposal practices.

Garden Centers

Garden centers can be a source of water quality contamination from the uncontrolled storage and use of large quantities of pesticides and fertilizers as well as sediment loading from inadequate control of stormwater runoff from mulch and soil piles.

- Eden Farms Nursery and Garden Center – 947 Stillwater Rd: Facility is approximately 4.8 acres and has outdoor growing areas and displays.
- Exquisite Environments Garden Center – 1351 Stillwater Rd: Facility is approximately 1.2 acres and has outdoor displays.
- Designs by Lee, Inc – 129 Interlaken Rd: Facility is approximately 7.2 acres and has outdoor growing areas and displays.
- High Ridge Nursery – 1854 High Ridge Rd: Facility is approximately 1.5 acres.
- Shanti Bithi Bonsai – 3047 High Ridge Rd: Facility is approximately 0.4 acres.

Animal Hospitals/Kennels

Uncontrolled feces from dog recreation areas can be a source of bacteria pollution in stormwater runoff. Detailed reconnaissance has not been done at any of the facilities listed below to evaluate their waste disposal or stormwater control practices.

- Bulls Head Animal Hospital – 28 Long Ridge Rd
- Canine Athletic Club, Inc – 143 Cold Spring Rd

- Lucky Leash Canine Care – 2 Hoover Ave
- High Ridge Animal Hospital – 868 High Ridge Rd

Wildlife

Dense populations of waterfowl in the watershed pose a threat to water quality. Runoff picks up the animals' feces and may contribute 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:

- Scalzi Park
- In the river and floodplain just north of the Broad St crossing
- In the river and floodplain between the Toilsome Brook confluence and the Cloonan Middle School
- Bendels Pond at the Stamford Museum and Nature Center

Regular feeding of ducks and other water fowl by residents adjacent to the Mill River also has been reported near Buckingham Drive.

Hazardous Waste Sites

CT DEP maintains a list of sites throughout the state that are classified as contaminated or potentially contaminated. Based on the September 2009 reporting from CT DEP, there are over 800 sites in Stamford on the list. Figure 2 shows the 325 Stamford sites that lie within the Mill River watershed. The descriptions given by CT DEP for the listed sites are as follows ("Hazardous Waste Facilities" as defined by CGS Section 22a-134f, source- www.ct.gov/dep/lib/dep/site_clean_up/sites/site_definitions.pdf):

- CERCLIS – 1 site (Scofieldtown Road Park)

CERCLIS sites are potential hazardous waste sites in Connecticut that the U.S.EPA is evaluating under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as Superfund. These sites are included in EPA's CERCLIS database. This database, the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), is the national database and management system EPA uses to track activities at hazardous waste sites considered for cleanup. Note that the list does not include sites that EPA evaluated and determined that no further remedial actions are necessary.

- Inventory of Hazardous Waste Disposal Sites – 1 site (Newfield Cleaners)

These are sites which may pose a threat to the environment or public health and are listed on the Inventory of Hazardous Waste Disposal Sites ("the Inventory"), pursuant to Section 22a-133c of the Connecticut General Statutes (CGS).

- Leaking Underground Storage Tanks – 200 total sites

These are residential and commercial sites with releases of petroleum products from underground storage tanks. A fact sheet on the CT DEP Underground Storage Tank Program is available at 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.

  - Pending **-** The leaking tank has been discovered and reported to DEP, 12 sites.
  - Investigation - Investigation of the release is underway, 9 sites.
  - Remediation Started - Remediation of the release to address emergency conditions is underway, 18 sites.
  - Completed **-** Remediation of the emergency conditions caused by a release has been completed. This designation does not mean that all contamination from a leaking tank has been remediated in accordance with State standards, 161 sites.

- Property Transfer – 123 total sites

Property Transfer sites are sites that have filed either a Form III or Form IV pursuant to CGS 22a-134a through 134d, inclusive. Forms III and IV are files when a discharge, spillage, uncontrolled loss, seepage or filtration of hazardous waste of a hazardous substance has occurred at the site. A fact sheet on the Property Transfer Program is available at www.dep.state.ct.us/pao/perdfact/proptran.htm.

Land Use Trends

The portion of the Mill River watershed covered in the windshield survey (from the Merritt Parkway corridor to the southern extent of the watershed) can be segmented based on land use trends. The observed trends are described below and shown in a series of maps and photographs, Figures 3-6 and Tables 1-4.

North of Merritt Parkway

The land use in this area is primarily heavily wooded and medium density residential. Non-residential properties include 2 gas stations/repair shops, 3 dry cleaners, a petting zoo, a school, the Stamford Museum and Nature Center and a garden center. The Scofieldtown Park landfill is located just north of this land use area in the upper watershed where a similar survey was conducted in 2003 as part of Connecticut's Source Water Assessment Program. The terrain is hilly, with frequent outcrops of bedrock. Hydrologically, the area is marked by small streams and drainage channels that appear to have intermittent flow, and flow in and out of small ponds and wetland areas. This land use area encompasses the downstream portions of the drainage basins for Mill River tributaries Poorhouse Brook and Haviland Brook, as well as the upstream portion of the Holts Ice Pond Brook subbasin. Unmanaged stormwater, both in terms of quantity and quality, may be contributing to erosion and pollution problems in the Mill River, which is the final destination of most of these pond outlets and drainage channels. The Holts Ice Pond sub-basin is an example of this issue. There are also many ponds that appear to be hydraulically isolated from the larger drainage system. These may be manmade ponds or natural depressions in the landscape. During the time of the windshield survey (end of summer) many of these ponds were laden with excessive algal growth and completely green in color. Stormwater flows from impervious surfaces to storm drains and collector streams via roadside channels that are vegetated, rock-lined, grassy, or culverted under roads and driveways. The majority of private landscaping does not include any visible watershed best management practices (BMPs), though a few rain gardens were noted in one neighborhood. The widespread use of private landscaping services is evident throughout the North Stamford area, and may contribute to excessive pesticide, herbicide, and fertilizer use; however, the landscaping services and garden center also provide an opportunity for larger-scale BMP implementation.

During low flow periods, private water intakes at commercial and residential areas may have a noticeable impact on flow quantity. Landscaping trucks have been observed withdrawing water from the river on several occasions.

South of Merritt Parkway, Residential Areas

The residential development south of the Merritt Parkway is less wooded and more densely populated than the land north of the Parkway. Two main commercial thoroughfares, High Ridge and Long Ridge Roads, run north to south and split the residential development into three segments. The commercial development along these two roads is described in the next section. The terrain is both hilly and flat, generally becoming more flat towards the south. Small streams and drainage channels lead to more significant tributaries, namely Ayers Brook and Toilsome Brook, which flow in and out of culverts while passing through densely populated neighborhoods and receiving stormwater runoff directly from street drains. Street drains are a likely source of stormwater runoff quality and quantity problems in the Mill River. Just as is the case north of the Merritt Parkway, ponds with excessive algal growth are plentiful in the residential areas. Closer to downtown, just north of Broad Street, there are numerous apartment complexes. Non-residential properties in the area include a garden center adjacent to the Rippowam River, 3 gas stations/repair shops, and several office parks and schools. The majority of office parks north of downtown are clustered along the main commercial thoroughfares, although there is a large industrial/office complex off High Ridge Road just south of the Merritt Parkway. Large office complexes that are not implementing BMPs can be a source of pollution in the river due to high volumes of unmitigated runoff from large impervious surfaces: parking lots and roofs.

There are several private residential communities within this portion of the watershed that may be venues for promoting BMPs to reduce negative effects of stormwater runoff. There are also several small municipal parks, as well as Scalzi Park, which directly abuts the river just north of downtown. Geese populations roam freely on park grass, likely contributing to bacteria pollution loads from stormwater runoff into the Mill River.

South of Merritt Parkway, Commercial Areas

Long Ride Road and High Ridge Road are the two main thoroughfares in the Mill River watershed, running from downtown to north of the North Stamford Reservoir. The majority of commercial development on both roads is found near the downtown shopping district and just south of the Merritt Parkway. Commercial entities that may pose direct threats to Mill River water quality include 10-15 gas stations/repair shops, 10-15 dry cleaners, and one small florist/garden center. A significant fraction of each corridor is largely residential, with similar characteristics described in the previous section. The areas of dense commercial development, mostly strip mall shopping centers, are almost entirely covered in impervious surfaces: parking lots, sidewalks, and roofs. Amongst the residential and strip mall shopping centers are large office buildings with extensive lawns and parking lots and garages. There are opportunities for BMPs in the commercially developed land along these two thoroughfares, which would likely have a positive effect on water quality and stormwater quantity entering the mainstem and tributaries to the Mill River.

Urban Residential/Downtown Stamford

The watershed south of Broad Street on the west side of the river is primarily urban residential development, and east of the river is largely part of downtown Stamford. The majority of land cover in both areas is impervious, making stormwater management a key issue for this part of the watershed, regardless of specific land use. The potential for pollutant loading from street runoff is high in many places, and could be improved through the use of proper sediment management at construction zones, street sweeping, refuse management and litter control, and landscape BMPs such as vegetated swales and rain gardens in place of concrete drainage and curbed medians. Litter, debris, and geese are plentiful along the river corridor and floodplain in this area, and are also threats to water quality.

References:

1) “Officials knew for decades that Scofieldtown Park was contaminated” Stamford Advocate. September 27, 2009.
2) “Scofieldtown dump yields ‘unintended consequences’” Stamford Advocate. September 22, 2009
3) Final Site Reassessment Report for Scofieldtown Road Park. USEPA Region 1. December 23, 2008.

