Baseline Watershed Assessment
North Branch Park River Watershed

Connecticut Department of Environmental Protection

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FUSS & O'NEILL
Disciplines to Deliver

146 Hartford Road
Manchester, Connecticut 06040

In Cooperation With:

Farmington River Watershed Association
Park River Watershed Revitalization Initiative

Project No. 20071468.A10

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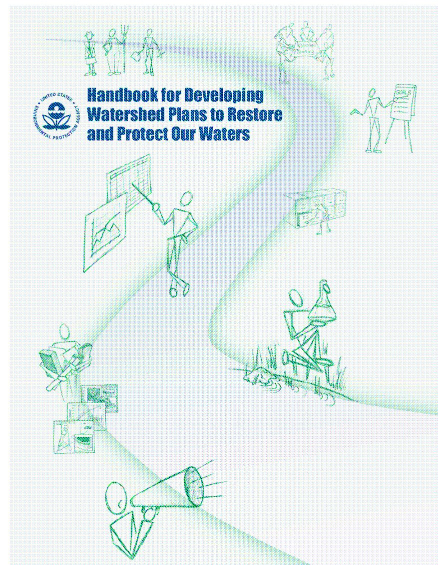
1 Introduction

The Connecticut Department of Environmental Protection (CTDEP) retained a project team led by Fuss & O'Neill, Inc. and including the Farmington River Watershed Association, the Park River Watershed Revitalization Initiative, and New England Environmental, Inc. to prepare a Watershed Management Plan for the North Branch of the Park River in Hartford County, Connecticut. The Watershed Management Plan is being developed in cooperation with the CTDEP, other governmental entities, stakeholder groups, and the general public.

The watershed planning process includes the preparation of three documents, including: (1) a baseline assessment report, (2) a detailed subwatershed field assessment report, and (3) a watershed management plan. The *Baseline Watershed Assessment Report*, which is the subject of this document, summarizes existing environmental and land use conditions in the watershed, while identifying priority areas in the watershed for subwatershed field inventories. The results of the subwatershed field inventories will be documented in a subsequent field assessment report, which will include targeted and site-specific opportunities for watershed restoration projects. Finally, the watershed management plan will identify prioritized action items to protect and improve the ecological integrity of the North Branch Park River and its watershed based on the priorities and issues identified in previous phases of the plan development, with input from the CTDEP and a project steering committee.



The management plan will be developed to satisfy EPA and CTDEP criteria for watershed-based plans.

The watershed management plan is being developed consistent with the U.S. Environmental Protection Agency (EPA) and CTDEP guidance for the development of watershed-based plans. The guidance outline nine key elements that establish the structure of the plan, including specific goals, objectives, and strategies to protect and restore water quality; methods to build and strengthen working partnerships; a dual focus on addressing existing problems and preventing new ones; a strategy for implementing the plan; and a feedback loop to evaluate progress and revise the plan as necessary. Following this approach will enable implementation projects under this plan to be considered for funding under Section 319 of the Clean Water Act.

The watershed management plan will be a comprehensive, scientifically-sound, and practical planning document for the protection and restoration of water resources in the North Branch Park River watershed. The watershed management plan will characterize the watershed conditions, identify, investigate, and address the current and emerging issues facing the watershed, and have the clear potential to affect on-the-ground change within the watershed.

1.1 Development of the Baseline Assessment Report

The following tasks were completed in developing this *Baseline Watershed Assessment Report* for the North Branch Park River watershed:

- Reviewed existing data, studies, and reports on the watershed.
- Compiled and analyzed available Geographic Information System (GIS) data.
- Consulted with the project steering committee, the watershed municipalities, the regional planning agency, and other governmental entities regarding available land use information, mapping, and land use planning regulations.
- Identified and delineated subwatersheds within the overall North Branch Park River watershed.
- Conducted a comparative subwatershed analysis to prioritize watershed field inventories and management plan recommendations.
- Performed a land use regulatory review.

This report documents current watershed conditions for the following topics:

- Study area, including a basic description of the watershed (Section 2).
- Historical and social perspective (Section 3).
- Natural resources including geology and soils, topography, hydrology, wetlands and watercourses, and fish and wildlife resources (Section 4).
- Watershed modifications including dams, water supply, wastewater, stormwater, and regulated sites (Section 5).
- Water quality including classifications and trends based on available monitoring data (Section 6).
- Land use and land cover (Section 7).
- Existing watershed practices (Section 8).
- Pollutant loading (Section 9).
- Comparative subwatershed analysis (Section 10).

1.2 Background

The North Branch Park River watershed is a moderate-sized watershed of slightly less than 30 square miles in area. The majority of the watershed (97%) is located within the original urban center of Hartford and the adjacent suburbs of West Hartford and Bloomfield, with Windsor, Avon and Simsbury comprising the remaining 3% of the watershed land area. The land uses within the watershed trend from highly urbanized at its confluence with the South Branch Park River to undeveloped in portions of its headwater regions. The lower portion of the river disappears completely within a several-mile long flood control conduit before it ultimately discharges to the Connecticut River. It is therefore unseen and often forgotten by many residents of the City of Hartford. The North Branch Park River is more prevalent and part of the landscape in its upper reaches where considerable amounts of open space and undeveloped land protect the river. In its middle reaches, there are encroachments of urban development interspersed with undeveloped or lightly developed areas adjacent to the river. Flood control reservoirs in the central and upper reaches of the watershed provide some measure of flood protection and open space. Flooding is common along the lower portions of the river due to a combination of development within the floodplain and higher amounts of impervious cover in the urban areas of Hartford.


The Mark Twain House overlooking the North Branch Park River.

The Park River is formed by the confluence of its north and south branches. These rivers have helped shape the culture and character of Hartford and its suburbs. Landmarks such as Bushnell Park, Pope Park and the Mark Twain House were constructed to capitalize on their proximity to the river. Many institutions currently front the aboveground portion of the North Branch Park River in Hartford including the University of Hartford, the UConn Law School, the Village of Family & Children Services and the Watkinson School. Despite the significant development within the watershed and its impaired water quality, the North Branch Park River is still considered an asset to these institutions due to its landscape function on their campuses. Other groups have also recognized its value in terms of landscape presence and have modified the land adjacent to the river to enhance its visibility and its aesthetic appeal, an example being the recently redeveloped Goodwin Estates residences.

The North Branch Park River watershed encompasses a sizeable portion of Hartford's urban core and includes many of the sociological and economic challenges that face urban areas. Water quality of urban streams is typically one of many challenges facing urban areas. The North Branch Park River, however, also has the potential to serve as a tremendous asset and a focal point for urban/suburban community collaboration. It can be perceived as a natural feature that could help define the character of the urban/suburban nexus. Cities across the United States are beginning to rediscover their connections to rivers and waterways. The reconnection of Hartford to the Connecticut River is a prime local example of the benefits that can be reaped from re-connecting people with the river. The North Branch Park River still retains sizeable natural areas along its banks as it flows from its headwaters into Hartford. The linear nature of rivers provides a tangible link and the potential for communities to collaborate on revitalization efforts. The potential exists for a regional vision to be developed where the

The North Branch Park River has the potential to serve as a tremendous asset and a focal point for urban/ suburban community collaboration.

upper watershed communities can offer substantial water quality and habitat protection benefits while the urban areas can provide the urban river experience with the river forming a physical and emotional connection to the community.

The river, in addition, has the challenge of an aging sanitary sewer infrastructure that combines stormwater runoff with sanitary sewage (combined sewer overflows or CSOs and sanitary sewer overflows or SSOs), resulting in frequent water quality impairments of the river. A long-term program to address these issues is being developed by the Metropolitan District Commission (MDC) in cooperation with the CTDEP. The MDC has developed preliminary plans to address the issues of CSOs and SSOs, with the potential to significantly improve the quality of the lower portions of the North Branch Park River. This is an enormous and expensive infrastructure project and opportunities may exist to enhance the physical quality of the river as part of the proposed infrastructure improvements.

The CTDEP is seeking to clearly define these technical and political challenges facing the North Branch Park River and to develop a comprehensive management plan for the watershed that addresses the full suite of challenges it faces. The watershed management plan will identify measures that can be taken to improve the health of the river, including physical on-the-ground improvements, infrastructure improvements including green infrastructure and sustainable design, improved land use decision-making with a shift to the concept of low impact development, river restoration, land or land rights acquisition to further protect the river and allow public access to increase the profile of the river, and public outreach and education programs.

The watershed management plan will identify measures that can be taken to improve the health of the river and have the clear potential to affect on-the-ground change within the watershed.

1.3 Ongoing Watershed Conservation and Restoration Efforts

A number of organizations are involved in efforts to preserve the existing high-quality natural resources of the North Branch Park River watershed, as well as to restore or improve degraded resources in the watershed. Notable conservation and restoration-related efforts and projects within the North Branch Park River watershed are summarized below.

- The Park River Assessment Program is a project funded by the United States Environmental Protection Agency (EPA) that was initiated in October 2007. The Children's Museum, the Farmington River Watershed Association, and the Park River Watershed Revitalization Initiative are working together on this program, recruiting family teams and community youth groups to adopt a stream in the watershed and monitor the water quality and habitat along its banks.

- The Park River Watershed Revitalization Initiative (PRWRI) was formed in 2006 as a collaboration between the Farmington River Watershed Association (FRWA) and an ad hoc network of local stakeholders to provide long-term stewardship of the Park River watershed. The two watersheds have common interests; they overlap across seven town boundaries and share municipal ordinances that define land-use policies.

- The Metropolitan District Commission (MDC), which is responsible for the water and sewer systems in the greater Hartford area, is implementing a major infrastructure improvement program known as "The Clean Water Project" to address a federal consent decree and a CTDEP consent order to achieve the Federal Clean Water Act goals. The Clean Water Project includes three basic elements: (1) reduction of combined sewer overflows (CSOs) within the Hartford central sewer system, (2) elimination of sanitary sewer overflows (SSOs) in the sanitary sewers of Wethersfield, West Hartford, Windsor, Rocky Hill and Newington and (3) nitrogen reductions. Projects will range from new sewer and drainage systems to greater wastewater treatment capacity to new tunnel storage and conveyance. These projects will help to eliminate sewage overflows to area waterways during an average year, significantly improving water quality.

The Metropolitan District Commission is embarking on an ambitious program, The Clean Water Project, to address approximately one billion gallons of combined wastewater and stormwater currently released each year to area waterways.

- The EPA promulgated a nation-wide stormwater program in 1990 to regulate stormwater discharges from cities and urbanized areas. Phase I of this program regulated large cities with populations of greater than 100,000 and without combined sewer overflows. Phase II, which began implementation in 1999, applies to small municipal separate storm sewer systems in urbanized areas, which includes the communities in the North Branch Park River watershed. The Phase II stormwater regulations require that regulated communities implement six minimum control measures to reduce levels of pollutants in stormwater discharges. The communities in the North Branch Park River watershed are currently implementing stormwater management plans as required by the Phase II stormwater program.

- Several educational programs within the North Branch Park River watershed focus on the North Branch Park River as a resource for environmental education. These include Trinity College, the Watkinson School, and the Harris Agri-Science Center at Bloomfield High School.

- The 4-H education center at Auer Farm in Bloomfield, a partner of the University of Connecticut, College of Agriculture, organizes childhood education programs focusing on agriculture within the watershed.

- The Knox Parks Foundation, an organization established to 'green' Hartford's neighborhoods through organizing community gardens, providing horticultural assistance, beautifying the city through horticulture, and reversing the trend of urban deforestation. This organization is now based in the watershed of the South Branch of the Park River, but works within the North Branch watershed as well.

- The North Central Conservation District, which provides conservation assistance to nonprofit organizations and municipalities, serves the communities of the North Branch Park River watershed.

- The Connecticut Coalition for Environmental Justice works to protect Connecticut's urban environments from the disproportionate affects of environmental pollution that may be caused by socioeconomic inequality.

- The Eastern Connecticut Resource Conservation and Development Area is a volunteer natural resource advocacy group that focuses on the interdependence of urban, suburban, and rural communities. The Eastern Connecticut RC&D Area encompasses the North Branch Park River watershed. Their activities include the recent completion of the South Branch Park River Trail and support of the ongoing planning effort in the North Branch Park River watershed.

- River and watershed clean-up programs, such as the University of Hartford Annual Spring Clean-up.

2 Study Area Description

2.1 North Branch Park River

The North Branch Park River conduit entrance near Farmington Avenue.