Jeanette Brown, Stamford WPCA
December 8, 2009

Figure 1: Potential Water Quality Threats in the Mill River Watershed

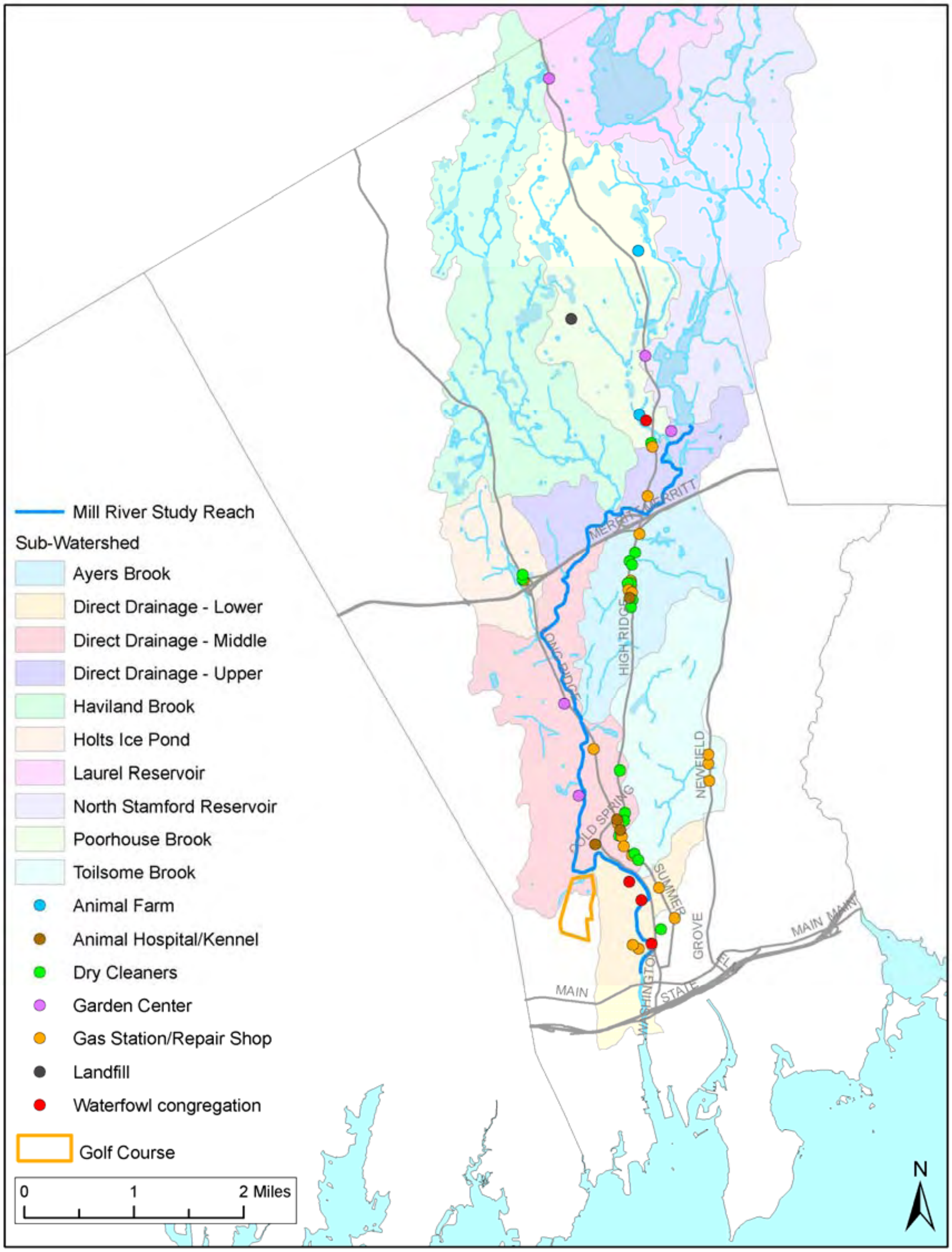


Figure 2: Hazardous Waste Sites in the Mill River Watershed

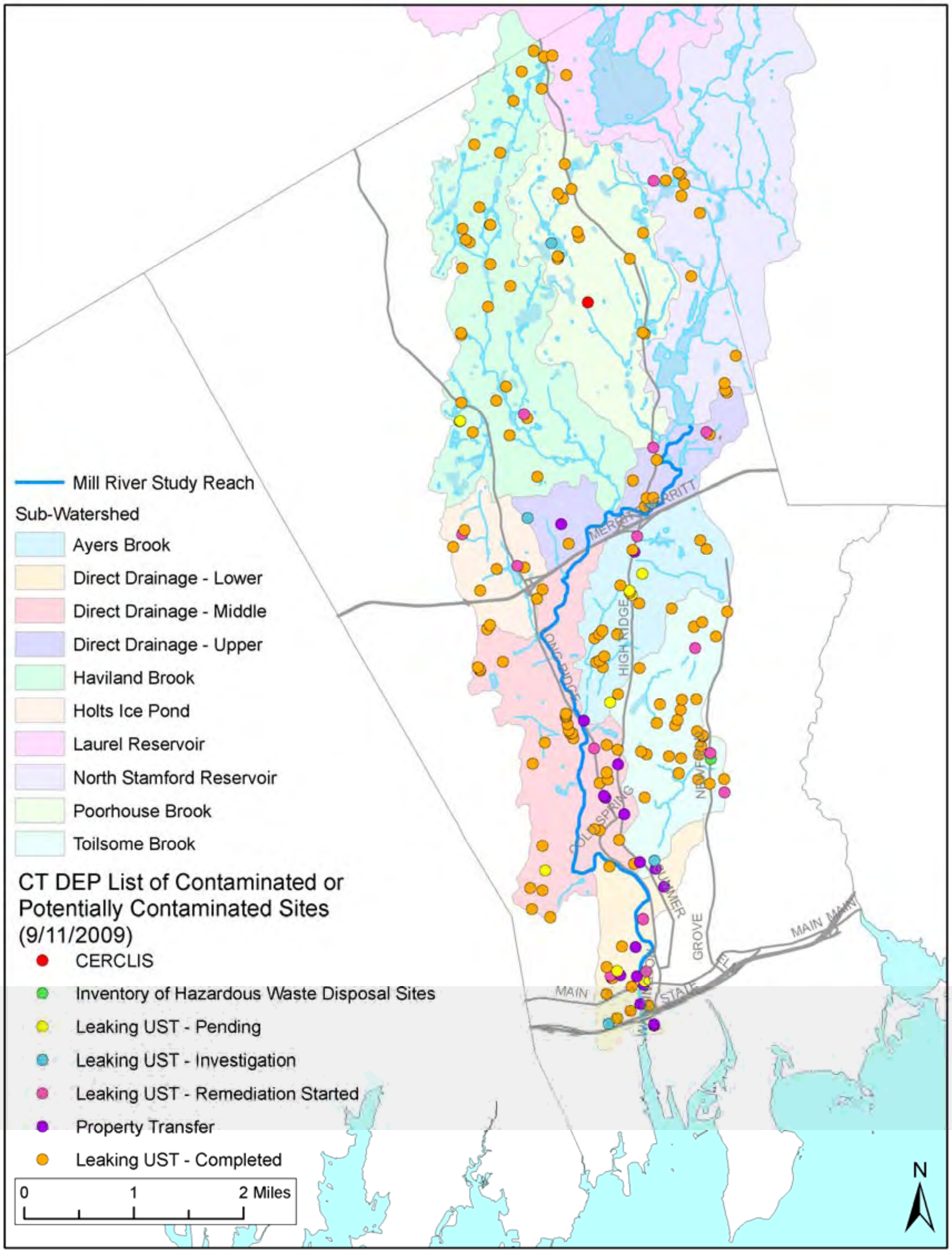


Figure 3: Land Use Area – North of Merritt Parkway

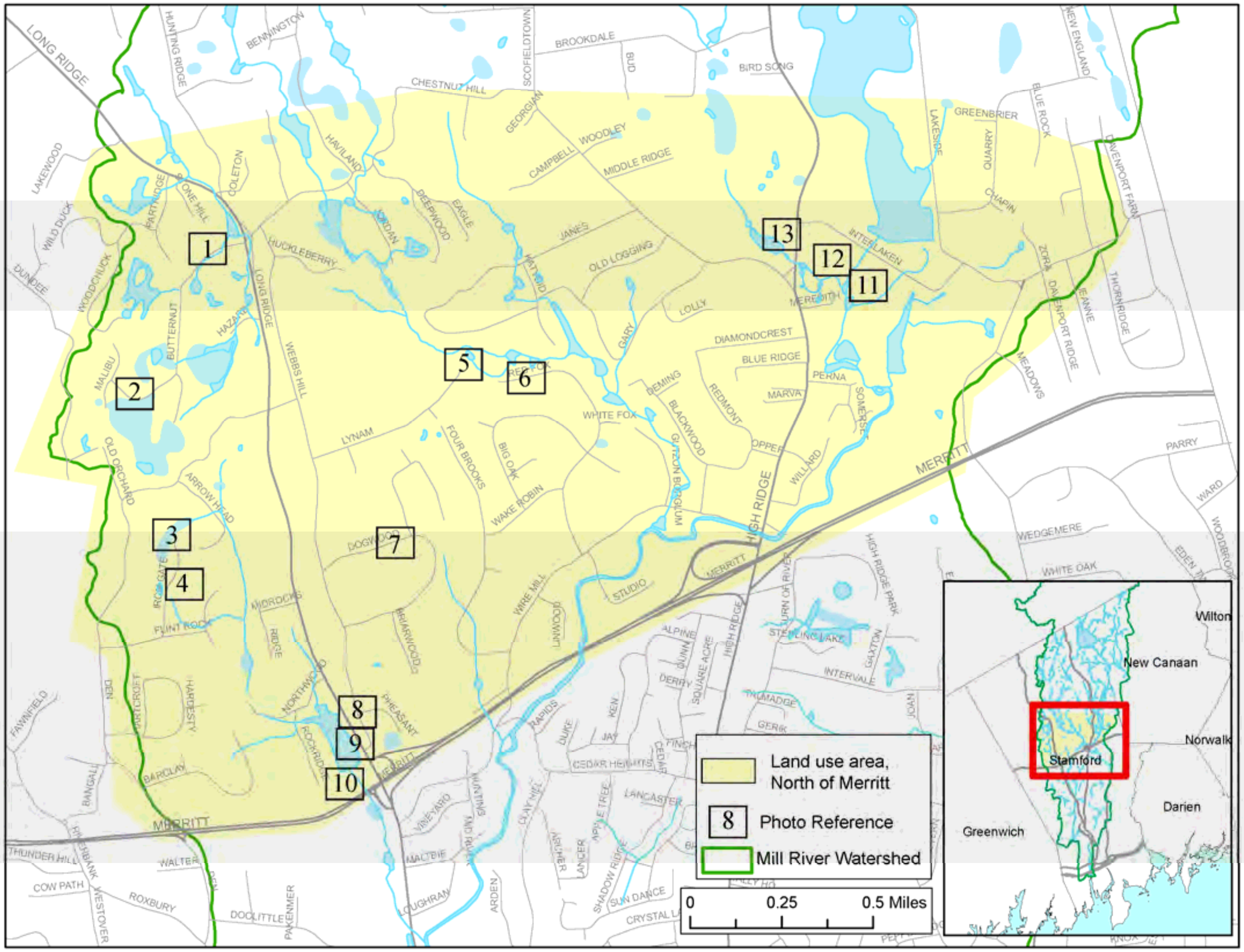


Table 1
North of Merritt Parkway
Photographs correlate with map shown in Figure 3

Area	Image Number	Image	Description
North of Merritt	1		Rain garden, private property
North of Merritt	2		Rain garden, private property
North of Merritt	3		Pond with algal growth
North of Merritt	4		Pond with algal growth and stormwater drain
North of Merritt	5		Typical roadside stormwater inlet

Table 1
North of Merritt Parkway
Photographs correlate with map shown in Figure 3

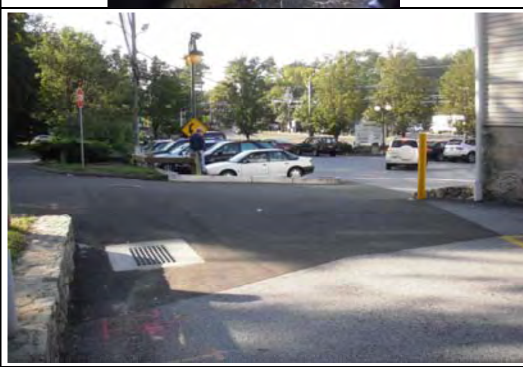
Area	Image Number	Image	Description
North of Merritt	6		Paved stormwater collection channel, leading to a pond
North of Merritt	7		Erosion control measures: silt fence at home construction site
North of Merritt	8		Parking lot storm drain
North of Merritt	9		Holts Ice Pond
North of Merritt	10		Holts Ice Pond outlet

Table 1
North of Merritt Parkway
Photographs correlate with map shown in Figure 3

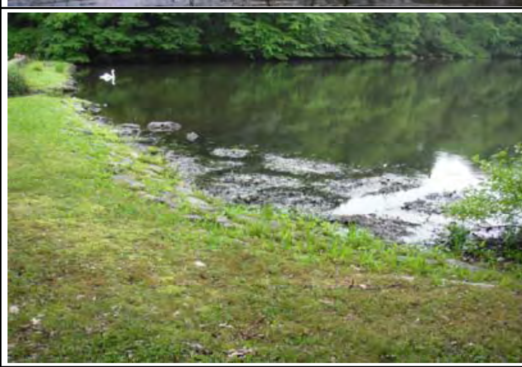
Area	Image Number	Image	Description
North of Merritt	11		Garden center mulch piles
North of Merritt	12		Garden center water intake
North of Merritt	13		Bendels Pond, in Stamford Museum and Nature Center, part of Poorhouse Brook tributary

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Figure 4: Land Use Area – South of Merritt Parkway, Residential Areas