The North Branch Park River is formed by four major tributaries - Beamans Brook, Wash Brook, Filley Brook, and Tumbledown Brook (*Figure 2-1*). These tributaries have a total combined length of approximately 13.3 miles, with an additional 28.7 miles of unnamed tributaries. The North Branch Park River begins at the confluence of Beamans Brook and Tumbledown Brook in a wooded area between Routes 218 and 189 in the southern portion of Bloomfield. The North Branch Park River flows in a southerly direction for approximately 5.9 miles through the northern sections of the City of Hartford before entering an underground conduit near Farmington Avenue. The river then flows approximately 0.5 miles in the underground conduit before joining the South Branch Park River and ultimately flowing to the Connecticut River via the Park River conduit. The North Branch Park River and its tributaries are further described in Section 4.3 *Hydrology*.

2.2 Watershed

The North Branch Park River watershed is an approximately 28.6-square mile (18,323 acre) sub-regional basin within the Park River watershed and the Connecticut River basin. The watershed is located within six communities, including Avon, Bloomfield, Hartford, Simsbury, West Hartford, and Windsor. However, Bloomfield, Hartford, and West Hartford comprise greater than 97% of the watershed land area, and approximately 68% of the watershed is within the Town of Bloomfield. *Table 2-1* summarizes the distribution of land area within the watershed by municipality.

Table 2-1. Distribution of Municipalities in the North Branch Park River Watershed

Municipality	Total Acreage of Municipality	Acreage in Watershed	% of Town in Watershed	% of Watershed
Avon	14,989	203	1%	1.1%
Bloomfield	16,872	12,540	74%	68.4%
Hartford	11,553	2,096	18%	11.4%
Simsbury	21,970	192	1%	1.0%
West Hartford	14,336	3,183	22%	17.4%
Windsor	19,868	108	1%	0.6%
Total	**99,587**	**18,323**		**100%**

Figure 2-1

The North Branch Park River watershed is characterized by a distinct mix of developed and undeveloped land uses. The far western portion of the watershed is sparsely developed, with large undeveloped tracts of land in the West Hartford Reservoir subwatershed and Talcott Mountain State Forest area. The northern-most portion of the watershed is moderately developed, characterized by areas of low-density residential development, agricultural areas, golf courses, and flood control reservoirs. The northeast portion of the watershed contains large areas of former agricultural land that has been converted to commercial and industrial/office park land use along Route 187. The central and southern portions of the watershed are more densely developed with residential, institutional, and industrial land uses. Section 7 *Land Use and Land Cover* further describes land uses within the North Branch Park River watershed.

Transportation corridors within the watershed include several heavily-travelled state routes as well as a dense network of local roads, particularly in the center of Bloomfield and in the north end of Hartford. A short segment of Interstate 84 and the West Boulevard Connector Interchange, which is located at the southern limit of the watershed near the confluence of the North and South Branches of the Park River, is the only portion of an interstate highway located within the watershed.

A basic profile of the watershed is provided in *Table 2-2*. Later sections of this document provide more detailed information on these watershed characteristics.

Table 2-2. Profile of the North Branch Park River Watershed

Area	**28.6 square mile (18,323 acre)**
Stream Length	**Approximately 48 miles**
Subwatersheds	**14**
Municipal Jurisdictions	**Bloomfield, Hartford, West Hartford, Avon, Simsbury and Windsor**
Water Quality	**2008 DEP Impaired Waters List for physical substrate habitat alterations due to channelization and *Escherichia* coli due to combined sewer overflows, and unspecified urban stormwater**
Current Impervious Cover	**15%**
Subwatersheds Most Sensitive to Future Development (Section 10)	**Wash Brook North Beamans Brook East Wintonbury Reservoir Blue Hills Reservoir Filley Brook**
Subwatersheds with the Highest Restoration Potential (Section 10)	**Beamans Brook West Tumbledown Brook Filley Brook North Branch Park River Wash Brook South**
Major Transportation Routes	**Interstate 84 State Route 44 (Albany Avenue) State Route 189 State Route 178 State Route 218 State Route 173 State Route 187 (Blue Hills Avenue)**
Significant Natural and Historic Features	**Mark Twain House, Harriet Beecher Stowe House, Connecticut Governor's Residence, Heublien Tower, Penwood State Park (portion), Talcott Mountain State Park, Elizabeth Park, Auer Farm**

Table 2-2. Profile of the North Branch Park River Watershed

Significant Institutions and Land Use Features	**University of Hartford, UConn Law School, St, Francis Hospital, Watkinson School, University High School of Science & Engineering, Weaver High School, Hartford Public High School, Hartford Classical Magnet School, Wintonbury Hills Golf Course, Tumble Brook Country Club, Gillette Ridge Golf Course, Hartford Golf Club, Wampanoag Country Club, COPACO Shopping Center, Bloomfield Shopping Center, The Center of Bloomfield Shopping Center, Tunxis Plaza Shopping Center, Kaman Corporation Complex, Blue Hills Industrial Park, Griffin Center, CIGNA Campus, Wintonbury Reservoir, Blue Hills Reservoir, Tunxis Reservoir, Cold Spring, West Hartford Reservoir**

2.3 Subwatersheds

For the purpose of this report, the North Branch Park River watershed is divided into 14 subwatersheds, from which surface runoff potentially enters the river or its tributaries. The subwatershed delineations are based on basin delineations by the CTDEP and the U.S. Geological Survey, with modifications based on updated land use mapping, topographic mapping, flood control structures, and field observations. Subwatersheds were also delineated to facilitate assessment and development of watershed management plan recommendations.

Five of the subwatersheds are delineated based on flood control structures and are named by the impounded reservoir, including the West Hartford Reservoir, Cold Spring Reservoir, Bloomfield (Tunxis) Reservoir, Wintonbury Reservoir, and Blue Hills Reservoir subwatersheds. The remaining nine subwatersheds are catchments associated with the major tributaries to the North Branch, including Wash Brook North, West, and South; Beamans Brook East and West; Tumbledown Brook and Tumbledown Brook South; Filley Brook; and the remaining area that discharges directly to the main stem of the North Branch Park River. General characteristics of these subwatersheds are presented in *Table 2-3*, and their locations and boundaries are shown in *Figure 2-2*.

Table 2-3. Subwatersheds

Subwatershed	Acronym	Area (acres)	Area (square miles)
Beamans Brook East	BBE	163	0.25
Beamans Brook West	BBW	1,185	1.85
Blue Hills Reservoir	BHR	1,035	1.62
Cold Spring Reservoir	CSR	1,155	1.80
Filley Brook	FYB	404	0.63
North Branch Park River	NBP	4,033	6.30
Tumbledown Brook	TDB	1,561	2.44
Tumbledown Brook South	TBS	1,622	2.53
Tunxis Reservoir	TUX	874	1.37
Wash Brook North	WBN	762	1.19
Wash Brook South	WBS	1,559	2.44
Wash Brook West	WBW	1,029	1.61
West Hartford Reservoir	WHR	2,048	3.20
Wintonbury Reservoir	WTR	894	1.40

3 Historical and Social Perspective

3.1 History of the Watershed

The North Branch Park River and its watershed, as it exists today, reflect the rich cultural history of the Hartford metropolitan area as well as many dramatic changes since the 1600s that have altered the development patterns along the river and within its watershed, the physical characteristics of the river, and even the name of the river itself. The following sections provide a brief history of the North Branch Park River watershed.

Before European settlers arrived along the Connecticut River, the Sukiaug and other Native American tribes populated the areas along the Connecticut and Park Rivers, which were first known as the Great and Little rivers. Dutch traders established a trading post near the mouth of the Little River. English settlers arrived two years later, in 1635, following Reverend Thomas Hooker's parish and found the confluence of the Great and Little rivers an ideal location. They settled near the Dutch trading post along the Little River. To their north and south, other settlements were being populated which would become known as Windsor and Wethersfield.

By 1640, the first mills were built and required the damming of the Little River. During this time the Little River began to be known as the Mill River. Hartford continued to grow through the 1780s. Industry along the river included a rum distillery and a large woolen mill, from which George Washington ordered a suit. By the 19th century, tanneries, a dye house, pigsties and slaughterhouses, brickyards, and tenements were built along the banks of the Mill River. The city's residents likely began calling the Mill River the Hog River due to the industries along its banks that used the river as an open sewer, most notably the pigsties and slaughterhouses that dumped their waste into the river.

The Park River was known as the "Hog River" during the 1800s due to the pigsties and slaughterhouses along its banks that used the river as an open sewer.

The conditions along the Hog River continued to deteriorate as the city grew; problems included crowded tenements, poverty, poor sanitation, polluted water and air. In the mid-19th century, these problems became a growing concern of civic leaders, lead by Reverend Horace Bushnell. He proposed building a central park to serve as a place for city residents to

The Park River, circa 1895 (Taylor Collection, Connecticut State Library).

enjoy outdoor recreation. Bushnell Park was opened in 1865, and the Hog River was renamed to the Park River in reference to Bushnell Park.

In the 1880s, the Park River water quality continued to suffer from direct, untreated discharge of human and animal sewage and industrial waste. A joint committee was formed on what was called the "Park River Nuisance" that proposed initiatives to prevent waste from entering the river and to flush the waste more quickly down the river by pumping water into the Park River during low flow. Eventually, the city wastewater system expanded to collect sewage and other wastes, treat it, and discharge it to the Connecticut River.

However, the early sewer systems were designed to carry both stormwater runoff and sanitary sewage in the same pipes. During smaller storms, wastewater treatment facilities receive and treat the flow from these combined sewers before discharging it to the Connecticut River. During larger storms, however, the combined sewers can become overwhelmed by stormwater runoff, discharging untreated wastewater directly to the North Branch Park River. Combined sewers still exist in some areas of the North Branch Park River watershed, resulting in numerous combined sewer overflows (CSOs) each year. The MDC is implementing a major infrastructure improvement program known as "The Clean Water Project" to eliminate CSOs in the North Branch Park River.

Concerns related to the North Branch Park River are not limited to water quality; flood control is also a significant challenge that became prominent in the 20th century. Two large storms occurred in the 1930s that resulted in major floods in Hartford and other areas of Connecticut, in 1936 and 1938. In response to these floods, the Hartford Department of Engineers and the U.S. War Department developed plans for dikes to protect the city from the Connecticut River and for twin underground conduits to control flooding along the Park River.

The Park River conduits during construction, circa 1942. (Hartford Collection, Hartford Public Library).

Burial of the Park River began in September 1940 and was completed three years later. The first phase of the conduit was just over a mile long and ended between the Capitol and Armory buildings. The majority of the flood control system was completed in 1943, although additional changes were constructed following flooding caused by Hurricane Diane in 1955, including construction of a section of the conduit from the Armory to Farmington Avenue in the early 1960s (Normen, 2008). The flood control system remains intact today. The system of underground conduits conveys both the North and South branches of the Park River below Hartford to an outfall on the Connecticut River.

A channelized section of the Park River, circa 1968 (Hartford Collection, Hartford Public Library).

While the flood control projects of the last century have protected the City of Hartford from the type of catastrophic floods that occurred in the 1930s and 1950s, channelization and burial of portions of the North Branch Park River dramatically altered the physical and habitat characteristics of the river and the land development patterns along the river and within its watershed. These changes have disconnected the river from the surrounding communities and have contributed to the river's deteriorated water quality and degraded habitat conditions that exist today.