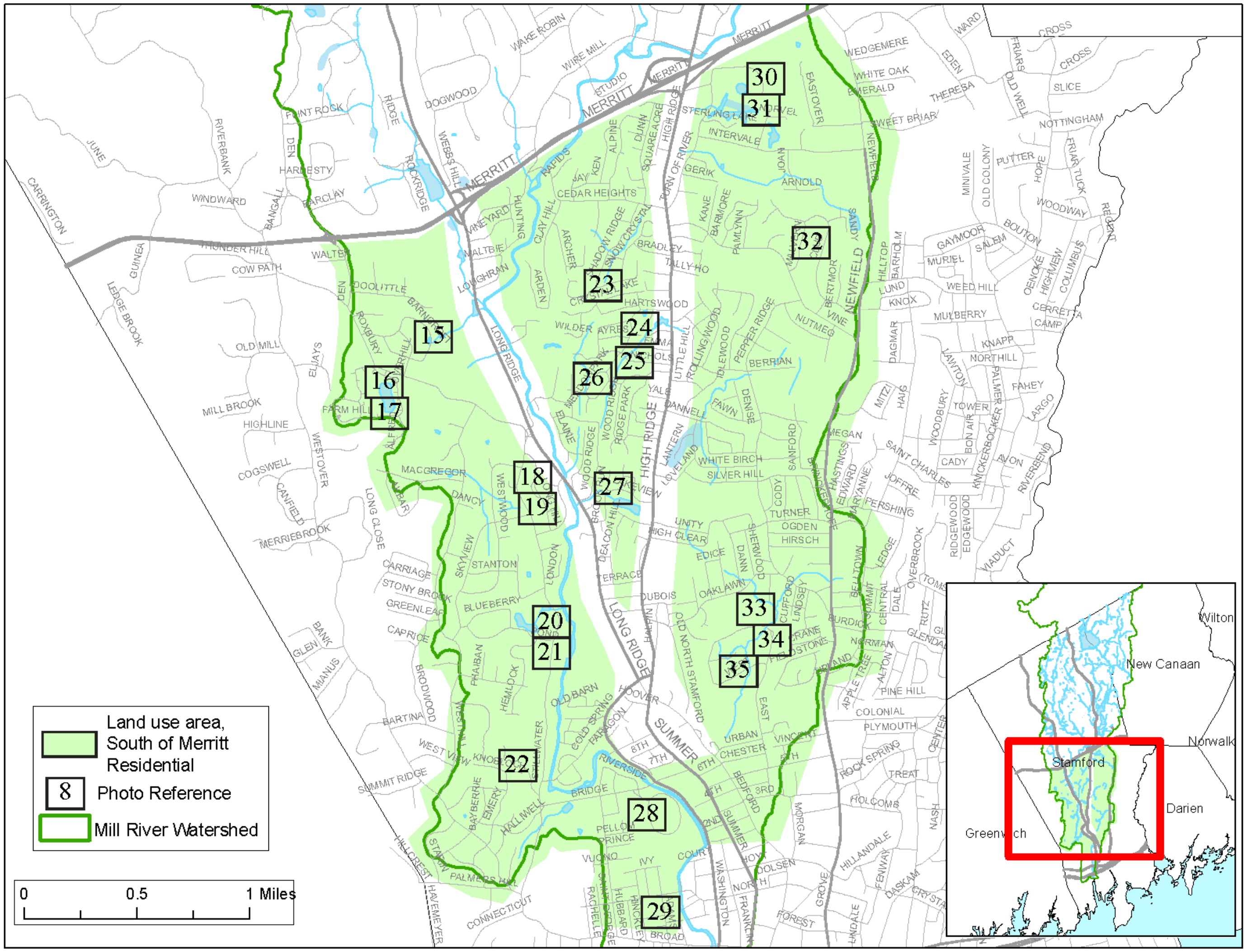


Table 2
South of Merritt Parkway, Residential Areas
Photographs correlate with map shown in Figure 4

Area	Image Number	Image	Description
South of Merritt - Residential	15		Pond with excessive algal growth
South of Merritt - Residential	16		Wetland area in private community
South of Merritt - Residential	17		Pond with algal growth, in private community
South of Merritt - Residential	18		Dense residential street
South of Merritt - Residential	19		Typical residential property

Table 2
South of Merritt Parkway, Residential Areas
Photographs correlate with map shown in Figure 4

Area	Image Number	Image	Description
South of Merritt - Residential	20		Garden center on Stillwater Rd, at river's edge
South of Merritt - Residential	21		Garden center on Stillwater Rd, at river's edge
South of Merritt - Residential	22		Typical residential property
South of Merritt - Residential	23		Culvert carrying baseflow at headwaters of Ayers Brook
South of Merritt - Residential	24		Small tributary to Ayers Brook

Table 2
South of Merritt Parkway, Residential Areas
Photographs correlate with map shown in Figure 4

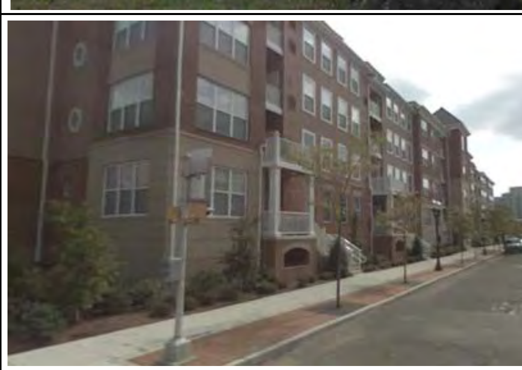
Area	Image Number	Image	Description
South of Merritt - Residential	25		Stormwater drainage to small stream
South of Merritt - Residential	26		Lawn clippings near wetland/floodplain area
South of Merritt - Residential	27		Leaves raked or blown into street
South of Merritt - Residential	28		Scalzi Park geese
South of Merritt - Residential	29		Apartment complexes

Table 2
South of Merritt Parkway, Residential Areas
Photographs correlate with map shown in Figure 4

Area	Image Number	Image	Description
South of Merritt - Residential	30		Office park median
South of Merritt - Residential	31		Office park, parking lot
South of Merritt - Residential	32		Typical residential property
South of Merritt - Residential	33		Baseflow at headwaters of Toilsome Brook
South of Merritt - Residential	34		Stormwater drainage to small stream in private community

Table 2
South of Merritt Parkway, Residential Areas
Photographs correlate with map shown in Figure 4

Area	Image Number	Image	Description
South of Merritt - Residential	35		Stormwater drainage to small stream in private community

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Figure 5: Land Use Area – South of Merritt Parkway, Commercial Areas

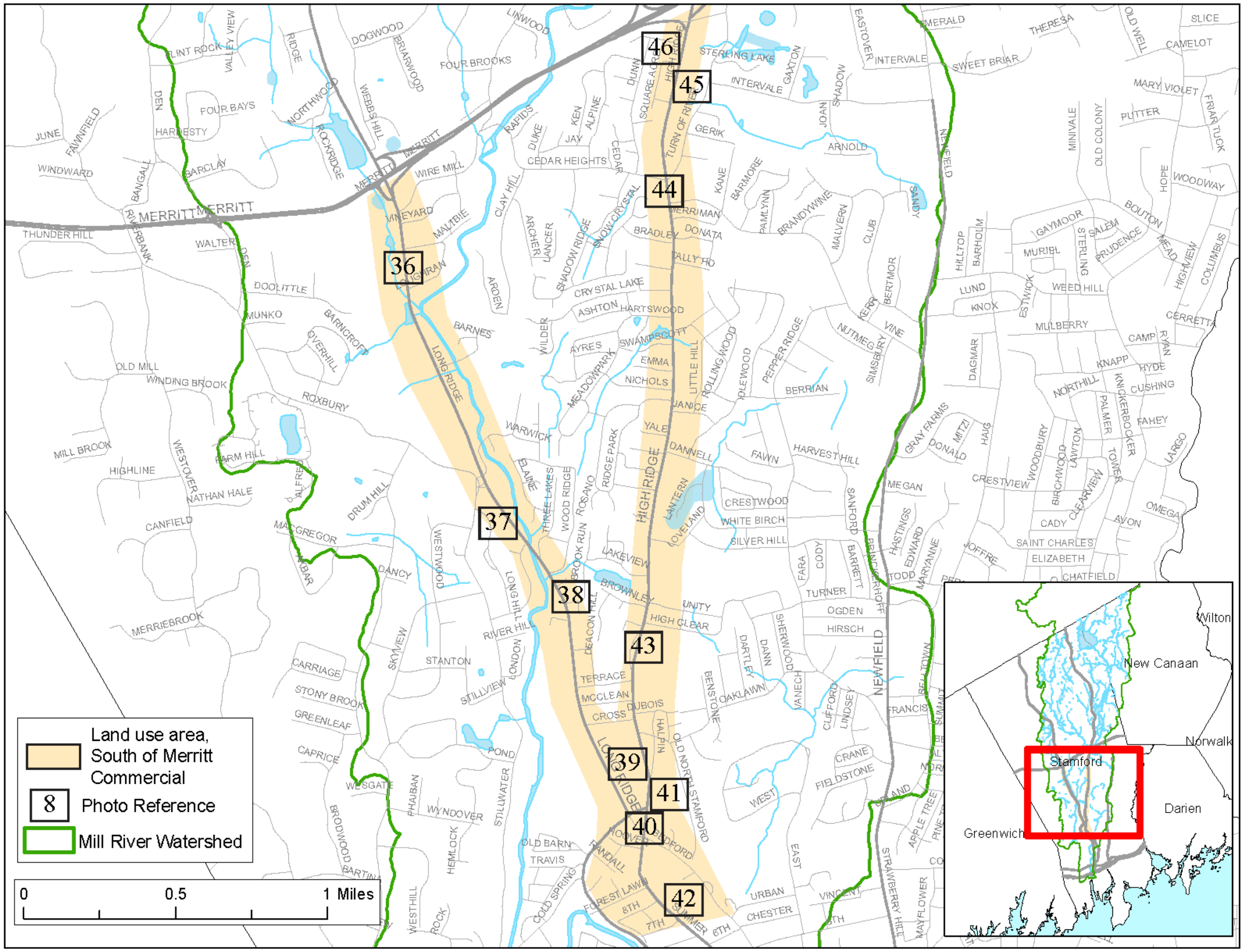


Table 3
South of Merritt Parkway, Commercial Areas
Photographs correlate with map shown in Figure 5

Area	Image Number	Image	Description
South of Merritt - Commercial	36		Long Ridge Rd near the Merritt Parkway, less commercial development
South of Merritt - Commercial	37		Long Ridge Rd office building
South of Merritt - Commercial	38		Long Ridge Rd at transition from majority residential to majority commercial development
South of Merritt - Commercial	39		Shopping district and new commercial development
South of Merritt - Commercial	40		Shopping district

Table 3
South of Merritt Parkway, Commercial Areas
Photographs correlate with map shown in Figure 5

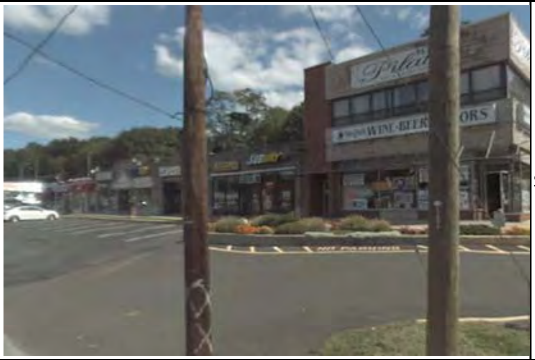
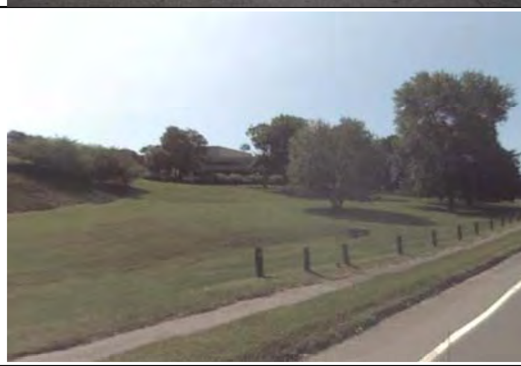
Area	Image Number	Image	Description
South of Merritt - Commercial	41		Strip mall landscaping on High Ridge Rd
South of Merritt - Commercial	42		Shopping plaza impervious surface and stormwater drain
South of Merritt - Commercial	43		Stormwater collection culvert, opportunity for stormwater BMP
South of Merritt - Commercial	44		Typical impervious cover on High Ridge Rd, just south of Merritt Parkway
South of Merritt - Commercial	45		Aerial image (Google, 2009), commercial district on High Ridge, opportunity for BMPs to reduce impervious area

Table 3
South of Merritt Parkway, Commercial Areas
Photographs correlate with map shown in Figure 5

Area	Image Number	Image	Description
South of Merritt - Commercial	46		Office building on High Ridge Rd

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Figure 6: Land Use Area – Urban Residential/Downtown

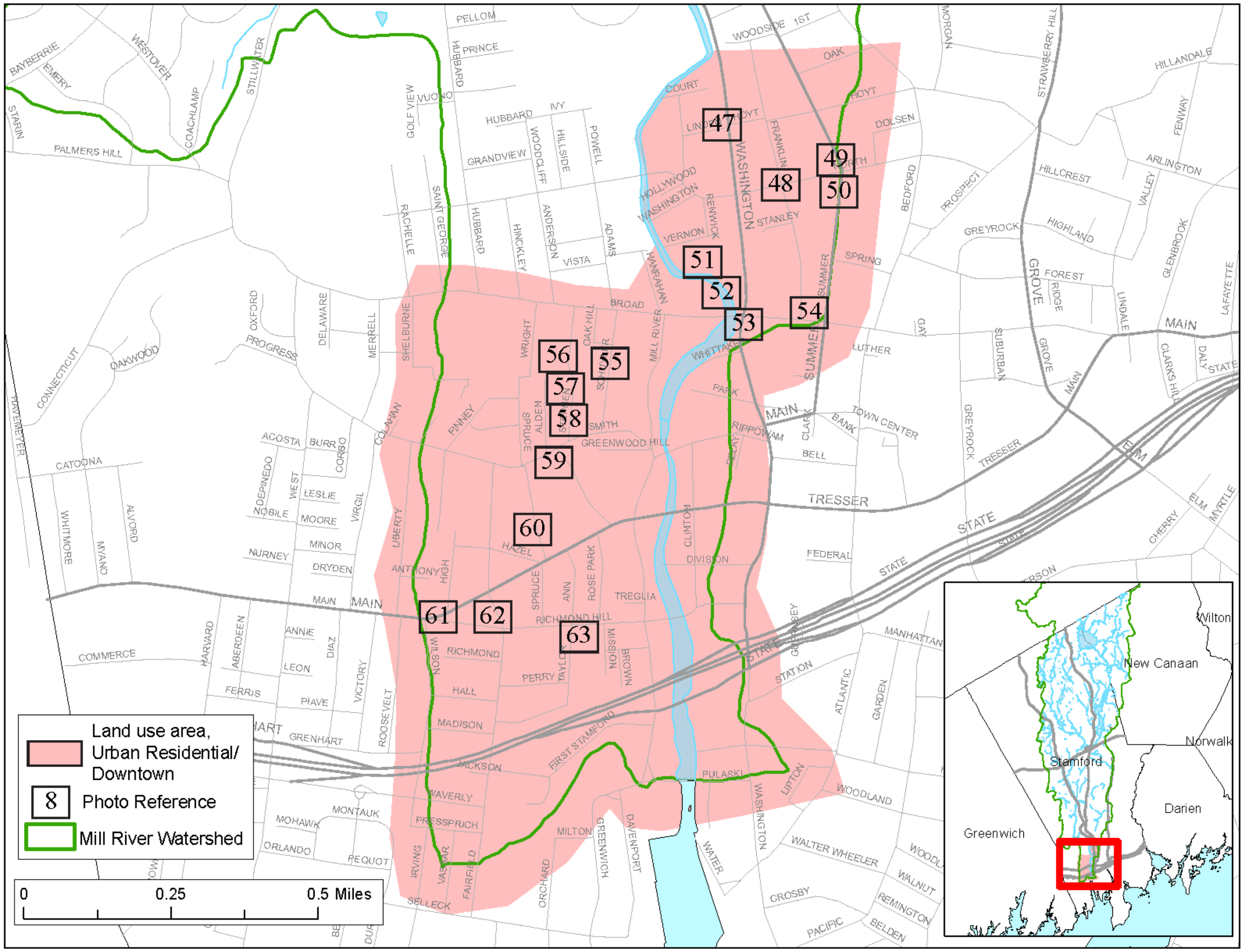
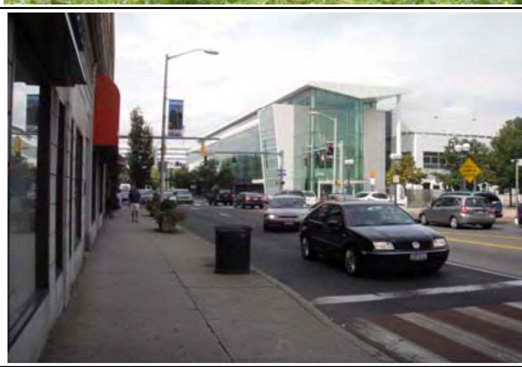
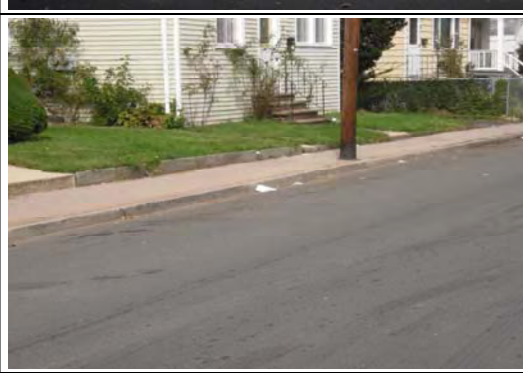


Table 4
Urban Residential/Downtown Stamford
Photographs correlate with map shown in Figure 6

Area	Image Number	Image	Description
Urban/Downtown Stamford	47		Office buildings near downtown
Urban/Downtown Stamford	48		Uncontrolled sediment from street construction
Urban/Downtown Stamford	49		Uncontrolled sediment from street construction
Urban/Downtown Stamford	50		Uncontrolled sediment from street construction
Urban/Downtown Stamford	51		Trash near river

Table 4
Urban Residential/Downtown Stamford
Photographs correlate with map shown in Figure 6

Area	Image Number	Image	Description
Urban/Downtown Stamford	52		Geese in river
Urban/Downtown Stamford	53		Geese on river banks
Urban/Downtown Stamford	54		Downtown Stamford impervious area
Urban/Downtown Stamford	55		Large impervious lots
Urban/Downtown Stamford	56		Street sweeping opportunity

Area	Image Number	Image	Description
Urban/Downtown Stamford	57		Street sweeping opportunity
Urban/Downtown Stamford	58		Street sweeping opportunity
Urban/Downtown Stamford	59		Landscaped median in urban area, opportunity for BMP
Urban/Downtown Stamford	60		Urban gardening area
Urban/Downtown Stamford	61		Covered sand storage

Table 4
Urban Residential/Downtown Stamford
Photographs correlate with map shown in Figure 6

Area	Image Number	Image	Description
Urban/Downtown Stamford	62		Geese on park grass
Urban/Downtown Stamford	63		Urban residential development near downtown

Appendix E: Action Items
Action 1.1: Rain Garden/ Bioretention Area

Target Objectives

4. Control and reduce high flows to reduce flooding
5. Improve water quality
6. Restore instream and riparian habitat
7. Ensure sufficient low flows
8. Promote sustainability mission of City of Stamford

Problem: High Runoff and Pollutants

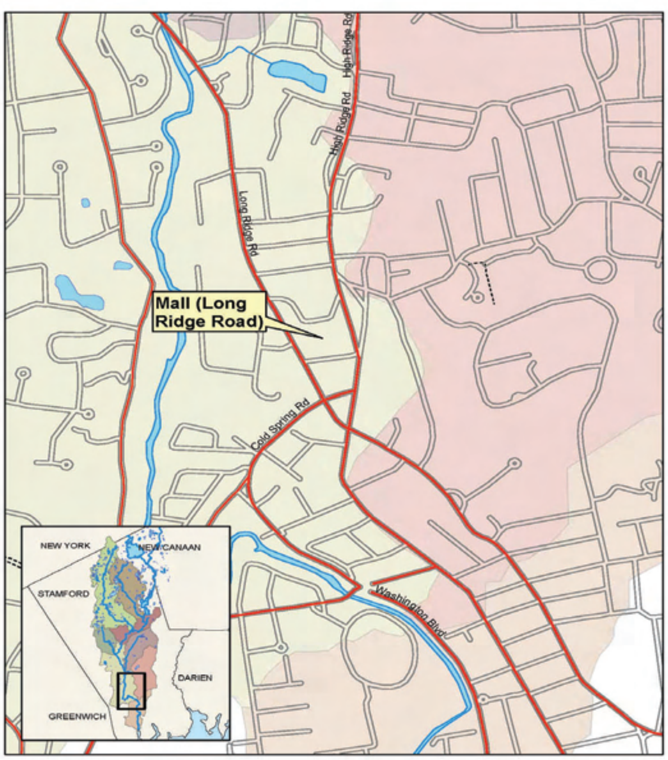
Rain on impervious surfaces such as concrete roadways, sidewalks, and building footprints increases stormwater volume and transports pollutants through the drainage system to surface water resources, adversely affecting receiving water quality and aquatic habitat.

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

Brief Description of Action

Rain gardens could be installed in medium to high density residential and developed urban areas where stormwater accumulates quickly and in large volumes such as parks, parking lots, and urban centers. Example locations for future rain garden are Scalzi Park (shown above) and the Stamford Hospital.

Action Item Summary



Expected Benefits

Rain gardens capture and collect water that would otherwise enter the storm drain system. Pollutants are naturally filtered by native plants, soil, and microbes and water is directed to infiltrate at point of capture, reducing demand on stormwater infrastructure and reducing adverse affects of common pollutants on surface water resources. Water that naturally infiltrates returns to base flow in the stream, improving low-flow conditions.

Responsible Parties

- City of Stamford
- Commercial/Residential Land Owners

Cost

\$4-\$6/ft^3 (construction only)

CDM Smith

Action 1.2: Tree Filter/ Street Planter

Target Objectives

4. Control and reduce high flows to reduce flooding
5. Improve water quality
6. Restore instream and riparian habitat
7. Ensure sufficient low flows
8. Promote sustainability mission of City of Stamford

Problem: High Runoff and Pollutants

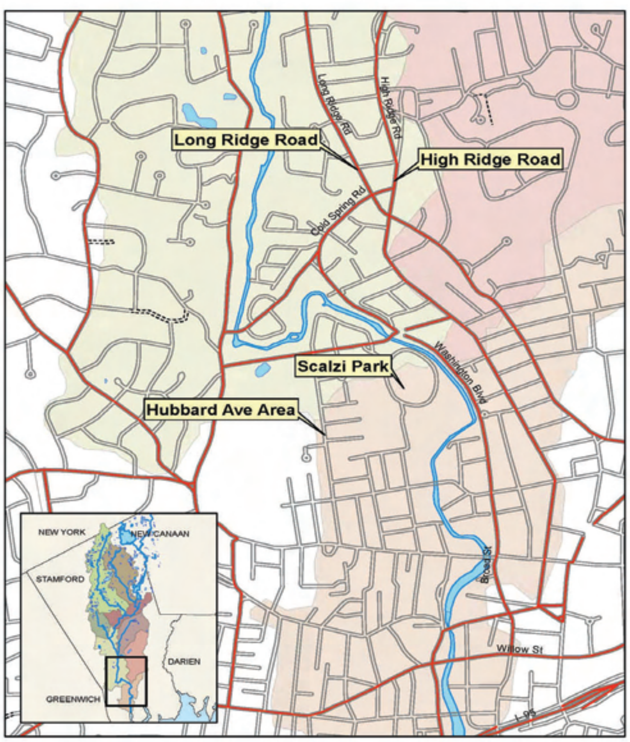
Rain on impervious surfaces such as concrete roadways, sidewalks, and building footprints increases stormwater volume and transports pollutants through the drainage system to surface water resources, adversely affecting receiving water quality and aquatic habitat.