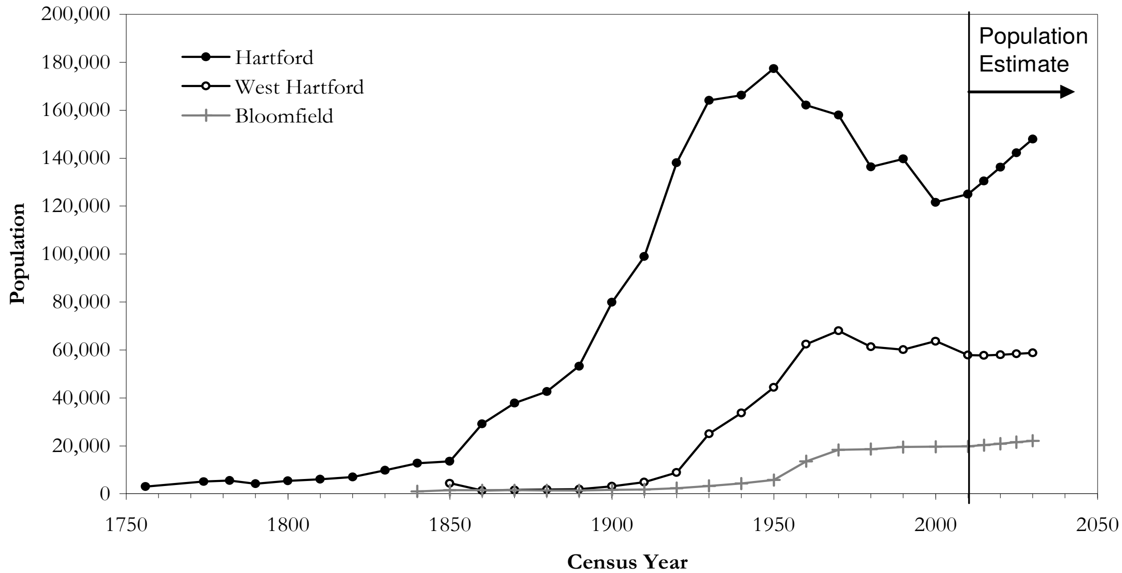
3.2 Population and Demographics

Although the North Branch Park River watershed is located within portions of six communities, the majority of the watershed's population resides in Bloomfield, Hartford, and West Hartford. The following sections provide a summary of overall population trends in these three communities, as well as population and demographic information for the North Branch Park River watershed.

> **The total watershed population is estimated at approximately 48,000 residents, with 41% of the population residing in the City of Hartford, 21% in West Hartford, and 38% in Bloomfield.**

The city of Hartford reached a peak population in 1950 of approximately 180,000 residents. Hartford's population began to decline in the late 1950s as city residents began to seek a higher quality of life in the suburbs. The decline in Hartford's population continued through the 1990s although has reversed since the most recent 2000 census (*Figure 3-1*). The most recent three-year estimated household population in Hartford (2005-2007) is 110,774 (U.S Census Bureau, 2008). Future population estimates by the Connecticut State Data Center predict an increase in population in the City of Hartford in the next 20 years. West Hartford continued to grow until 1970 as a result of the migration out of the urban core and reached a maximum population of approximately 68,000, with an estimated

2005-2007 household population of 61,165 (U.S Census Bureau, 2008). Bloomfield also experienced a large population increase between 1950 and 1970, but has remained stable since then with a population of 19,587 based on the 2000 census. The populations of West Hartford and Bloomfield are predicted to be stable between 2010 and 2030.



Source: US Census and Connecticut State Data Center

Figure 3-1. Population Trends

According to the Capital Region's Census Data Profile Report (Capitol Region Council of Governments, 2003) , the pattern of housing unit increase over the 1960 to 2000 period reflects the shift in the Region's population from city to suburbs. In 2000, there were 294,092 housing units in the Capitol Region. The number of housing units in the Capitol Region increased more rapidly than population over this forty-year period, increasing by 72% as compared to the 32% increase in population. This is due both to declining household sizes and the movement of households from older, urbanized communities to new housing in the suburbs.

While the trend of increasing suburbanization may be tempered by the recent economic downtown in Connecticut and nationally, this recent trend of movement away from the urban center raises concerns about the loss of open space and development pressure on nearby suburban and rural communities. Such a trend within the North Branch Park River watershed could result in further development pressure in the headwater areas of Bloomfield, West Hartford, and Avon. Initiatives that protect open space and reinforce sustainable development within the urban center where infrastructure already exists are intended to address these concerns.

Population and demographic information within the North Branch Park River watershed was analyzed using 2000 U.S. Census data. There are 39 census blockgroups and 497 blocks located wholly or mostly within the watershed. From this data, the total watershed population is estimated at approximately 48,000, with approximately 41% of the population residing in the City of Hartford, 21% in West Hartford, 38% in Bloomfield, and less than 1% in Simsbury, Avon, and Windsor combined. *Figure 3-2* summarizes the racial and ethnic composition of the watershed's population. The majority of the watershed population is white (86.7%), 4.3% are Hispanic, 3.4% are Asian, 2.0% are Black, and 3.7% are reported as Multi-race or Other.

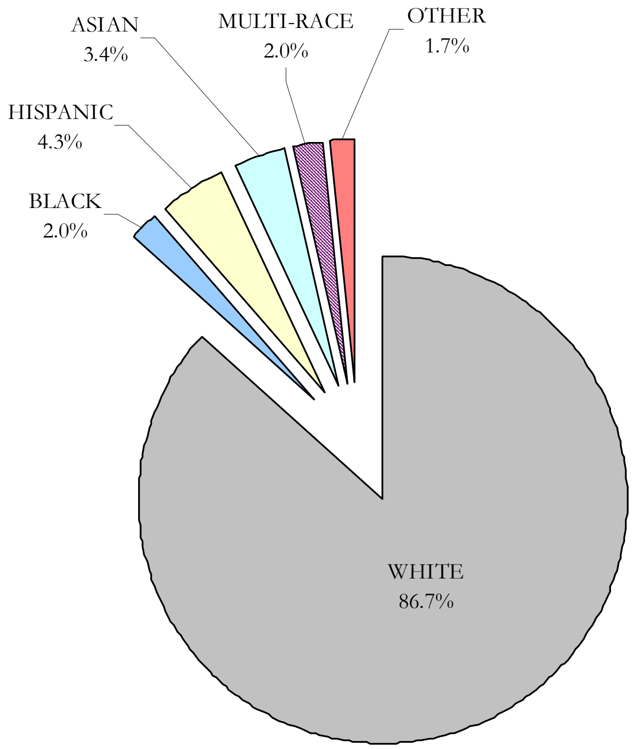


Figure 3-2. Demographics in the North Branch Park River Watershed

3.3 Historical Resources

The North Branch Park River watershed has a rich cultural history and is home to numerous sites and buildings that are on the State or National Register of Historic Places. Existing State or National-registered historic places in the watershed are listed in *Table 3-1*. Several of the notable cultural resources in the watershed include:

- The Harriet Beecher Stowe House, which served as the residence of this well-known abolitionist from 1873 through her death in 1896. This residence is located in the Nook Farm grounds, a former compound of artists and writers.
- The Mark Twain House, neighboring the Harriet Beecher Stowe House on the Nook Farm grounds.
- The Connecticut Governor's Residence, located on Prospect Avenue in Hartford is a 19-room Georgian Revival Colonial home.

- The 22-room Goodwin Mansion and Estate is owned by the City of Hartford. The property was built in 1903 for Walter L. Goodwin, a descendant of a family that had been influential in developing the city.
- Elizabeth Park, a public park with recreational areas and a 2.5-acre rose garden with 800 varieties of roses.
- Heublein Tower, a six-story observation structure built atop the Metacomet Ridge by Gilbert F. Heublien, a hotelier and restaurateur in Hartford, which is now open to the public.
- There are four historic districts within the watershed (listed in *Table 3-1*), including
    - Little Hollywood Historic District
    - Nook Farm and Woodland Street District (the Nook Farm grounds being the location of the Mark Twain and Harriet Beecher Stowe houses)
    - West End North Historic District
    - West End South Historic District

In December 2006, the Hartford City Council adopted an ordinance that protects properties designated on the State or National Register of Historic Places from unauthorized demolition or alteration. The ordinance states that all work requiring a building permit being performed on properties that are individually listed or within a historic district must gain the approval of the Historic Preservation Commission before they may receive a permit. Building permit applicants who are subject to this requirement must fill out an Application for Historic Review in the City's Department of Licenses & Inspections.

Table 3-1. National Register of Historic Places

Town/City	Date Listed	Resource Name	Address
Bloomfield	5/15/2007	Filley, Capt. Oliver, House	130 Mountain Ave.
Bloomfield	3/25/1982	Gillette, Francis, House	545 Bloomfield Ave.
Bloomfield	10/18/1972	Old Farm Schoolhouse	Jct. of Park Ave. and School St.
Bloomfield	7/24/1992	Southwest District School	430 Simsbury Rd.
Hartford	4/19/1994	Austin, A. Everett, House	130 Scarborough St.
Hartford	7/31/1994	Barlow, Boce W., Jr., House	31 Canterbury St.
Hartford	6/28/1982	Children's Village of the Hartford Orphan Asylum	1680 Albany Ave.
Hartford	4/16/1971	Day House	77 Forest St.
Hartford	3/10/1983	Elizabeth Park	Asylum Ave.
Hartford	3/2/1989	Engine Company 16 Fire Station	636 Blue Hills Ave.
Hartford	6/26/1986	Hartford Golf Club Historic District	Roughly bounded by Simsbury Rd. and Bloomfield Ave., Northmoor Rd., Albany Ave., and Mohegan Dr.
Hartford	6/22/1982	Hartford Seminary Foundation	55 Elizabeth St. and 72-120 Sherman St.
Hartford	11/29/1979	Hooker, John and Isabella, House	140 Hawthorn St.
Hartford	2/24/1983	House at 36 Forest Street	36 Forest St.
Hartford	4/29/1982	Little Hollywood Historic District	Farmington Ave., Owen, Frederick and Denison Sts.
Hartford	10/31/1975	Lyman House	22 Woodland St.

Table 3-1. National Register of Historic Places

Town/City	Date Listed	Resource Name	Address
Hartford	11/29/1979	Nook Farm and Woodland Street District	Woodland, Gillett, and Forest Sts., and Farmington Ave.
Hartford	12/14/1978	Perkins-Clark House	49 Woodland St.
Hartford	8/29/1985	Prospect Avenue Historic District	Roughly bounded by Albany Ave., N. Branch Park River, Elizabeth & Fern Sts., Prospect & Asylum Aves. & Sycamore Rd.
Hartford	2/24/1983	Spencer House	1039 Asylum Ave.
Hartford	10/6/1970	Stowe, Harriet Beecher, House	73 Forest St.
Hartford	12/1/1978	Temple Beth Israel	21 Charter Oak Ave.
Hartford	10/15/1966	Twain, Mark, House	351 Farmington Ave.
Hartford	3/23/1995	Watkinson Juvenile Asylum and Farm School	140, 180 and 190 Bloomfield Ave.
Hartford	7/25/1985	West End North Historic District	Roughly bounded by Farmington Ave., Lorraine, Elizabeth, and Highland Sts.
Hartford and West Hartford	4/11/1985	West End South Historic District	Roughly bounded by Farmington Ave., Whitney and S. Whitney Sts., West Blvd. and Prospect Ave.
Simsbury	6/30/1983	Heublein Tower	Talcott Mountain State Park
West Hartford	12/22/1983	Mount St. Joseph Academy	235 Fern St.
West Hartford	6/14/1979	Spanish House, The	46 Fernwood Rd.

3.4 Recreation and Community Resources

The North Branch Park River watershed provides opportunities for a variety of recreational activities, such as fishing, boating, cross-country skiing, picnicking, golf, and hiking. The oldest designated open space area near the North Branch Park River is Bushnell Park in Hartford, designated in 1865. Talcott Mountain State Park and the Penwood State Park are located in or near the watershed.West Hartford Reservoir, the Metacomet Hiking Trail, the Metacomet, Monadnock and Mattabesett National Scenic Trail, and Heublein Tower are prominent recreational features in the watershed.

The watershed is also home to the Greater Hartford Urban Outdoor Classroom and Nature Trail, a facility developed with assistance from the Eastern Connecticut Resource Conservation and Development Area, a nonprofit organization, working with community, educational, and government partners. There is a teachers' guide available for this area which assists the teacher and students in learning about habitats and wildlife found in the watershed.

Several golf courses are located throughout the watershed including the Wintonbury Hills Golf Course, Tumble Brook Country Club, Gillette Ridge Golf Course, Hartford Golf Club, and Wampanoag Country Club. Many of the municipal parks and schools located within the watershed provide public recreational opportunities.

Although fishing opportunities exist along the North Branch Park River tributaries as well as lakes and ponds within the watershed, fishing opportunities along the mainstem of the North Branch Park River are severely limited due to impaired water quality, degraded aquatic habitat, and limited river access. As discussed in Section 6 *Water Quality*, the North Branch Park River is designated by the CTDEP as impaired for fish habitat, other aquatic life and wildlife, and recreation due to nonpoint source pollution and channel modifications. Furthermore, the Park River is not included in the CTDEP Angler's Guide.