Pollutant	Estimated % 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%

Brief Description of Action

Tree filters or street planters could be installed in medium to high density residential and developed urban areas where stormwater accumulates quickly and in large volumes such as parks, parking lots, and urban centers. The Ayers Brook and Downtown basins and the Long Ridge Rd and High Ridge Rd commercial areas would benefit from tree filters.

Action Item Summary



Expected Benefits

Tree filters pre-filter water before it enters the storm drain system through a subsurface chamber containing filter media or by trees underlain with soil. Water is directed to infiltrate at point of capture, reducing demand on stormwater infrastructure and the adverse affects of common roadway pollutants.

Responsible Parties

- City of Stamford
- Commercial Property Owners

Cost

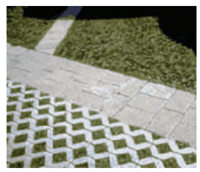
\$71-\$101/ft^3

CDM Smith

Action 1.3: Porous Pavement

Target Objectives

4. Control and reduce high flows to reduce flooding
5. Improve water quality
6. Restore instream and riparian habitat
7. Ensure sufficient low flows



Problem: Excessive Urban Runoff

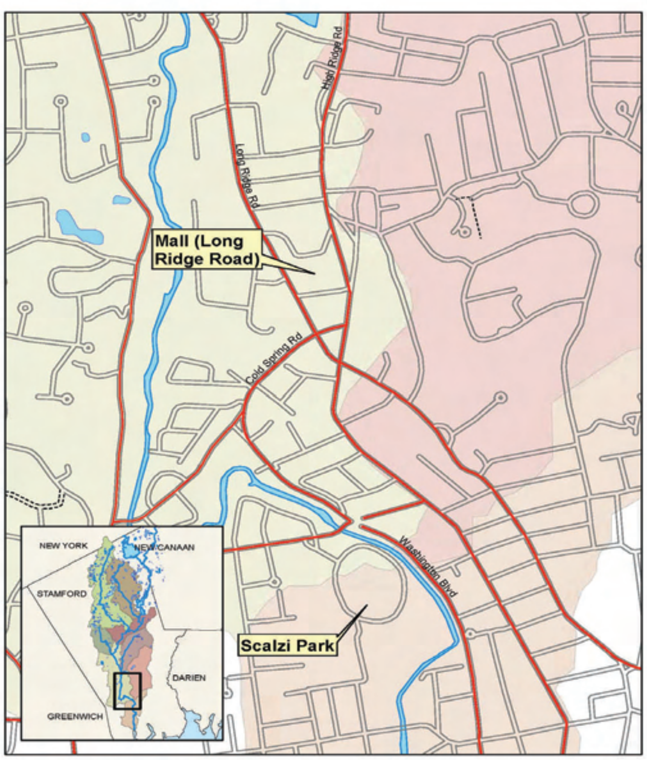
Impermeable pavements in urban areas increase surface runoff which is conveyed offsite to receiving surface water resources. Runoff contains harmful pollutants including heavy metals, alkali-chlorides, and suspended solids which adversely affect receiving water habitat.

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

Brief Description of Action

Porous pavement may be installed in parking lots, light use roadways, driveways, sidewalks, and commercial developments where impervious surfaces are prevalent as in medium to high residential and urban settings. Examples include Scalzi Park, residences, and the commercial areas on Long Ridge Rd and High Ridge Rd.

Action Item Summary



Expected Benefits

Permeable pavements increase rain water infiltration, decrease stormwater peak flows, and improve overall stormwater quality before discharge to surface water resources.

Responsible Parties

- City of Stamford
- Commercial/Residential Property Owners

Cost

$192,000-$715,000 per acre

Action 1.4: Green Roof

Target Objectives

4. Control and reduce high flows to reduce flooding
5. Improve water quality
6. Restore instream and riparian habitat
8. Promote sustainability mission of City of Stamford

Problem: Excessive Stormwater Runoff

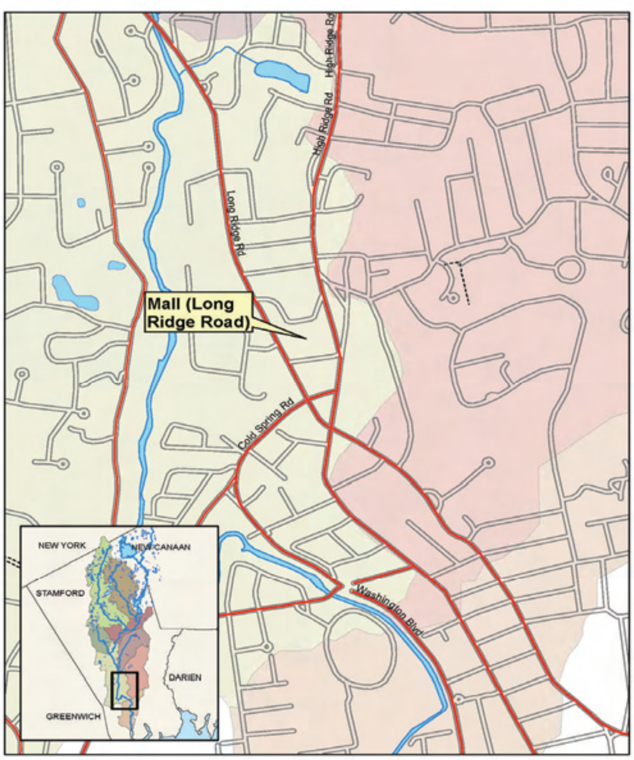
Impermeable roofs shed water quickly, leading to high volumes of stormwater to be conveyed offsite. This water is discharged to receiving surface water resources, introducing harmful pollutants and sediment to the river.

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

Brief Description of Action

Green roofs could be installed on a commercial or residential building in medium to high density residential and urban settings which contain a high percent of impervious surfaces.

Action Item Summary



Expected Benefits

Green roofs collect, store, and filter stormwater from impervious surfaces before it enters the drain system. While a portion of water is retained, the delayed peak flow assists in reducing demand to infrastructure.

Responsible Parties

- City of Stamford
- Commercial/Residential Property Owners

Cost

$240,000-$1,300,000 per acre of roof

CDM Smith

Action 1.5: Sand Filter

Target Objectives

4. Control and reduce high flows to reduce flooding
5. Improve water quality
6. Restore instream and riparian habitat
7. Ensure sufficient low flows
8. Promote sustainability mission of City of Stamford



Problem: High Runoff and Pollutants

Impermeable pavements in urban areas increase surface runoff which is conveyed offsite to receiving surface water resources. Runoff contains harmful pollutants including heavy metals, alkali-chlorides, and suspended solids which adversely affect receiving water habitat.

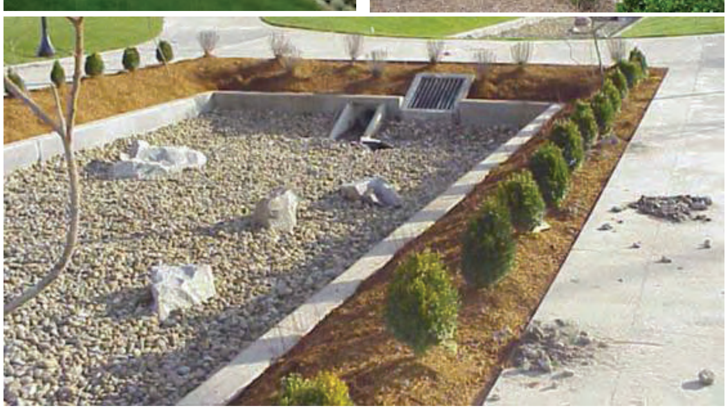
Brief Description of Action

Sand filters are appropriate in locations where ground-water is high, soils are relatively permeable, or in areas with limited space. Design typically includes an upper gravel or rock layer underlain by coarse to medium sand.

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

Action Item Summary





Expected Benefits

Sand filters pre-filter stormwater before discharge to a storm drain system, improving stormwater quality and delaying discharge to the system. This reduces peak flow and peak flow related backups. Sand filters also remove oil, grease, and particulates from stormwater, improving water quality.

Responsible Parties

- City of Stamford
- Commercial Property Owners

Cost

\$34-\$91/ft^3

CDM Smith

Action 2.1: Removal of Low Head Dams

Target Objectives

2. Improve access and connection to the river
6. Restore instream and riparian habitat

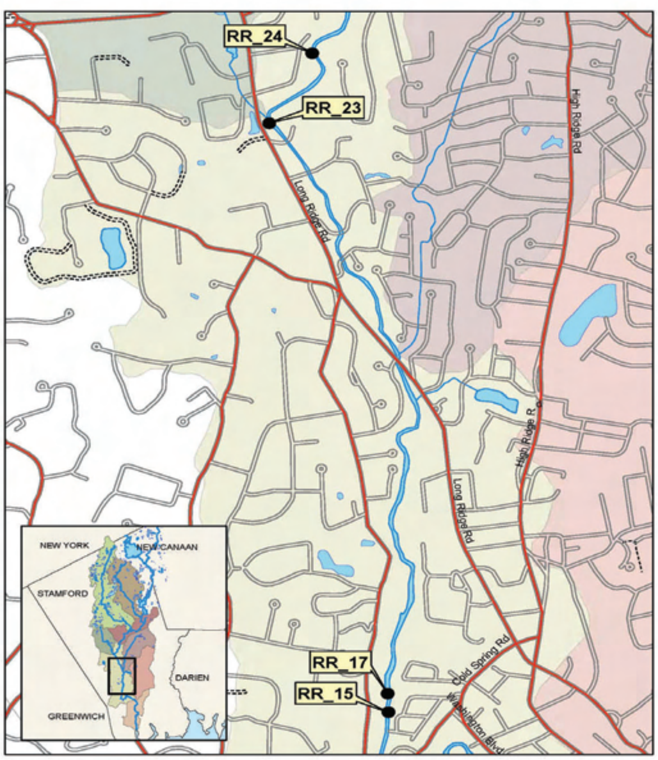
Problem: Disruption of Species Migration and River Flow

The existing low head dams create a barrier for the natural patterns of the river by disrupting natural flow patterns, leading to temperature fluctuations, excessive algal growth, and limited species migration.

Brief Description of Action

This action recommends the removal of low head dams along the Mill River that are dilapidated, abandoned, and no longer serve their intended purpose.

Action Item Summary



Expected Benefits

By removing low head dams, the river will be more navigable for aquatic species, provide a healthier habitat through less sediment buildup, and maintain an even and low temperature. In order to restore the natural flow of the river, these defunct structures must be removed.

Responsible Parties

- City of Stamford

Cost

Up to $500,000

Action 2.2: Change North Stamford Dam Outlet

Target Objectives

5. Improve water quality
6. Restore instream and riparian habitat
7. Ensure sufficient low flows

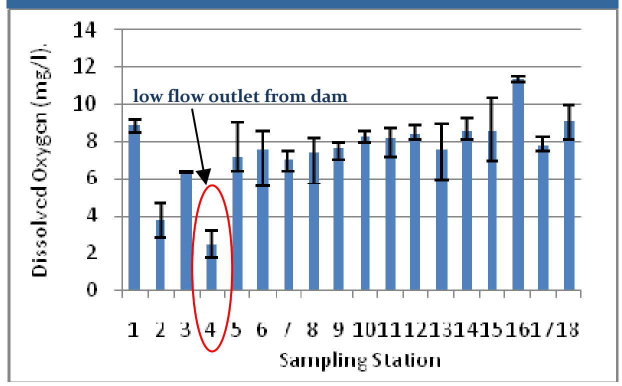
Problem: Low Dissolved Oxygen

The low flow outlet from the North Stamford Dam discharges water with very low dissolved oxygen and temperature during summer months when the reservoir is stratified. Sufficient oxygen is necessary to sustain aquatic life.

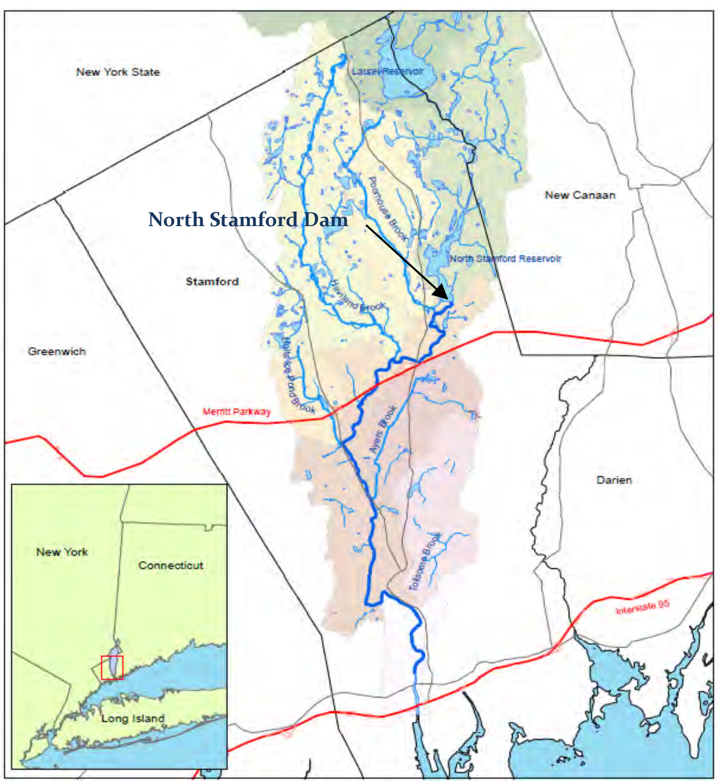
Brief Description of Action

The low flow outlet should be relocated to discharge flow from a higher elevation in the reservoir, or actively managed as conditions change.

Min, Max and Average of Summer DO Measurements



Action Item Summary



Expected Benefits

Increasing the concentration of dissolved oxygen in the outlet flow would improve the habitat for fish and other aquatic life in the downstream reach of river. In addition, the low flow outlet could potentially be a source of low flow augmentation.

Responsible Parties

- Aquarion Water Company
- City of Stamford

Cost

Up to $500,000

CDM Smith

Action 2.3: Holts Ice Pond Remediation

Target Objectives

4. Control and reduce high flows to reduce flooding
5. Improve water quality
6. Restore instream and riparian habitat

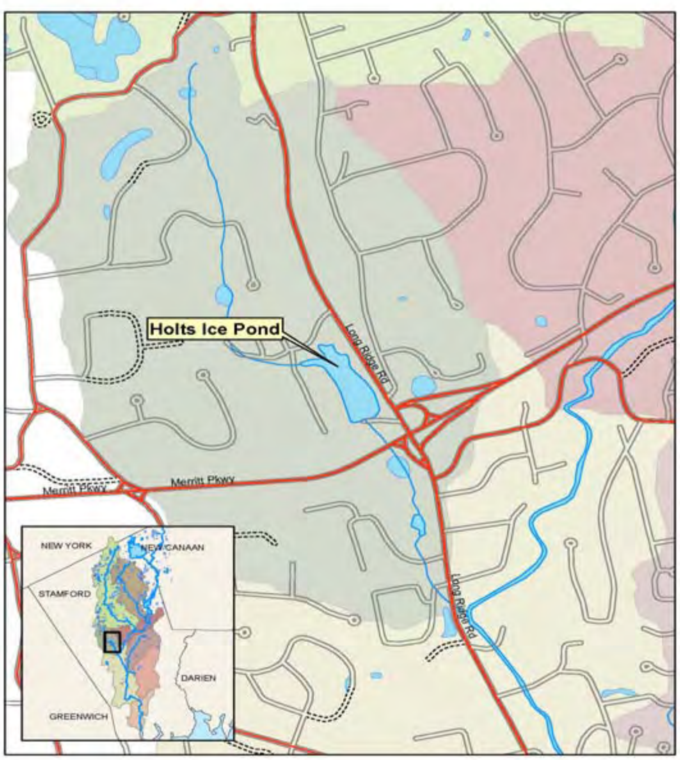
Problem: Eutrophication

Holts Ice Pond becomes eutrophied during warm weather months due to high nitrogen inputs from surrounding land use.

Brief Description of Action

Holts Ice Pond should be assessed to increase flushing, establish source control to the pond, remove built up sediment, and improve land management practices in the surrounding area.

Action Item Summary



Expected Benefits

The Holts Ice Pond is in a state of extreme eutrophication where nutrients spur excessive algae growths, which later decompose and become toxic to aquatic life. By addressing pollutant sources which contribute to eutrophication and improving flushing within the pond, conditions within the pond, and the river, will improve.

Responsible Parties

- City of Stamford
- Land owners

Cost

Up to $500,000

CDM Smith

Action 2.4: River Bank Restoration

Target Objectives

5. Improve water quality
6. Restore instream and riparian habitat

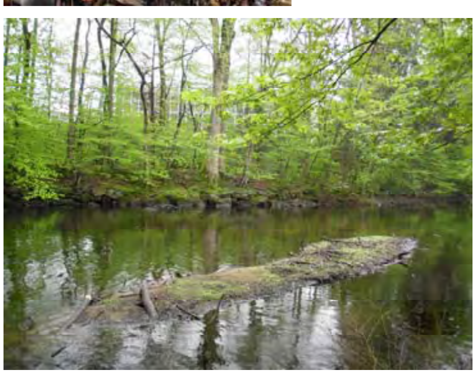
Problem: Bank Instability

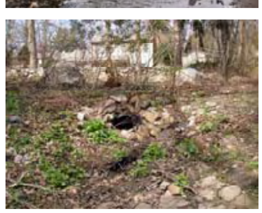
Excessive sedimentation, erosion, and bank armoring are the result of unstable embankments. Over time, sediment deposition decreases water quality, chokes benthic communities, and degrades aquatic specie habitat.

Brief Description of Action

Decreasing slope angles, filling gaps, and introducing rooted plants will aid in restoring river bank stability. In addition, riparian buffer improvements will provide long-lasting benefits to river banks.

Action Item Summary





Expected Benefits

The restructuring of river banks would reduce erosion and incidence of armored river banks, reducing sedimentation and deposition while improving benthic and aquatic specie habitat.

Parties Involved

- City of Stamford
- Watershed Constituency

Cost

Based on a cost of $350-$1000 per linear foot of stream bank, restoring 10% of the Mill River will cost $2.8 to $7.9 million.

CDM Smith

Action 2.5: Riparian Buffer Improvements

Target Objectives

4. Control and reduce high flows to reduce flooding
5. Improve water quality
6. Restore instream and riparian habitat

Problem: Degraded Riparian Buffers

Unshielded banks, encroaching development, and heavily landscaped border areas lead to erosion and an influx of sediment, nutrients, and other materials to the river.

Brief Description of Action

Planting native grasses, trees, and shrubs while allowing for unmanaged undergrowth along river banks will improve the quantity and quality of stormwater and pollutants which enter the River.

Action Item Summary

Sediment Intrusion | Silt Fence | Failed Erosion Control | Algal Growth

Expected Benefits

Improving riparian buffers along the river will reduce pollutant loading, peak flow, and erosion while absorbing pollutants. It will also serve to provide habitat, shade, and cover for the river, aquatic species of plants and animals, and other wildlife.

Responsible Parties

- City of Stamford
- Watershed Constituency
- Land Owners

Cost

None to Minimal

Action 2.6: Removal of Invasive Plants

Target Objectives

6. Restore instream and riparian habitat

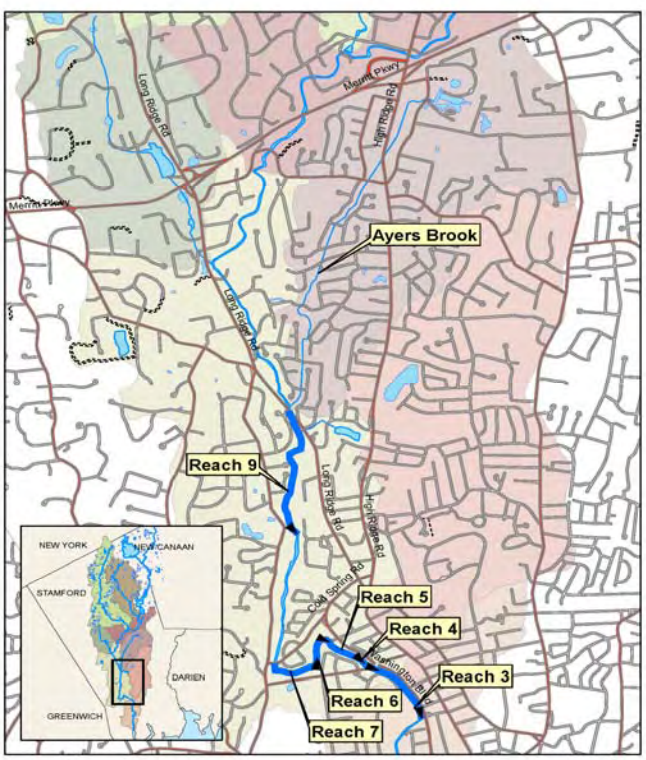
Problem: Non-Native Plant Overgrowth

Non-native invasive (NNI) plants 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.

Brief Description of Action

Japanese Knotweed is an invasive species which exists throughout the Rippowam/Mill River. Removal programs include community action group support,

Action Item Summary



Expected Benefits

Removal of invasive plants will help to restore the natural environment of the river by encouraging the growth of native species, increasing area biodiversity, and helping to restore the river's chemical properties.

Responsible Parties

- Watershed Constituency
- Land Owners

Cost

None to Minimal

CDM Smith

Action 2.7: Instream Restoration

Target Objectives

4. Control and reduce high flows to reduce flooding
6. Restore instream and riparian habitat

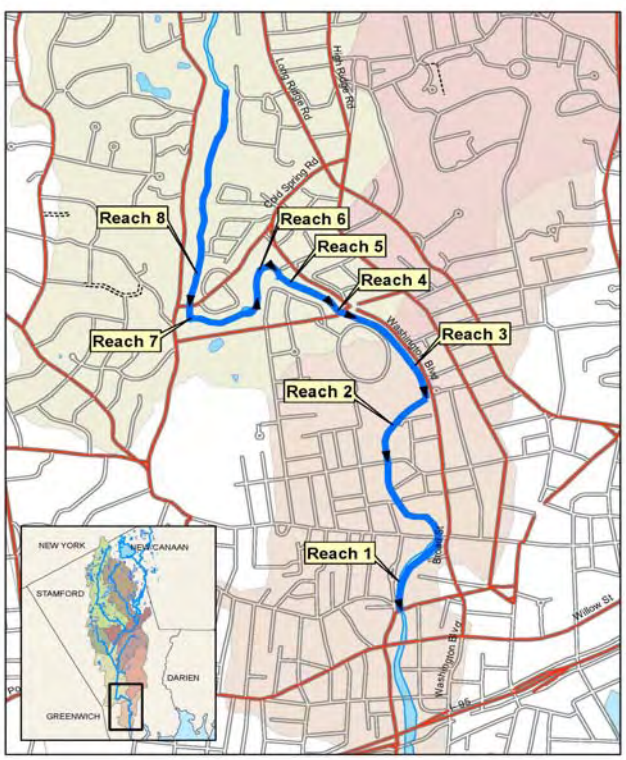
Problem: Excessive Sediment and Debris Buildup

High sediment and excessive debris buildup has altered the hydrology of the river, causing streams to be disconnected from the river, choking benthic animal and aquatic plant life populations, and inhibiting fish migration and leading to flooding.