4 Natural Resources

4.1 Geology and Soils

The State of Connecticut is composed of three distinct geologic units divided longitudinally across the state. These three units are known as the Western Uplands, the Central Valley, and the Eastern Uplands. The Western and Eastern Uplands are comprised of metamorphic rocks – rocks subjected to intense heat and pressure of the Earth's interior – while the Central Valley is a younger unit comprised of sedimentary rocks. The Central Valley began forming about 225 million years ago when the super-continent Pangaea began to break apart. A large rift formed a long, narrow valley through the middle of the state, eventually filling with sediments from the eroding hills to the east and west (presently known as the Eastern and Western Uplands). The sediments were compacted into soft, easily eroded, red and brown sandstones through which the Connecticut Rivers flows.

The North Branch Park River watershed is entirely within the Central Valley geologic region, which is separated from the Eastern Uplands by the Eastern Border Fault and the Western Uplands by the Cameron's Line Fault. The Central Valley is composed of Connecticut's youngest rocks (190 million years) and is primarily Brownstone (a sand-stone-like sedimentary rock) and Traprock (lava flows and intrusive rock). Talcott Mountain and the Metacomet Ridge form the western limit of the watershed. The Metacomet Ridge is a ridge of traprock that cuts across Connecticut from Branford to West Suffield and continues into western Massachusetts.

Drastic changes in the surficial geology have occurred within Connecticut since the formation of these geologic regions. Above the sandstone of the Central Valley lie extensive glacial deposits, or "glacial till," left as the large glaciers receded. Advancing glaciers left a moraine, or pile of glacial till, at Rocky Hill, Connecticut approximately 15,000 years ago. The moraine impounded the Connecticut River, forming Glacial Lake Hitchcock. Sediment settling out within the glacial lake laid down flat, fine deposits that result in high quality farmland in towns surrounding the Connecticut River north of Rocky Hill. Melting glacier ice formed rivers which sorted glacial till into layers of sand and gravel, or "stratified drift" (Bell, 1985).

The Natural Resources Conservation Service Soil Survey Geographic (SSURGO) database for the State of Connecticut indentifies five predominant surficial materials in the North Branch Park River watershed. Till is the predominant surficial material in the upland areas of the western portion of the watershed. The surficial material transitions to finer material moving east toward the Connecticut River. The northeast area of the watershed around Blue Hills Avenue is predominantly sand and fines. Smaller non-contiguous areas of surficial material include alluvial fines and thick till, which are found interspersed throughout the watershed.

The soil parent material in the watershed is predominantly bedrock in the western uplands west of the West Hartford Reservoir. The parent material gradually changes from bedrock to Ledgemont Till, then Glaciofluvial, Glaciolacustrine, and eventually Alluvial Floodplain moving east from the uplands toward the Connecticut River floodplain. The majority of the soil parent material in Hartford and the western portion of West Hartford is composed of Urban Influenced material.

4.2 Topography

The topography of the North Branch Park River watershed is generally characterized by steep hills along the Metacomet Ridge to the west, leading to a gently sloping valley on the eastern portion of the watershed near the Connecticut River. Based on U.S. Geological Survey topographic mapping of the area, elevations in the westernmost, upper portions of the watershed on Talcott Mountain are as high as 920 feet above mean sea level (MSL) sloping steeply (5-10% slope) eastward. The eastern portion of the watershed is gently sloped (less than 5%) with typical elevations of 130 feet above MSL. The elevation at the watershed outlet at the confluence with the South Branch Park River is less than 60 feet above MSL in an underground conduit. The Park River conduit discharges to the Connecticut River approximately 1 mile from the confluence of the North and South Branches at an elevation of approximately 10 feet above MSL. *Figure 4-1* presents a shaded relief map of the North Branch Park River watershed showing the variation in topography across the watershed.

4.3 Hydrology

The North Branch Park River is a 28.6-square mile (18,323 acre) sub-regional basin within the Park River basin (*Figure 2-1*). The watershed is located within the municipal boundaries of Avon, Bloomfield, Hartford, Simsbury, West Hartford, and Windsor, although greater than 97% of the watershed lies within the communities of Bloomfield, Hartford and West Hartford. The North Branch Park River has four named tributaries (listed upstream to downstream) – Tumbledown Brook, Wash Brook, Filley Brook, and Beamans Brook – that are fed by smaller tributaries in the upper portions of the watershed. Overall, there are approximately 48 miles of mapped perennial and intermittent streams within the North Branch Park River watershed. *Table 4-1* summarizes the miles of mapped streams within each subwatershed.

Table 4-1.Miles of Mapped Streams Within Each Subwatershed

Subwatershed	Length of Stream (miles)
Beamans Brook East	0.51
Beamans Brook West	2.59
Blue Hills Reservoir	1.70
Cold Spring Reservoir	3.96
Filley Brook	1.11
North Branch Park River	7.27
Tumbledown Brook	5.91
Tumbledown Brook South	5.15
Tunxis Reservoir	1.75
Wash Brook North	3.33
Wash Brook South	5.79
Wash Brook West	3.31
West Hartford Reservoir	4.30
Wintonbury Reservoir	1.35

Figure 4-1

Wash Brook begins north of Bloomfield Center and flows in a southerly direction to its confluence with Beamans Brook near the northwest corner of Hartford. Tumbledown Brook (also known as Tumble Brook), with its headwaters on the eastern slopes of Talcott Mountain, flows south, then east, and then north to its confluence with Wash Brook. Beamans Brook begins in the northeastern portion of the watershed and flows south to join Wash Brook. The junction of Wash and Beamans Brooks (just north of the Bloomfield-West Hartford town line) forms the North Branch Park River, which then flows in the southeastern direction through Hartford to its confluence with the South Branch.

The northern portion of the watershed drains to Wash Brook, which is located almost entirely in Bloomfield. The Wash Brook subwatershed is characterized by a commercial and industrial corridor along State Route 187 and moderate residential development, forested open space, golf courses, and some commercial and industrial facilities. The general patterns of natural drainage have not been significantly altered in this portion of the watershed. However, small impoundments and flood control reservoirs (that generally do not impound water during dry weather) are located throughout the upper portion of the watershed.

Drainage from the western portion of the watershed, a portion of the Tumbledown Brook watershed, is conveyed from the upland portions of the Talcott Mountain reservation area to the West Hartford Reservoir No. 6, controlled by the Metropolitan District Commission (MDC). Water from the Nepaug River, a tributary of the Farmington River, and Barkhamsted Reservoir is also diverted to West Hartford Reservoir No. 6. Water from West Hartford Reservoir No. 6 is treated at a facility located at the reservoir. Water may also be diverted from West Hartford Reservoir No. 6 to West Hartford Reservoir No. 5, which is located in the South Branch Park River watershed.

Filley Brook is a small intermittent stream that flows in a southerly direction through the center of Bloomfield. Filley Brook joins Wash Brook south of Cottage Grove Road (State Route 218), less than a quarter-mile upstream from the confluence of Wash Brook and Beamans Brook where the North Branch Park River begins.

The mainstem of the North Branch Park River flows through the southern and eastern portions of the watershed. The majority of the North Branch Park River subwatershed is located in Hartford and West Hartford and is characterized by high-density urban development, including primarily residential, institutional, and commercial land use. The channel of the North Branch Park River and significant portions of the drainage in this section of the watershed have been significantly altered from natural conditions as a result of urban development. An approximately half-mile section of the North Branch flows underground through a conduit system before reaching the confluence with the South Branch and ultimately flowing to the Connecticut River via the Park River conduit.

Figure 4-2 shows the seasonal pattern of mean monthly streamflow in the North Branch Park River measured at the stream gage 60 feet downstream from the stone-arch bridge on Albany Avenue in Hartford and 3 miles upstream from the confluence with the South Branch (United States Geological Survey Stream Gage 01191000, at Hartford, CT [Latitude 41°47'03", Longitude 72°42'31" NAD27]) for the period of record (11/1/36 to 9/30/86). Note that stream flow measurements have been discontinued at this stream gage. Normalized by drainage area, the streamflow data in *Figure 4-2* are presented in units of cubic feet per second per square mile (CFSM). The highest streamflow generally occurs during March and April, while seasonal low-flows typically occur during late summer or early fall.

The United States Geological Survey (USGS) has also estimated peak-flow magnitudes for 1.5-, 2-, 10-, 25-, 50-, 100- and 500-year recurrence intervals (corresponding to exceedance probabilities of 0.67, 0.50, 0.10, 0.04, 0.02, 0.01, and 0.002, respectively) based on historical streamflow measurements at the North Branch Park River stream gage location near Albany Avenue (Ahearn, 2003). *Table 4-2* summarizes peak flow frequency estimates for given recurrence intervals and the maximum known peak flow for the North Branch Park River. Beginning in 1963, flows in the North Branch Park River watershed were affected by flood control regulation resulting from the construction of the Cold Spring, Bloomfield (Tunxis), Wintonbury, and Blue Hills flood control reservoirs. Details of these flood control reservoirs are presented in Section 5.1.

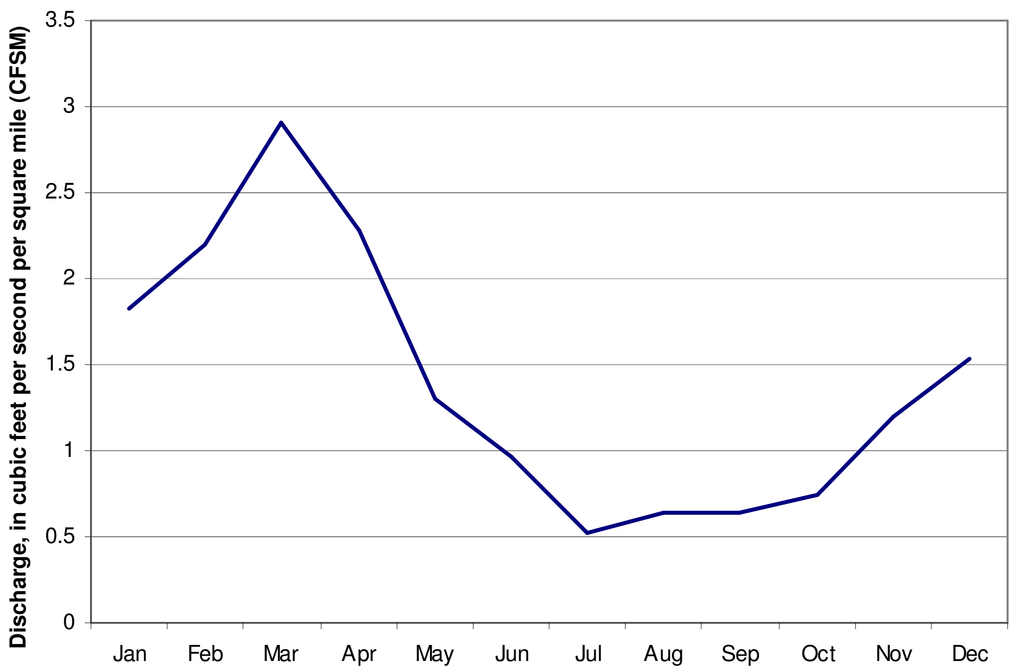


Figure 4-2. Mean Monthly Streamflow of North Branch Park River

Table 4-2.Peak Flow Frequency Estimates and Maximum Peak Flow	
Parameter	**Peak Flow (cubic feet per second)**
Peak-flow frequency estimates for given recurrence interval	
1.5 years	943
2 years	1,150
10 years	2,460
25 years	3,430
50 years	4,330
100 years	5,400
500 years	8,760
Maximum Known Peak Flow	
August 19, 1955	10,000

Source: Based on stream flow data from USGS Gage Station 01191000, North Branch Park River at Hartford, period of record 1936-1962 and 1963-1996 (regulated) (Ahearn, 2003).

4.4 Flood Hazard Areas

Figure 4-3 depicts flood hazard areas within the North Branch Park River watershed, including the 100-year and 500-year flood zones and CTDEP Stream Channel Encroachment Lines (SCELs). Flood zones are defined by the Federal Emergency Management Agency (FEMA) as the area below the high water level that occurs during a flood of a specified size. FEMA also defines a "floodway" as the stream channel and adjacent areas that carry the majority of the flood flow at a significant velocity, whereas "floodplain" also includes the flood fringe or areas that are flooded without a strong current. SCELs are regulatory boundaries associated with selected rivers and streams in Connecticut that define the jurisdiction of CGS Sections 22a-342 through 22a-349a. These areas are similar to floodways and delineate the portion of the waterway that is considered necessary for passage of flood flows. SCELs are mapped for the North Branch Park River upstream of Albany Avenue; Tumbledown Brook between its confluence with Wash Brook and Cold Spring Reservoir; Beamans Brook between its confluence with Wash Brook and the Blue Hills and Wintonbury Reservoirs, and Wash Brook to the Tunxis Reservoir. All of the SCELs in the North Branch Park River Watershed were established in 1965.