Brief Description of Action

Large accumulation of sediments and debris should be removed, annual cleanup programs should be instituted, and a comprehensive maintenance program should be established.

Action Item Summary



Expected Benefits

Removing large sediment pockets will immediately improve the hydrology of an affected area, however long term strategies which reconnect benthic animal and aquatic plant life populations will enhance the overall river health.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

Up to $500,000

Action 2.8: Public Access Points

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river

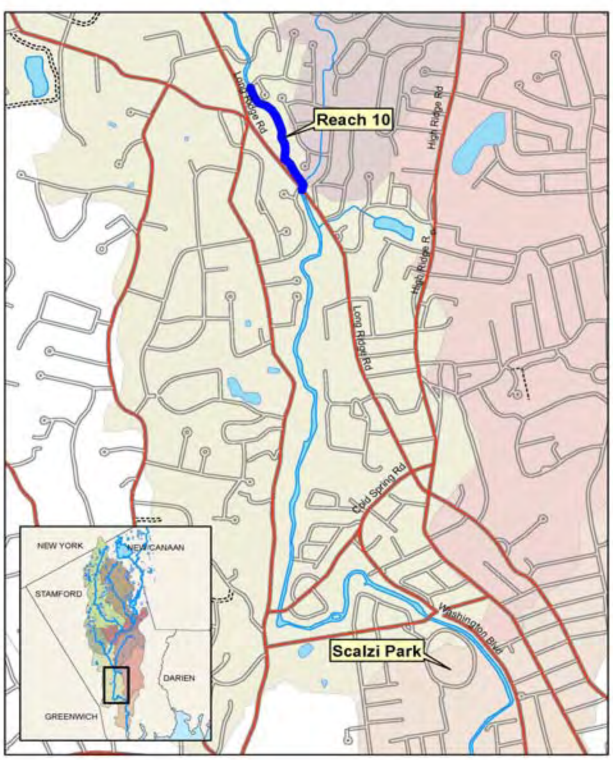
Problem: Public Awareness and Accessibility

Urban rivers are neglected elements of the natural environment which are largely ignored if they are not accessible by the public.

Brief Description of Action

Increasing access points to the river, including walkways, bike paths, boat launches, wildlife viewing areas, and parks will improve the community relationship with the river and increase stewardship.

Action Item Summary



Expected Benefits

Increasing public access to natural resources leads to an increased sense of pride and ownership in the health and well-bring of the river and lead to greater public efforts on its behalf and indirectly benefits water quality and reduced sedimentation initiatives.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

Up to $100,000

Action 2.9: Designate Wildlife Protection and Viewing Areas

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
3. Build a grassroots watershed constituency
6. Restore instream and riparian habitat

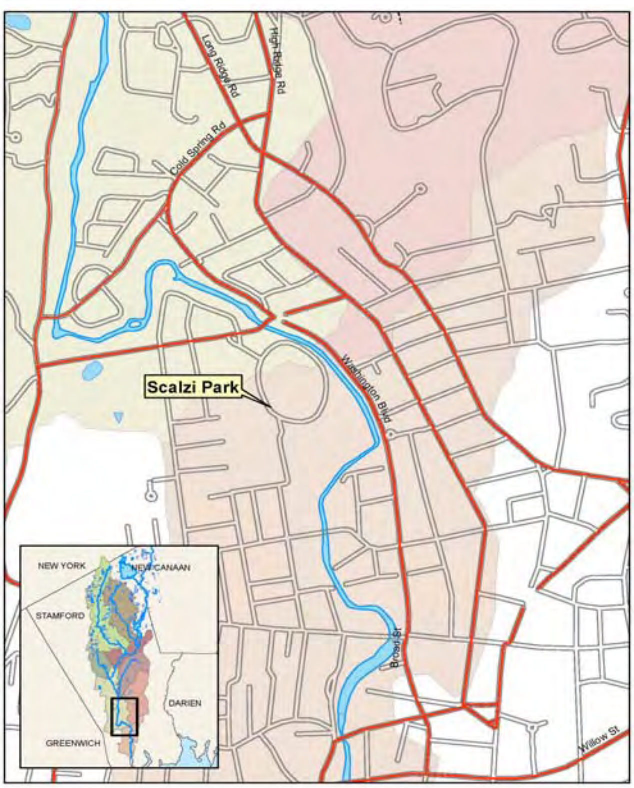
Problem: Public Accessibility and Awareness

Disconnect between City residents and the Rippowam/Mill River leads to choices which negatively influence the river.

Brief Description of Action

Attractions such as wildlife viewing areas, benches in parks, educational signage, bird watching sites, and river walkways should be created to allow residents the opportunity to enjoy their local environment.

Action Item Summary



Expected Benefits

Increasing public usage can lead to a greater sense of pride and ownership in the health and well-bring of the river and lead to greater public efforts on its behalf.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

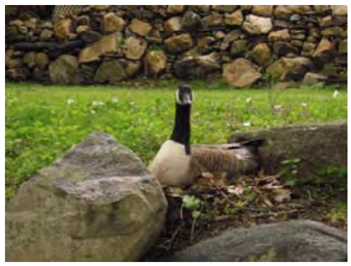
None to Minimal

CDM Smith

Action 3.1: Waterfowl Reduction Program

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
5. Improve water quality



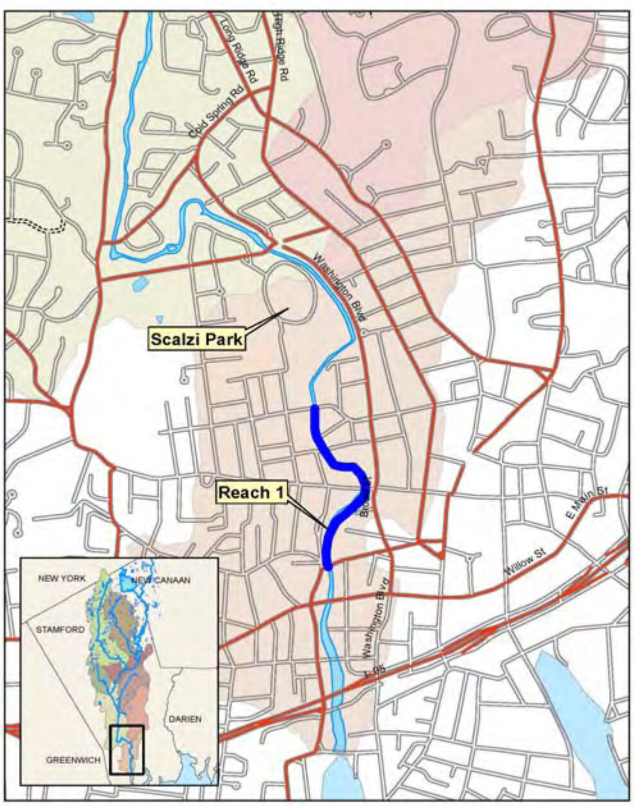
Problem: Waterfowl Over-Population as a Bacteria Source

Waterfowl waste introduces concentrated and excessive amounts of bacteria, disease, and nutrients to the river leading to severely degraded aquatic habitat, promoting algae growth, and limiting aquatic species.

Brief Description of Action

Local regulations must be instituted to prevent feeding, public outreach must including education and information related to the detrimental affects of waterfowl populations to water resources, and riparian buffers should be planted to control the bacterial runoff.

Action Item Summary



Expected Benefits

Reducing the affects of waste from waterfowl would reduce the amount of bacteria and algae and increase the dissolved oxygen content of the river and improve the aquatic habitat for animal and plant species.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

None to Minimal

CDM Smith

Action 3.2: Pet Waste Reduction Program

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
5. Improve water quality

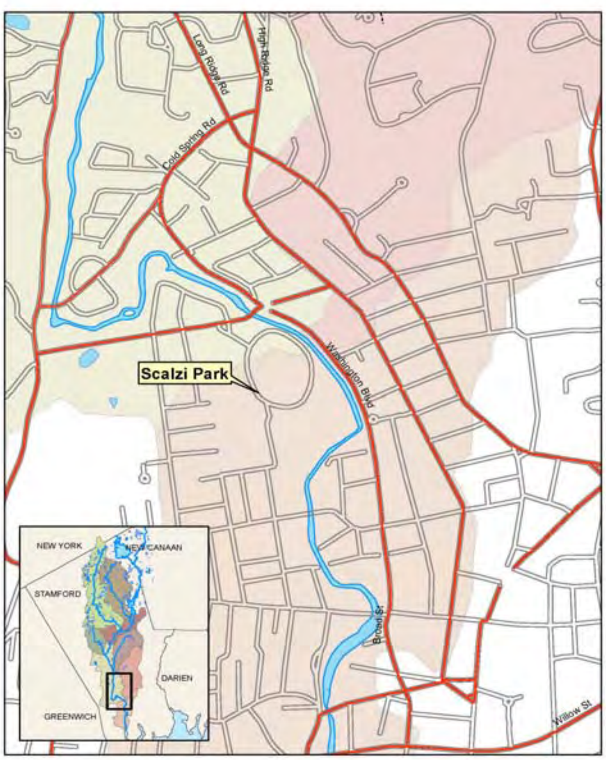
Problem: High Bacteria Pollution

Runoff carrying pet waste contributes to high levels of bacteria and algae. This pollutes the river and reduces the dissolved oxygen, negatively affecting the habitability of the river basin.

Brief Description of Action

A public education program should be implemented to make residents aware of the negative effects of mis-managed waste.

Action Item Summary



Expected Benefits

Properly managing pet wastes will reduce the amount of bacterial pollution that enters the river basin.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

None to Minimal

Action 3.3: Community Participatory Events

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
6. Restore instream and riparian habitat

Problem: Disregard for River as a Resource

Disregard for the river as a community resource leads to trash and litter deposited along the river or roadway often migrates into the river, causing harm to the river's ecology and aquatic life.

Brief Description of Action

Annual river cleanups, tree plantings, and other community participatory events should be developed to engage local residents in the welfare of the river as a natural resource in the community.

Action Item Summary

Expected Benefits

Such events will allow stakeholders to develop long term relationships with the river and get them engaged in its wellbeing. Overall, such events will improve the aesthetics and ecological health of the river while fostering local partnerships and personal investment in the river's future.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

None to Minimal

CDM Smith

Action 3.4: Reduce Improper Yard Waste Disposal

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
6. Restore instream and riparian habitat

Problem: Illicit Yard Waste

Improperly disposed yard waste, commonly dumped in buffer areas behind residences and along stream banks, leads to excessive sediment intrusion, changes stream flow, disrupts wildlife habitat, and increases flooding along river banks. Improper yard waste disposal can also add lawn chemical pollutants and trash to the river.

Brief Description of Action

Reduce illicit yard waste disposal through education on affects on river habitat, awareness of local ordinance, and enforcement of ordinance in addition to increasing embankment buffer plantings.