The September 2008 Hartford County Flood Insurance Study (FIS) prepared by FEMA indicates that much of the 100-year flood zone in the watershed is free of development. However, low-lying areas along the lower portions of the North Branch Park River routinely experience flooding, including buildings along Woodland Drive, Dillon Road, and Woodside Circle as well as other areas.

An example of flooding that is common along the lower portion of the North Branch Park River during a January 2006 storm.

Figure 4-3

The upper segment of the North Branch Park River from the confluence of Wash and Beamans Brooks to the Bloomfield/West Hartford boundary is another large flood-prone area, including residences on the east side of Kenwood Circle.

Based on the floodway information included in the 2008 FEMA FIS, the widest portion of the floodway along the North Branch Park River is approximately 1,000 feet downstream of the University of Hartford Road Dam (551 feet wide), while the narrowest portion of the floodway occurs near the conduit entrance (53 feet wide). The FIS reports the highest estimated water velocity within the North Branch Park River occurs near the University of Connecticut Road (10.1 feet per second) and the lowest is approximately 1,000 feet downstream of the confluence of Wash and Beamans Brooks (1.2 feet per second).

4.5 Climate

The North Branch Park River watershed is located in an area with a temperate and humid climate. The annual average precipitation in the Hartford area is 44.29 inches. Rainfall is fairly evenly distributed throughout the year. The wettest month of the year is May with an average rainfall of 3.99 inches, while the driest month is February. During a normal winter, snow cover can accumulate the equivalent of 5 inches of precipitation (average snowfall is 49 inches). On average, the Hartford area experiences approximately 128 days per year with 0.01 inches or more of precipitation. Typical air temperatures in the watershed are relatively mild with 19 days per year on average when temperatures are above 90° F and six days per year when temperatures are below 0°F.

Changes in climate are anticipated to occur over the next century. The magnitude of changes in temperature, sea level, and the timing and intensity of rainfall will depend upon future emissions of carbon dioxide and other greenhouse gases driving climate change. However, using different emissions scenarios, climate modelers have predicted the following changes to the climate in the Northeast United States as summarized below (Ashton et al., 2007; Fogarty et al., 2007; Frumhoff et al., 2007; Hayhoe et al., 2008; Kirshen et al., 2008).

Changes in climate are anticipated to occur over the next century. The magnitude of changes in temperature, sea level, and the timing and intensity of rainfall will depend upon future emissions of carbon dioxide and other greenhouse gases. In the Northeast, the anticipated hydrologic response will be higher winter and lower summer streamflow.

Over the next several decades, temperatures are anticipated to rise 2.5-4°F in winter and 1.5-3.5°F in summer. By the end of the century, winter temperatures are predicted to rise 5-12°F and summer temperatures 3-14°F compared to current conditions. As a result, days over 90°F will be more frequent, there will be a longer growing season, less winter precipitation falling as snow and more as rain, a reduced snowpack, and an earlier spring snowmelt. In addition, regional sea surface temperatures are expected to rise 4-8°F by 2100.

The Northeast is anticipated to experience an increase in total precipitation of about 10% or 4 inches on an annual basis by the end of the century. Seasonally, winter precipitation is predicted to increase 20-30%, while summer precipitation amounts will remain relatively unchanged. In addition to increased precipitation amounts, more extreme precipitation is expected. Current model predictions include an increase in the precipitation intensity, i.e., the average amount of rain falling on a rainy day, and the number of heavy precipitation events. Precipitation intensity is predicted to increase 8-9% by mid-century and 10-15% by the end of the century. An 8% increase in the number of heavy precipitation events is expected by mid-century, with a 12-13% increase by the end of the century. The anticipated hydrologic response will be higher winter and lower summer streamflow.

4.6 Wetlands

4.6.1 Resource Description

Generally, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Wetlands and buffer zones between watercourses and developed areas help to preserve stream water quality by filtering pollutants, encouraging infiltration of stormwater runoff, and protecting against stream bank erosion.

Wetlands are considered valuable because they clean surface waters, recharge water supplies, reduce flood risks, and provide fish and wildlife habitat. In addition, wetlands provide recreational opportunities, aesthetic benefits, and sites for research and education.

Differing definitions of wetlands are used in Connecticut depending on the legal jurisdiction being considered. The State of Connecticut designates wetlands by soil classification since certain soils can cause groundwater to linger near the ground surface and since, conversely, groundwater lingering near the ground surface tends to transform soil characteristics. Wetland soils can also be defined by landscape position. The following classes of soils are defined by the Connecticut Inland Wetland and Watercourses Act (CTDEP, 2009).

- *Poorly drained soils.* These soils occur in places where the groundwater level is near or at the ground surface during at least part of most years. These soils generally occur in areas that are flat or gently sloping.

- *Very poorly drained soils.* These soils are typically characterized by groundwater levels at or above the ground surface during the majority of most years, especially during the spring and summer months. These areas are generally located on flat land and in depressions.

- *Alluvial and floodplain soils.* These soils form where sediments are deposited by flowing water, and thus typically occur along rivers and streams that are flooded periodically. The drainage characteristics of these soils vary significantly based on the characteristics of the flowing water, ranging from excessively drained where a stream tends to deposit sands and gravel to very poorly drained where a stream deposits silts or clays.

Connecticut's definition of inland wetlands is based on soil characteristics. In contrast, the Federal Clean Water Act definition for wetlands is based on a three-part criteria: 1) soil characteristics; 2) hydrophytic vegetation; and 3) hydrology. The federal wetland designation, established by Cowardin *et al.* (1979) defines wetlands as:

> "Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominately hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water as some time during the growing season of each year."

Vernal pools are a unique category of wetlands. A vernal pool is an isolated land depression which lacks a permanent aboveground outlet. Vernal pools vary in size and may be the size of a small puddle or shallow lake. In the Hartford area, as is true for much of the Northeast, a vernal pool fills with freshwater in the fall and winter due to the rising water table and/or in the spring due to the meltwater from winter snow and runoff from spring rains. Many vernal pools in the Northeast are covered with ice in the winter months. They contain water for a few months in the spring and early summer but by late summer, are generally dry.

As vernal pools usually dry up during a period of most years, species tend to use the area for specific portions but not all of their life cycle. "Obligate" vernal pool species (typically reptiles and amphibians) are those that must use a vernal pool for a portion of their life cycle. Common obligate species in Connecticut include spotted, Jefferson's, and marbled salamanders, wood frogs, eastern spadefoot toads, and fairy shrimp.

Vernal pools are unique and very fragile, containing significant biodiversity, frequently including endangered plants and animals. They are typically threatened by adjacent land uses and development including changes to the natural topography. Given the importance of these microhabitats, the EPA, CTDEP, and the U.S. Army Corps of Engineers regulate their protection.

4.6.2 Existing Wetlands Information

Figure 4-4 depicts the extent and distribution of wetland soils in the North Branch Park River watershed based on Natural Resources Conservation Service soil classifications, following the State of Connecticut definition. *Figure 4-4* also shows wetland classifications available from the U.S. Fish & Wildlife Service National Wetlands Inventory. State-designated wetlands and surface waters comprise nearly 20% of the overall watershed (approximately 3,600 acres), while approximately 8% of the watershed area (approximately 1,500 acres) is mapped as freshwater emergent wetlands or freshwater forested/shrub wetlands following the Federal definition or as surface waters.

Mapped wetland soils are generally located in riparian and floodplain areas along the North Branch Park River and its tributaries. The concentration of wetland soils is generally higher in the less developed northern portions of the watershed such as Bloomfield, and significantly lower in the southern, more densely-developed areas of the watershed such as Hartford and West Hartford. *Table 4-3* summarizes wetland soils coverage by subwatershed.

Table 4-3. Wetlands in the North Branch Park River Watershed

Subwatershed	Area of Mapped State Wetlands & Surface Waters (ac)	% of Subwatershed	Area of Mapped Federal (NWI) Wetlands & Surface Waters (ac)	% of Subwatershed
Beamans Brook East	50.7	31.2%	19.3	11.8%
Beamans Brook West	320.6	27.1%	57.9	4.9%
Blue Hills Reservoir	259.1	25.0%	83.8	8.1%
Cold Spring Reservoir	225.3	19.5%	145.9	12.6%
Filley Brook	39.2	9.7%	14.0	3.5%
North Branch Park River	447.2	11.1%	115.3	2.9%
Tumbledown Brook	344.7	22.1%	101.5	6.5%
Tumbledown Brook South	336.3	20.7%	116.5	7.2%
Tunxis Reservoir	240.6	27.5%	141.0	16.1%
Wash Brook North	123.1	16.2%	55.5	7.3%
Wash Brook South	280	18.0%	117.2	7.5%
Wash Brook West	350.7	34.1%	170.5	16.6%
West Hartford Reservoir	337.4	16.5%	255.5	12.5%
Wintonbury Reservoir	239.5	26.8%	67.7	7.6%
North Branch Park River Watershed	**3,594.6**	**19.6%**	**1,461.7**	**8.0%**

The Town of Bloomfield completed a town-wide wetlands inventory in 1985 (Inwoods Environmental Consultants, 1985). The inventory identified and mapped wetland areas within the Town and evaluated these areas for their hydrologic, biological, and cultural functions using a common rating scale to allow for relative comparisons between wetlands. The Bloomfield inventory identified a number of priority wetlands for preservation and protection because of their importance in maintaining water quality, providing open space and wildlife habitats, and

Figure 4-4

providing flood protection. The 1985 inventory concluded that relatively few wetlands are providing significant water quality protection functions, but many of Bloomfield's wetlands are providing valuable wildlife habitat, recreational sites, and flood protection.

The Town of Bloomfield has also identified numerous vernal pools within the North Branch Park River watershed, which are shown on the Town's inland wetlands and watercourses maps (http://www.bloomfieldct.org/adminonline/upload/1223961542_Wetlands_Index_Web_Dial Up.pdf) but were unavailable digitally for incorporation into the mapping for this report. Inland wetlands and watercourses mapping is also available for the other watershed municipalities.

4.6.3 Wetlands Field Assessment

A field assessment of selected wetlands throughout the North Branch Park River watershed was performed to augment the existing wetland information and mapping. The purpose of the field assessment was to evaluate the current functions and values of representative wetlands in the watershed and to compare current wetland conditions to those identified in the 1985 Bloomfield wetland inventory. Details of this assessment are presented in the following sections.

4.6.3.1 Selection of Study Areas

As indicated in *Table 4-3,* areas classified as State-designated wetland soils account for more than 3,500 acres (more than 5.5 square miles) of land in the North Branch Park River watershed. Given the limited resources available for this baseline watershed assessment, a desktop analysis was performed to identify a priority list of wetlands for field assessment, which are representative of wetlands throughout the entire watershed. Several wetlands were selected for field assessment from the categories listed below. Additionally, some of the wetlands that were previously assessed in the 1985 Bloomfield wetland inventory were selected for comparison purposes. The selected wetlands are shown in *Figure 4-5*.

- *Baseline Wetlands.* These are large, high-quality wetlands located in protected open space areas with little development in their contributing drainage areas. These baseline wetlands can provide a basis for comparison to wetlands in more developed areas. Wetlands in the vicinity of the Blue Hills Reservoir in Bloomfield and Hoe Pond in West Hartford were selected as baseline wetlands. The Blue Hills Reservoir was also assessed in 1985 (referred to as wetland #34 in the 1985 inventory).

- *Headwater Wetlands.* These wetlands are located at or near headwater areas of mapped streams, but may be at risk for impacts from future development. Hoe Pond and the associated wetlands were identified as representative of this category, since it is located on private land in the Reservoir No. 6 watershed. Several other wetlands listed below are also located in headwater areas with future development potential, including Dudley Town Pond and Adams Road to Duncaster Hollow.

Figure 4-5

- Potentially Impacted Wetlands. These wetlands are located near more urbanized areas of where wetland impacts are more likely. Wetlands near several different land uses were assessed, including residential, commercial, and industrial development, agriculture, and unsewered areas. The wetland areas assessed in this category include:
  - Croydon Drive, North Branch Park River subwatershed – This wetland, identified as Wetland #5 in the 1985 inventory, is located in the North Branch Park River subwatershed near the municipal boundaries of Bloomfield, Hartford, and West Hartford and is located adjacent to an older residential neighborhood.
  - School Street/Wheeler Park, Beamans Brook West subwatershed – This area includes wetlands assessed in 1985 as Wetland #30 and a portion of Wetland #26, and is located near former agricultural land west of School Street in Bloomfield.
  - COPACO Shopping Mall, North Branch Park River subwatershed – The wetland assessed in this location consists of a portion of wetland #4 in the 1985 inventory, and is located west of Goodman Street in Bloomfield, adjacent to commercial land use.
  - Cliffmont Open Space, Tumbledown Brook subwatershed – This wetland, assessed in 1985 as wetland #20, is adjacent to residential land uses between Burnwood and Cliffmont Drives in Bloomfield.
  - Sunset Lane and Valley View Drive, Wash Brook South subwatershed – This wetland is adjacent to residential and agricultural land uses and was assessed as Wetland #23 in 1985.
  - Adams Road to Duncaster Hollow, Wash Brook West subwatershed – This headwaters portion of previously-assessed Wetland #38 is adjacent to agricultural land use areas.
  - Dudley Town Pond, Wintonbury Brook subwatershed – This wetland, near the headwaters of Beamans Brook and located south of Route 187, is adjacent to commercial/industrial land uses.

4.6.3.2 Assessment Methods

The selected wetlands were assessed by New England Environmental, Inc. (NEE) on September 14, 2009 using the "Highway Methodology" developed by the U.S. Army Corps of Engineers. This is a descriptive methodology in which a standard set of criteria are evaluated for each wetland. These criteria indicate the degree to which a particular function or process is present in a wetland, and ultimately allow an assessment of the "principal" functions associated with the wetland.

4.6.3.3 Assessment Results

The assessed wetlands range from completely isolated to fully integrated with watercourses, from small to large, from degraded to relatively pristine, and include the full range of wetland types, often in combination. Below is a summary of the assessment results for the selected wetlands. The complete letter report, functions and values forms, and hand sketches of the wetland locations are included in *Appendix A*.

Blue Hills Reservoir

The assessment was performed in the southwestern portion of the Blue Hills Reservoir, which lies within the Beamans Brook East subwatershed. The assessment transect passed through wet meadow and marsh in the open, southern end of the site, shrub habitat and a small stream walking north, a recreational field which contains large patches of mown wet meadow, a Red Maple swamp adjacent to another stream north of the field, mixed shrub/herbaceous and wetland/upland along a power line easement, and exited along the reservoir dike. The reservoir (which is not normally flooded) contains a mosaic of uplands as well as wetlands.

As noted in the 1985 report, this is a diverse and rich habitat, protected as open space. Aside from ongoing maintenance of the recreational field and the power line corridors, and its function as flood control in extreme storm and meltwater events, it will remain a large unit of undisturbed habitat. The site contains multiple circles on the CTDEP Natural Diversity Data Base (NDDB) map. Although the transect did not run through any potential vernal pools, vernal pools could be potentially present in wooded areas north and east of the transect route.

School Street – Wheeler Park

Wheeler Park is located in a former agricultural field west of School Street. It is maintained in an open condition by seasonal mowing. It incorporates both wetland #30 and a portion of wetland #26 from the 1985 inventory. It was mown in late summer 2009, and periodic mowing may be a consistent policy to preserve grassland bird breeding capacity. The mowing practices noted in 1985 are now limited, and grazing, and agricultural practices noted then now appear to be eliminated, improving the habitat functions and reducing erosion potential. Its park status and location adjacent to Bloomfield Middle School enhance its capacity to provide educational and recreational functions. Its groundwater and surface water quality functions remain important.

COPACO Shopping Center

Although much of this area was altered in the past and continues to be impacted by stormwater runoff from the shopping center and other nearby impervious areas, a square-shaped wooded portion in the southeast corner of the assessment area remains relatively undisturbed. Open water and marsh dominate the northern end of this wetland. Four distinct vernal pools (breeding habitat not confirmed) are evident within the undisturbed woods. One of them held a small amount of water on the date of the assessment, while the other three were dry. Because of the large amount of water directed to these wetlands from developed areas, they provide important water quality functions.


Wooded wetland near the COPACO Shopping Center (NEE, 2009).

Croydon Drive

Much or all of the forested swamp designated as wetland #5 in the 1985 inventory is hydrologically isolated on the surface, and contains potential vernal pool habitat in isolated depressions. The 1985 assessment classified this area with low wildlife habitat function, due to the assessment matrix used, which did not take into account important connectivity and contextual qualities. The area is connected to a long stretch of the North Branch Park River by relatively undisturbed forest, and contains tightly interspersed wetlands and uplands.

Hoe Pond

Hoe Pond is impounded by a dam at the south end, and its outlet flows though an extremely rocky channel to the east, ultimately discharging to West Hartford Reservoir #6. It occupies an unusual place in the landscape for a pond, near the top of a stony ridge with steep slopes nearby on the west and east. Emergent wetlands along the shore are narrow. The pond and its shoreline are on private land, but this land is surrounded on three sides by Talcott Mountain State Park. The south end is covered by a habitat circle on the NDDB map.

Cliffmont Open Space

This small isolated wetland is within a pocket of open space in the middle of a mature residential development, and appears to have changed very little since its assessment in 1985. It is in a wooded depression with no outlet, and does not apparently hold standing water for an extended period. It has a groundwater recharge function, and provides limited wildlife habitat and educational/recreational opportunities within its residential setting.

Outlet stream from Hoe Pond (NEE, 2009).

Sunset Lane and Valley View Drive

This is a wetland fragmented and altered by agricultural use (now reduced to a single corn field) and residential development. While the corn field and surrounding residential neighborhoods continue to exert pressure on this wetland corridor, it remains a diverse system providing important functions, especially with respect to water quality. The main stream running through the middle of the corridor drains east to Wash Brook. A marsh south of Sharon Lane, identified as a cat-tail marsh in 1985, is now dominated by Common Reed (*Phragmites australis*). The wetland north of Sharon Lane is a patchwork of Red Maple swamp, marsh, and shrub/scrub habitat.

West of the end of Ryefield Hollow Drive on the west side of the stream, an area of extensive wetland vegetation is present in the bottom of the plowed field. The resource area also includes open water at a small pond west of Countryview Drive, with a wet meadow covered with Reed

Canary-grass and an open stream channel bordered by Alders and other shrubs nearby. From the end of Valley View Drive, the transect accessed the wooded swamp adjacent to the main stream as it turns east. There are some shallow potential vernal pools in this area, and also some trash and abandoned vehicles and equipment, as noted in the 1985 report. The northernmost section of woods, extending to Terry Plains Road, is within a circle on the NDDB map.

Adams Road to Duncaster Hollow

Ground-pine on former farmland (NEE, 2009).

The wetland complex assessed in 2009 is within the northern, headwaters portion of a large wetland system, #38 in the 1985 inventory. A portion of this wetland north of Adams Road and south of Duncaster Hollow was assessed. The area is a patchwork of old farmland in various stages of regeneration, from second growth forest to recently abandoned fields. Varieties of habitat observed included wet meadow, shallow marsh, and shrub/scrub patches. Among the diverse wetland vegetation, Swamp Lousewort (*Pedicularis lanceolata*), a rare plant (listed as Threatened in Connecticut) was observed. A circle on the NDDB map touches the southwestern corner of the wetlands assessed where the plant was found. A second area of this wetland complex was also assessed. The transect followed an old farm road extending from Duncaster Road to Harvest Lane, running along the northern edge of a large open field that appeared to have been farmed recently but was fallow or abandoned at the time of assessment. The eastern end of the field is dominated by wetland vegetation, and beyond the edge of the field is a wooded swamp. North of the old farm road is a dammed farm pond, surrounded by woods on three sides. As noted in 1985, this is a diverse, functionally-rich wetland system.

Dudley Town Pond

Commercial and industrial development along Dudley Town Road borders this pond to the east. A very large warehouse complex was recently built to the northwest, and a large area which was previously forested to the west has now been cleared and was in the process of being regarded at the time of the assessment. Emergent wetlands extend out from the pond to the north and northwest. The pond and these wetlands are generally protected by a forested buffer in most places, but the pond is suffering from eutrophication. On the date of assessment, it was almost completely covered with a thick, green, foul-smelling scum. Ducks were landing in the water at the northern end of the pond despite the algae, but the southern end was covered in a solid mat of thick algae. A wooded swamp and open cat-tail marsh are present along a northwest branch of the pond. With the exception of the wetlands along the stream corridors to the north and northwest, the wetland fringe around the pond is narrow.

The 1985 inventory lists under upstream impacts, "direct runoff from surrounding industries into the pond." However, it does not mention eutrophication, and specifically mentions diverse wildlife use around the pond. It appears that there has been significant degradation of this pond and wetlands since 1985.

4.7 Fish and Wildlife Resources

Portions of the North Branch Park River have abundant habitats supportive of a variety of fish and wildlife. Various waterbodies, wetlands, and upland areas provide habitat for fish, mammals, amphibians, and birds. Ecological assets in the Park River include common species such as the great blue heron, mallard, wood ducks, white-tailed deer, coyote, and fox. A 1988 fish survey by the CTDEP Fisheries Division found pickerel, abundant blacknosed dace, large-mouth bass, and other varieties of fish (Normen, 2008).

A number of relatively large areas of open space are present within the North Branch Park River watershed. These areas, which are generally located in the upper reaches of the watershed, vary in their level of protection and quality of their habitats. See Section 7.1 for a discussion of open space in the watershed.

4.7.1 Fish

The North Branch Park River and its tributaries support a variety of fish species despite the significant level of development within the watershed and historical modification of the rivers and streams including channel modifications, road crossings, flood control dams, and other impoundments.

The CTDEP Ambient Monitoring Program conducted ambient fish community sampling in 2000 in the North Branch Park River at Albany Avenue and in 2008 in Wash Brook at Cottage Grove Road. The fish species observed in Wash Brook were all native, including plentiful numbers of Blacknose dace, Longnose dace, Tesselated darter and White sucker. A combination of native and exotic species was identified in the North Branch Park River, including the exotic species Bluegill sunfish, Carp, Largemouth Bass, and Rock Bass. *Table 4-4* summarizes the fish species identified during these surveys.

Table 4-4. Fish Species Surveyed in the North Branch Park River Watershed

Fish Species	North Branch Park River (8/22/00 Survey)	Wash Brook (6/13/08 Survey)
American eel	15	2
Banded killifish	1	--
Blacknose dace	4	46
Bluegill sunfish	3	--
Carp	8	--
Common shiner	1	--
Fallfish	--	6
Largemouth Bass	3	--
Longnose dace	3	34
Pumpkinseed	15	--

Table 4-4. Fish Species Surveyed in the North Branch Park River Watershed

Fish Species	North Branch Park River (8/22/00 Survey)	Wash Brook (6/13/08 Survey)
Pumpkinseed X Red breast	1	--
Redbreast sunfish	9	1
Rock Bass	8	--
Tesselated darter	69	28
White sucker	23	26

4.7.2 Birds

As noted in the Eastern Connecticut Environmental Review Team Report (2000), blue heron, mallards, wood ducks, belted kingfisher, American robin, blue jay, northern flicker, mourning dove, American goldfinch, catbird, black-capped chickadee, tufted titmouse, and American crow have been observed along the North Branch Park River.