Action Item Summary

Expected Benefits

Reduction of illicit yard waste in the river will decrease sedimentation, reduce chemical pollutants in river, and improve water quality and habitat.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

None to Minimal

CDM Smith

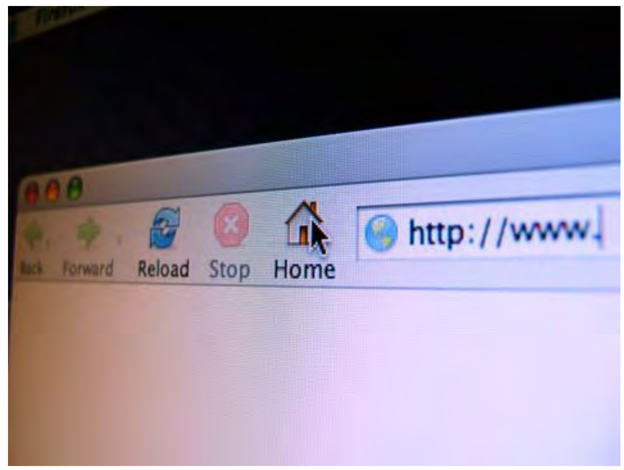
Action 3.5: Develop Website for Public Education and Information

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
3. Build a grassroots watershed constituency

Problem: Public Accessibility and Awareness

Lack of awareness of how resident activities influence the health and habitat of the river leads to mismanagement of yard waste, buffer areas, and public spaces, resulting in excessive sedimentation and degradation of water quality.



Brief Description of Action

A website should be developed to provide reference materials and electronic resources for interested residents to educate themselves on best management practices, river and habitat restoration, and events.

Action Item Summary


Image: Jeff Woelker

Expected Benefits

A website will allow residents to become informed on how their choices influence river habitat and what they can do to improve and protect the Mill River by managing their yards, habits, and participating in events This website could allow residents and business owners to proactively engage in river restoration.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

Up to $100,000

CDM Smith

Websites

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psabcontent.com

Action 3.6: Educational Signage Near River

Target Objectives

1. Increase public awareness, education, and community involvement
2. Improve access and connection to the river
3. Build a grassroots watershed constituency

Problem: Public Accessibility and Awareness

Lack of public awareness on how Human and pet activities contribute to the pollution of the Rippowam/Mill River leads to pollution, degraded river habitat, and increased degradation.

Brief Description of Action

Signs should be installed near the river promoting education on the history, ecology, and benefits of this resource as well as education on how to protect and care for it. The river area should be easily accessible.

Action Item Summary

Expected Benefits

By increasing river access and educational river signage, the City of Stamford and the Watershed Constituency will support continued resident involvement and ownership of the river.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

None to Minimal

Quantitative Benefits

5% reduction in targeted pollutants

Action 3.7: Mark Stormwater Grates With Educational Message

Target Objectives

1. Increase public awareness, education, and community involvement
5. Improve water quality
6. Restore instream and riparian habitat

Problem: Lack of Awareness of Stormwater Outfalls

Lack of resident awareness on stormwater conveyance results in chemical, biological, and bacterial contamination from stormwater catch basins which drain directly into the Rippowam/Mill River.

Brief Description of Action

Stormwater grates should be marked with educational messages to increase awareness of stormwater influence on surface water resources so residents are aware of how their choices affect the River.

Action Item Summary

Expected Benefits

Educational messages on grates will increase public awareness of stormwater conveyance to surface water resources. This low cost action can be implemented by local community groups. The messages will promote public awareness and discourage dumping, leading to a reduction in stormwater pollution.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

None to $500,000, depending on the extent the program is implemented.

Quantitative Benefits

5% reduction in targeted pollutants

Sources

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http://streetsforall.wordpress.com/2010/07/27/green-streets-for-all/

http://enclosuretakerefuge.wordpress.com/2011/07/28/sidewalk-planter-18th-and-f-streets-nw/

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effectively

Action 3.8: Improve Stormwater Practices at Commercial Sites

Target Objectives

5. Improve water quality
6. Restore instream and riparian habitat

Problem: Solids Pollution

Expansive impervious surfaces such as parking lots collect litter, waste from vehicles, and other surface contaminants which are washed into catch basins and deposited in the

Brief Description of Action

Stormwater best management practices such as porous pavement, green roofs, rain gardens, tree plantings, and other forms of stormwater pre-filtration decrease the negative influence developed areas have on the river.

Action Item Summary

Expected Benefits

Incorporating stormwater best management practices will improve stormwater quality. In addition to pollutant removal, structural BMPs can remove high amounts of TSS and reduce total peak discharge.

Responsible Parties

- City of Stamford
- Business Owners

Cost

None to Minimal

Action 3.9: Improve Stormwater Practices—Residential

Target Objectives

1. Increase public awareness, education, and community involvement
5. Improve water quality
6. Restore instream and riparian habitat

Problem: Pollution of Solids, Bacteria, and Nutrients

Runoff from residential properties introduces contamination, sediment, bacteria, chemicals, and litter to the river, degrading water quality and aquatic habitat.

Brief Description of Action

An outreach and education campaign should target residential best management practices and low impact development strategies to improve overall stormwater quality and limit sediment and litter in the river.

Action Item Summary

Expected Benefits

Overall decrease in pollution, yard waste, and litter entering the river, while increasing resident awareness of their influence on overall water and habitat quality and inspiring stewardship of this local resource.

Responsible Parties

- City of Stamford
- Land Owners

Cost

None to $500,000, depending on the extent the program is implemented.

CDM Smith

Action 3.10: Bacteria/DNA Source Tracking

Target Objectives

5. Improve water quality

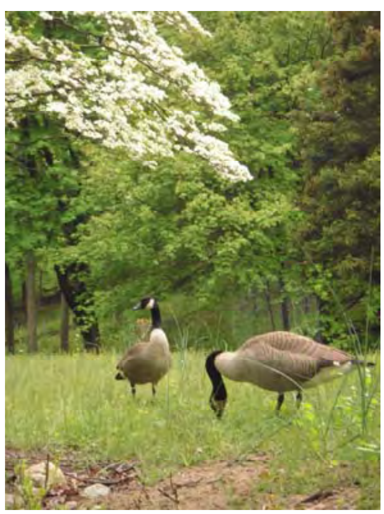
Problem: Bacterial Source Unknown

Unknown sources of fecal matter can introduce disease and nutrients to surface water resources, promote algal growth, and decrease dissolved oxygen levels in water and lead to conditions unsuitable for recreational activities.

Brief Description of Action

Conducting a bacteria source tracking study will reveal which species (humans, farm animals, pets) the bacteria originates from so that source elimination efforts can be directed accordingly.

Action Item Summary



Expected Benefits

Identifying the source of the bacteria will inform a targeted reduction program in areas where bacteria counts are high. This will lead to overall reduction of bacteria in the river, increase dissolved oxygen, and decrease algal growth.

Responsible Parties

- City of Stamford

Cost

$10-$100 per isolate (depending on method used)

CDM Smith

Action 3.11: Increase Street Sweeping and Catch Basin Cleaning

Target Objectives

5. Improve water quality
6. Restore instream and riparian habitat

Problem: Solids and Metals Pollution

Litter, including organic waste, leaves, and litter, accumulates along roadways and curbs, washes into storm drains, and increases sediment deposits at outfalls along the river.

Brief Description of Action

Assess current street sweeping program and frequency and increase cleaning frequency in areas where organics and litter accumulate quickly. Catch basins should be routinely cleaned of large solids.

Action Item Summary

Expected Benefits

Cleaning the streets and catch basins in greater frequency will help decrease the amount of litter, larger particles, and which would otherwise enter the drainage system and be deposited in the river, improving receiving water quality by decreasing sedimentation.

Responsible Parties

- City of Stamford

Cost

None to Minimal

CDM Smith

Action 3.12: Illicit Discharge Detection and Elimination

Target Objectives

5. Improve water quality
6. Restore instream and riparian habitat

Problem: Illicit Discharge

Illicit sewer connections to the storm drain system, floor drain connections, leaking water mains, leaking septic systems, and roof leaders introduce additional water to the storm drain system and can introduce bacteria and other hazardous contaminants to receiving waters.

Brief Description of Action

An illicit discharge detection and elimination program should be conducted and implemented to assess the City's storm drain system to eliminate illicit pipe connections.

Action Item Summary

Expected Benefits

A system-wide survey will allow the City to identify specific, significant sources of bacteria, preventing future inputs to the river, improving water quality, and restoring habitat in affected areas.

Responsible Parties

- City of Stamford

Cost

>$500,000

CDM Smith

Action 3.13: Address Private Water Intakes

Target Objectives

1. Increase public awareness, education, and community involvement
7. Ensure sufficient low flows

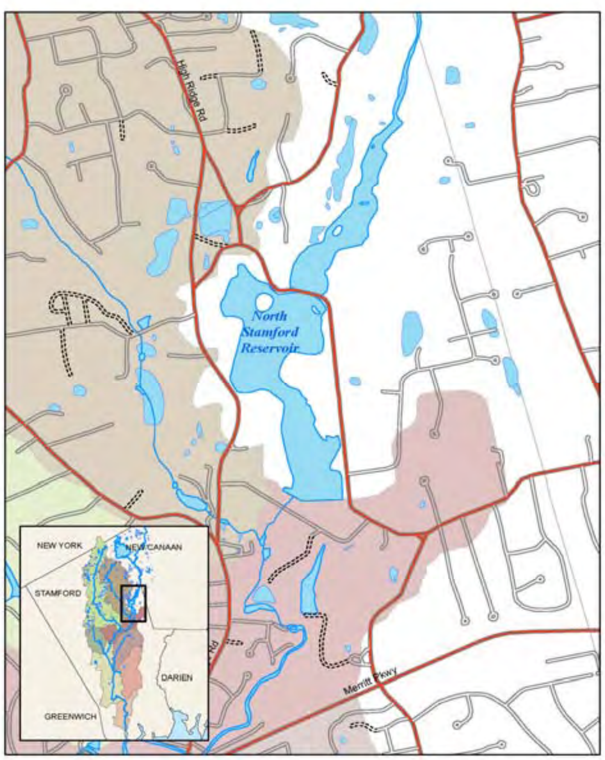
Problem: Private Water Intakes

Private water intakes reduce the overall flow of the river, limiting recreational activities and disrupting natural processes.

Brief Description of Action

Regulations will be developed to establish water withdrawal limits and a permitting process will be established to regulate withdrawals.

Action Item Summary



Expected Benefits

By limiting water withdrawals, the City will be able to maintain more active control of the river and establish a minimum flow which will allow the river to maintain natural processes and support aquatic life.

Responsible Parties

- City of Stamford

Cost

Up to $100,000

Action 3.14: Create Mill River Watershed Association

Target Objectives

1. Increase public awareness, education, and community involvement
3. Build a grassroots watershed constituency

Problem: Community Involvement

The current condition of the Rippowam/Mill River is degraded. In order to improve overall river health, the river requires an independent community-driven steward to lead restoration efforts.

Brief Description of Action

A citizen-based community organization should be developed to steward restoration efforts, collaborate with the City, and engage local residents and businesses to lead in implementing these action items.

Action Item Summary

Expected Benefits

Creation of the Mill River Watershed Association will establish a venue for action, improve public accessibility and awareness of issues pertaining to the health of the Mill River, and provide a platform for resident involvement and ownership of this community resource.

Responsible Parties

- Watershed Constituency

Cost

None to Minimal

CDM Smith

Action 3.15: Regular Monitoring Program

Target Objectives

5. Improve water quality
8. Promote sustainability mission of City of Stamford

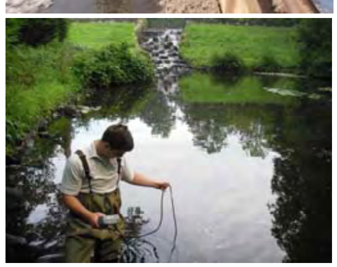
Problem: Inconsistent Environmental Data

In order to assess the performance of action items on improving overall habitat quality in the Rippowam/Mill River, a regular monitoring program must be established to gauge direction of future efforts.

Brief Description of Action

The watershed association should establish a volunteer annual monitoring program during a variety of river conditions: during rain events, low flow, after rain events, to assess the performance of action items.

Action Item Summary



Expected Benefits

Establishing a regular monitoring program will provide information to direct future restoration efforts and assess performance of implemented action items.

Responsible Parties

- City of Stamford
- Watershed Constituency

Cost

Up to $100,000

CDM Smith