The Atlas of Breeding Birds of Connecticut (1994) collected information from 1982 to 1986 and found approximately 97 confirmed or probable species in the watershed. A complete species list is provided in *Appendix B.*

Mr. Jay Kaplan of the Roaring Brook Nature Center has organized summer bird counts (second weekend in June) along the North Branch Park River from Route 44 north to the University of Hartford Magnet School over the past two years (2008-2009). During these counts 32 species were observed including red-tailed hawk, barn swallow, and Baltimore oriole. It should be noted that the count only indicates birds which were observed, it does not indicate if the bird witnessed is confirmed as a breeder at the location. A complete species list is provided in *Appendix B.*

Additionally, Mr. Kaplan has organized Christmas Bird Counts (CBC) every December for approximately the past 20 years. The study area covers a 7.5-mile radius from the Old State House in downtown Hartford. Within the North Branch Park River portion of the study area, approximately 44 species of birds have been observed over the approximate 20 years of data collection, with 5 of the species including bald eagle, peregrine falcon, and ruby-crowned kinglet witnessed on a few occasions. Other notable species witnessed over the period of data collection include the great horned owl, yellow-rumped warbler, and fox sparrow. The birds witnessed during the CBC are considered permanent residents, winter visitors, or lingering migrants that may have not yet moved southward for a variety of reasons. A complete species list is provided in *Appendix B.*

4.7.3 Amphibians & Reptiles

Documentation is not readily available regarding the extent and population of amphibians and reptiles within the North Branch Park River watershed. However, the extent of available habitats (e.g., wetlands, watercourses, sandy upland areas, old field, etc.) within the watershed suggests that it likely supports a broad range of amphibians and reptiles. For example, suburban areas with medium to small wetlands, intermittent or small perennial streams, or moist woodland areas can support species such as the American toad, northern spring peeper, wood frog, redback salamander, and garter snake. Any of the numerous ponds and lakes either associated with water supply reservoirs, farms, or golf courses can support species such as bullfrogs, green frogs, spring peepers, painted turtles, spotted turtles, and snapping turtles. Finally, upland areas may support snakes including garter, northern ringneck, black racer and black rat snake. The presence of these common species within the watershed was confirmed by Mr. Hank Gruner of the Connecticut Science Center. A listing of the reptiles and amphibians he has observed in the various North Branch Park River subwatersheds is also included in *Appendix B*.

Mr. Brian Kleinman of Riverside Reptiles, a wildlife education company specializing in reptiles, has completed many bioinventories in the North Branch Park River watershed. He reports having observed within the watershed all of the common amphibians and reptiles found in Connecticut as well as less common species, including the eastern box turtle, the Jefferson/blue-spotted complex spotted salamander, the black rat snake and northern copperhead. Similar to the rest of Connecticut, the populations of these species within the watershed are threatened by development and potential additional fragmentation of their habitats.

4.7.4 Threatened and Endangered Species

The CTDEP Natural Diversity Data Base (NDDB) maintains information on the location and status of endangered, threatened, and special concern species in Connecticut. The Connecticut Endangered Species Act defines "Endangered" as any native species documented by biological research and inventory to be in danger of extirpation (local extinction) throughout all or a significant portion of its range within Connecticut and to have no more than five occurrences in the state. The Act defines "Threatened Species" as any native species documented by biological research and inventory to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range within Connecticut and to have no more than nine occurrences in the state. "Species of Special Concern" means any native plant or any native non-harvested wildlife species documented to have a naturally restricted range or habitat in the state, to be at a low population level, to be in such high economic demand that its unregulated taking would be detrimental to the conservation of its population, or has become locally extinct in Connecticut.

Figure 4-6 displays the generalized areas of endangered, threatened, and special concern species in the North Branch Park River watershed. *Table 4-5* presents a list of species known to exist within the watershed. The areas represent a buffered zone around known species or community locations.

The locations of species and natural community occurrences depicted on the NDDB mapping are based on data collected over the years by the Environmental and Geographic Information Center's Geologic and Natural History Survey, other units of the CTDEP, conservation groups, and the scientific community. Approximately fourteen such areas were identified throughout

Figure 4-6

the watershed. Because new information is continually being added to the Natural Diversity Database and existing information updated, the areas are reviewed on an annual basis by the CTDEP. Areas can be removed or added based upon the results of the review.

Table 4-5. Endangered, Threatened, and Special Concern Species

Common Name	Scientific Name	Status
Flora		
Sedge	*Carex squarrosa*	Special Concern
Goldie's Fern	*Dryopteris goldiana*	Special Concern
Swamp Lousewort	*Pedicularis lanceolata*	Threatened
Fauna		
Jefferson Salamander	*Ambystoma jeffersonianum*	Special Concern
Upland Sandpiper	*Bartramia longicauda*	Endangered
Bobolink	*Dolichonyx oryzivorus*	Special Concern
Peregrine Falcon	*Falco peregrinus*	Endangered
American Kestrel	*Falco sparverius*	Threatened
Atlantis Fritillary	*Speyeria atlantis*	Special Concern
Eastern Meadowlark	*Sturnella magna*	Special Concern
Eastern box turtle	*Terrapene c. carolina*	Special Concern
Brown thrasher	*Toxostoma rufum*	Special Concern
Habitats		
Subacidic rocky summit/outcrop	--	--

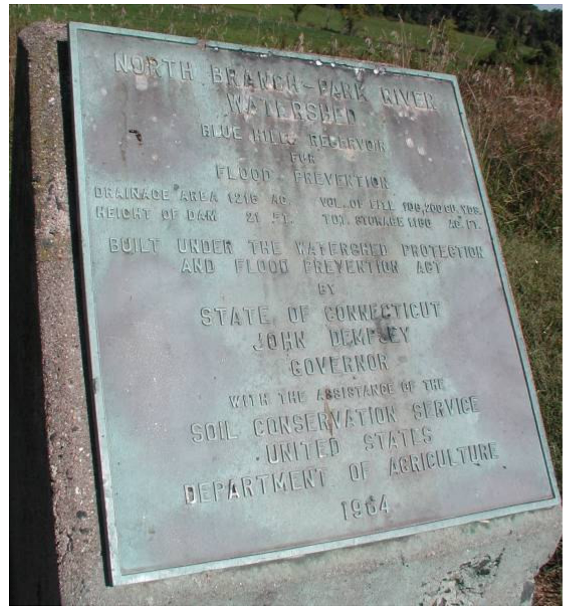
Source: CTDEP Natural Diversity Data Base, 2009.

The 2009 wetland field assessment described in Section 4.6.3 of this report identified the presence of one "threatened" species, Swamp Lousewort (*Pedicularis lanceolata*) within the wetland complex between Adams Road and Duncaster Hollow.

5 Watershed Modifications

5.1 Dams and Impoundments

The North Branch Park River watershed includes a number of dams and reservoirs that were constructed for flood control, water supply, industrial power, and recreation. Some of the existing dams and reservoirs retain their original uses, while others now primarily provide recreation, habitat, and open space. The major flood control reservoirs in the watershed, several of which only impound water during large storms, are largely undeveloped and therefore provide valuable wildlife habitat and open space. Other impoundments in the watershed provide aquatic and wildlife habitat and recreational opportunities, but may also limit or impede fish migration. *Table 5-1* lists the flood control reservoirs in the watershed, while *Table 5-2* lists state-registered dams in the watershed. *Figure 5-1* depicts the locations of the various dams and impoundments in the watershed.



Monument at Blue Hills Reservoir (NEE, 2009).

Table 5-1. Flood Control Reservoirs in the North Branch Park River Watershed

Name/ Year Completed	CTDEP Flood Control ID No.	Location	Drainage Area (square miles)	Flood Control Pool Volume (acre-feet)	Pool Surface Area (acres)
Wintonbury Reservoir/ 1963 *dam only	1	Westerly branch of Beamans Brook, 1.2 miles northeast of Bloomfield Town Hall	1.42	850	165
Blue Hills Reservoir/1964 *dam only	2	Easterly branch of Beamans Brook, 1.3 miles northeast of Bloomfield Town Hall	1.9	700	175
Bloomfield (Tunxis) Reservoir/1962 *dam w/dike structure	3	Wash Brook, 1.5 miles north of Bloomfield Town Hall, adjacent to Tunxis Avenue (Rt. 189)	3.05	1,750	245
Cold Spring Reservoir/1968 *dam only	9	Northerly branch of Tumbledown Brook, 1.7 miles southwest of Bloomfield Town Hall	1.94	1,100	137

Figure 5-1

The flood control reservoirs listed in *Table 5-1* were constructed by the State of Connecticut in the early 1960s in response to the severe flooding that occurred in 1955. The reservoirs are designed to be primarily dry (no permanent pool) during non-flood events but have a total combined flood storage capacity of 1.44 billion gallons (4,408 acre-feet). These reservoirs are also designed to control approximately 12 inches of runoff from the contributing drainage area with allowances for approximately 50 years of sediment accumulation. A 1959 report to the Greater Hartford Flood Commission (Metcalf & Eddy, 1959) estimated the construction cost of these reservoirs at $2,200,000 (based on 1955 prices).

Figure 5-1 shows the location and hazard classification of state-registered dams within the North Branch Park River watershed. According to the CTDEP Dam Safety Regulations, the hazard classification of a dam is based on the damage potential from failure of the structure. For example, a Class C dam is a high hazard potential dam which, if it were to fail, would result in probable loss of life; major damage to habitable structures, residences, hospitals, and other inhabited and public gathering places; damage to main highways with greater than 1,500 average daily trips; and great economic loss.

Table 5-2. Hazard Classification of State-Registered Dams

Dam Name	Hazard Class	Town
Brainard Pond Dam #1	A	West Hartford
Brainard Pond Dam #2	A	West Hartford
Tobacco Pond Dam #3	A	Bloomfield
Wash Brook Pond Dam	A	Bloomfield
Park Pond Dam	A	Bloomfield
Detention Basin Dam	A	Bloomfield
Dudley Town Pond Dam	A	Bloomfield
Filley Park Pond Dam	A	Bloomfield
Old Mill Pond Dam	A	Bloomfield
Natural Pond Dam	A	Bloomfield
Emerick Pond Dam	B	Bloomfield
Sinnot Pond Dam	B	Bloomfield
Serbin Dam	B	Bloomfield
Gale Pond Dam	BB	Bloomfield
Bloomfield Site 3A Dam	BB	Bloomfield
Schweitzer Pond Dam	BB	Bloomfield
University Of Hartford Dam	BB	Hartford
Cold Spring Dam	C	Bloomfield
Hartford Reservoir Dam #6	C	West Hartford
Talcott Reservoir Dam #1	C	West Hartford
Bloomfield Dam	C	Bloomfield
Wintonbury Site #1 Dam	C	Bloomfield
Blue Hills Reservoir Site #2 Dam	C	Bloomfield

Dams that have changed use or ownership often degrade in condition and fall into a state of disrepair, increasing the likelihood of dam failure. The CTDEP Dam Safety Section is required to inspect dams periodically, with increased inspection frequency for dams with higher hazard potential.

5.2 Park River Conduit System

The confluence of the Park River conduit with the Connecticut River in Hartford.

Prior to the construction of the flood control reservoirs in the 1950s, a major flood control system was designed and constructed in Hartford in response to the devastating floods that occurred in the 1930s. The flood control system, much of which is intact today, consists of dikes to protect the city from the Connecticut River and twin underground conduits to control flooding along the Park River. Construction of the Park River conduits began in 1940, and was later modified in the 1950s following the 1955 flood. The Park River conduit system conveys flows from Hartford's interior drainage system, both artificial and natural, including the north and south branches of the Park River, into the Connecticut River. The Park River conduit system consists of tunnels that carry the north and south branches of the Park River separately to their confluence, and then join to form a twin-barreled conduit that carries the entire main branch of the Park River to its mouth at the Connecticut River. The North Branch Park River enters this conduit system near Farmington Avenue in Hartford. Each of the two conduits that comprise the main branch of the conduit system is 36 feet wide and 27.5 feet high. Under typical conditions, the conduits flow by gravity with a free water surface. However, during large flood events, the conduit inlets can become submerged, causing the conduits to flow under pressure. The conduit system also includes an additional siphon conduit that augments the capacity of the main conduits.

While the flood control projects of the last century have protected the City of Hartford from the type of catastrophic floods that occurred in the 1930s and 1950s, these changes have also disconnected the river from the surrounding communities and have contributed to the river's deteriorated water quality and degraded habitat conditions that exist today.

The Park River conduit system is designed to manage flows associated with localized storm events (i.e., limited to the Park River watershed) much larger than the 100-year storm, which is the design standard for flood control. The selected design storm for the Park River conduit system was the "storm of record" in New England (18.3 inches of rain in a 24-hour period as recorded at Westfield, Massachusetts in 1955). By comparison, a 100-year storm in Hartford is estimated to be approximately 6.7 inches of rain in

24 hours. The conduit system is designed to accommodate these flood flows even while the Connecticut River is peaking at its 100-year flood elevation. A drainage analysis of the City of Hartford's Levee and Flood Control System was completed in June 2009 as part of the City's effort to obtain FEMA accreditation for the system. Based on this analysis, the capacity of the main branch of the Park River conduit system is approximately 24,000 cubic feet per second (cfs) and the capacity of the Auxiliary Conduit is approximately 6,700 cfs.

The flood control projects of the last century have protected the City of Hartford from the type of catastrophic floods that occurred in the 1930s and 1950s. However, as indicated in Section 3.1 *History of the Watershed*, channelization and burial of portions of the North Branch Park River dramatically altered the physical and habitat characteristics of the river and the land development patterns along the river and within its watershed, which have disconnected the river from the surrounding communities and have contributed to the river's deteriorated water quality and degraded habitat conditions that exist today.

5.3 Water Supply

The Metropolitan District Commission (MDC), chartered by the Connecticut General Assembly in 1929, provides potable water to approximately 90,000 customers and 400,000 people in its eight member communities, which include Bloomfield, East Hartford, Hartford, Newington, Rocky Hill, West Hartford, Wethersfield and Windsor; as well as portions of East Granby, Farmington, Glastonbury, South Windsor, Manchester and Windsor Locks. As of 2000, 95% of Bloomfield's and 100% of West Hartford's and Hartford's populations were supplied water by the MDC. Avon and Simsbury, small areas of which are located within the North Branch Park River watershed, are served by Connecticut Water Company and Aquarion Water Company, respectively.

Drinking water supplied to the North Branch Park River watershed originates from surface waters located outside of the watershed boundaries, including the East Branch of the Farmington River and the Nepaug River, a tributary of the Farmington River. The associated drinking water reservoirs are located in the northwest hills of Connecticut – the 30.3 billion gallon Barkhamsted Reservoir and the 9.5 billion gallon Nepaug Reservoir. Water from these sources flows by gravity to two treatment facilities, including a slow sand filtration plant located off Farmington Avenue in West Hartford and a rapid sand filtration facility located at the MDC-operated West Hartford Reservoir No. 6, which is located in the southwest portion of the North Branch Park River watershed. West Hartford Reservoir No. 6 typically receives water from Barkhamsted

Drinking water supplied to the North Branch Park River watershed originates from surface waters located outside of the watershed boundaries, including the East Branch of the Farmington River and the Nepaug River, a tributary of the Farmington River.

Reservoir and may receive water from Nepaug Reservoir depending on the positioning of flow control valves along the transmission main (MDC, 2008).

Portions of the watersheds of two other MDC reservoirs, West Hartford Reservoirs No. 2 and No. 3, are located within the North Branch Park River watershed. Although active, West Hartford Reservoirs No. 2 and No. 3 are rarely used at this time. *Table 5-3* provides additional information on the three MDC reservoirs that are located within the North Branch Park River watershed.

Table 5-3. MDC Drinking Water Reservoirs in the North Branch Park River Watershed

West Hartford Reservoir	Location	Use	Built	Capacity (million gallons)		Watershed Area (sq.mi.)
				Total	Usable	
No. 2	West Hartford	Water supply (active, rarely used)	1867-1868	284	277	1.1
No. 3	West Hartford	Water supply (active, rarely used)	1875	144	96	0.6
No. 6	West Hartford & Bloomfield	Water supply (active)	1891-1895	809	796	2

Source: The Metropolitan District Individual Water Supply Plan, 2008.

The MDC water supply system is largely protected by its undeveloped watershed land. The West Hartford Reservoir system watershed is predominantly rural, with few commercial or industrial facilities. A large percentage of the watershed land is owned by the MDC or the State of Connecticut. Of the over 2,300 acres of watershed area associated with the West Hartford Reservoir system (Reservoirs No. 2, 3, 5, and 6), approximately 91 percent of the land in the watershed is preserved including all watershed land owned by the MDC, state forest and parklands, and municipally or privately held land designated as open space (CTDPH, 2003). However, the MDC implements a number of source water protection programs to further protect the quality of its drinking water supplies, including:

- Watershed inspection
- Water quality monitoring
- Land use monitoring
- Land use planning and zoning
- Technical assistance and education
- Emergency spill response
- Watershed forest management
- Land acquisition

The State of Connecticut Department of Public Health, Drinking Water Section completed an assessment of public drinking water sources to identify and document potential sources of contamination that could adversely impact drinking water quality. The assessments found that the West Hartford Reservoir system has a low susceptibility to potential sources of contamination (CTDPH, 2003).

Less than 10 percent of the residents of the North Branch Park River watershed obtain their drinking water from private groundwater wells and other water supplies sources. Private water supplies are regulated by the local health departments.

5.4 Wastewater

In addition to water supply, the MDC also provides sewerage services on a regional basis to its member communities. The MDC owns and operates a combined sewer system within Hartford and a small portion of West Hartford. These sewers date back to the 19th century, when it was believed that dual-purpose pipes for sewage and storm water conveyance would result in more manageable and cost-effective collection systems. While the pipes were originally sized to carry both sewage and stormwater, intense storm events and expansion of the collection system due to development have historically taxed the capacity of the MDC's interceptor sewers and the wastewater treatment facility, which cannot handle the large wet weather flows from the combined sewer system (CTDEP, 2007). During rain events, basements may fill with sewage, streets may flood, and untreated wastewater may discharge from the sewer system at combined sewer overflow (CSO) and sanitary sewer overflow (SSO) locations.

A combined sewer system uses a single pipe to carry both sewage and stormwater. When it rains, stormwater enters the pipe with the sewage. As these sewers become overloaded, they can back up onto streets, into yards and into basements. Combined Sewer Overflows or CSOs are used to alleviate pipe surcharging, spilling sewage into open waters.

Six of the eight member communities contribute flow to the Hartford collection system for conveyance to the Hartford Water Pollution Control Facility, including all of Hartford, all of West Hartford, and portions of Bloomfield, Newington, Wethersfield and Windsor. Hartford and West Hartford are the only member communities with any combined sewers. The MDC's CSOs are ultimately discharged to the Connecticut River having a direct effect on multiple downstream communities (CTDEP, 2007). *Figure 5-2* depicts the sewer service area within the North Branch Park River watershed. There are currently four CSOs (Hartford) and one SSO (Bloomfield) within the North Branch Park River watershed (*Figure 5-3*). The partially and fully combined portions of the sewer system are located within the West Hartford and Hartford portions of the watershed.

The MDC is implementing a major infrastructure improvement program known as "The Clean Water Project" to address a federal consent decree and a CTDEP consent order to achieve the Federal Clean Water Act goals by 2020. The Clean Water Project includes three basic elements: (1) reduction of combined sewer overflows (CSOs) within the Hartford central sewer system, (2) elimination of sanitary sewer overflows (SSOs) in the sanitary sewers of Wethersfield, West Hartford, Windsor, Rocky Hill and Newington and (3) nitrogen reductions. The MDC

Figure 5-2

Figure 5-3

abatement plan would eliminate all discharge from CSOs/SSOs during storms up to and including the typical one-year frequency event. The District plans to address the SSO and CSO issues by implementing one or more of the following strategies:

- Separating the combined sewer systems
- Correcting illegal connections including roof drains and sump pumps and groundwater infiltration locations
- Installing new, larger sewer pipes
- Installing storage pipes to hold storm flows and prevent storm event related discharges
- Increasing sewer treatment plant capacities

These projects will help to eliminate sewage overflows to area waterways during an average year, significantly improving water quality. In addition to CSO and SSO abatement program, the "Clean Water Project" also includes plans to upgrade District water pollution control facilities (WPCFs) to meet nitrogen removal requirements. However, none of the MDC WPCFs discharge into the North Branch Park River watershed.

The MDC and the City of Hartford are also evaluating the use of green infrastructure approaches and low impact development (LID) to further manage wet weather flows, including storm runoff volume and quality. Such practices include the installation of rain gardens, open channels/swales, and pervious pavements which promote the infiltration of runoff into the soil instead of directing it into the storm and/or combined sewer system. Green infrastructure concepts have been proposed for in and around the State Capitol in Hartford including the removal of impervious cover (reduction of paved areas) and the installation of stormwater swales and rain gardens.

The Towns of Avon and Simsbury are not served by MDC sewer system. Alternately, all private septic systems in these Towns are regulated under the Farmington Valley Health District. This District is responsible for the enforcement of the Connecticut Public Health Code requirements governing the disposal of sewage through septic systems including the installation of new systems as well as the repair and replacement of existing septic systems.

5.5 Regulated Sites

Historical and current industrial and commercial development within the North Branch Park River watershed poses a potential threat to surface water and groundwater supplies in the watershed. Wastewater discharges, illegal waste disposal, improper use and disposal of chemicals such as used oil, pesticides, and herbicides, chemical spills, and historical site contamination are potential sources of contaminants from industrial and commercial facilities.

Table 5-4 summarizes the facilities in the North Branch Park River watershed with surface water discharges regulated under the National Pollutant Discharge Elimination System (NPDES) permit program, which is administered by the CTDEP. The facilities listed in *Table 5-4* have permits for discharges of wastewater or stormwater discharges either directly to surface waters or indirectly via stormwater drainage systems. The majority of these facilities are located in Bloomfield, although a number are also located in Hartford and West Hartford.

Table 5-4. Facilities with NPDES Discharge Permits
in the North Branch Park River Watershed

Type of Discharge Permit	Permit ID Prefix	Number of Facilities in the Watershed		
		Bloomfield	Hartford	West Hartford
Surface Water Discharge	CT	3	0	1
General Permit for Cooling Water	GCW	4	1	0
General Permit for Domestic Sewage	GDS	1	1	1
General Permit for Food Processing	GFP	2	0	0
General Permit for Groundwater Remediation	GGR	2	2	1
General Permit for Miscellaneous Discharges to Sewer	GMI	2	0	0
General Permit for Photographic System	GPH	3	6	1
General Permit for Swimming Pool Filters	GPL	7	4	5
General Permit for Printing & Publishing	GPP	4	0	0
General Permit for Commercial Stormwater	GSC	4	1	0
General Permit Industrial Stormwater	GSI	15	0	0
General Permit for Municipal Separate Storm Sewer Systems (MS4s)	GSM	1	1	1
General Permit for Construction Stormwater	GSN	26	8	6
General Permit for Parts Tumbling and Cleaning	GTC	3	0	0
General Permit for Vehicle Maintenance	GVM	5	2	0
General Permit for Potable Water Filtration	GWT	5	0	0
Pretreated Sewer Discharge	SP	2	0	0
	Total:	**89**	**25**	**15**

Source: CTDEP, December 2007.

Table 5-5 summarizes hazardous waste generators and other regulated industrial facilities within the watershed. These facilities are located in the upper portion of the watershed primarily along the Route 187 corridor in Bloomfield and in the lower portion of the watershed clustered along Homestead Avenue in Hartford. Hazardous waste facilities are regulated under the Resource Conservation and Recovery Act (RCRA), including Large Quantity Generators (i.e., facilities that generate 1,000 kilograms per month or more of hazardous waste, more than 1 kilogram per month of acutely hazardous waste, or more than 100 kilograms per month of acute spill residue or soil) and facilities registered with the CTDEP Corrective Action Program. Small Quantity Generators are not included in *Table 5-5*. The Toxics Release Inventory (TRI) is a database containing detailed information on chemicals that industrial facilities manage through disposal or other releases, or recycling, energy recovery, or treatment. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. Certain facilities are required to report to the TRI Program annually.

There are no sites in the watershed that are listed as potential hazardous waste sites under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise known as "Superfund." Additionally, there are no facilities in the watershed requiring a Federal Title V permit for major emitters of air pollutants.

Table 5-5. Summary of Regulated Waste Facilities

Facility Name	Address	Town	Resource Conservation and Recovery Act	Toxic Release Inventory
Birken Manufacturing Company, Inc.	3 Old Windsor Road	Bloomfield	Corrective Action	Reporter
Connecticut Printers, Inc.	55 Granby Street	Bloomfield	-	Reporter
Kamatics Corporation	1330 Blue Hills Ave.	Bloomfield	Large Quantity Generators	Reporter
Lesro Industries, Inc.	55 Peters Rd	Bloomfield	Large Quantity Generators	--
New England Dairies, Inc.	255 Homestead Avenue	Hartford	--	Reporter
Otis Service Center	212 W. Newberry Rd.	Bloomfield	--	Reporter
Philbrick-Booth & Spencer	367 Homestead Avenue	Hartford	--	Reporter
Rollprint Packaging Prod, Inc	16 Southwood Rd.	Bloomfield	--	Reporter
St Francis Hospital & Med Ctr	114 Woodland Street	Hartford	Large Quantity Generators	--
Stanley P Rockwell Company	296 Homestead Avenue	Hartford	--	Reporter
Tilcon Connecticut, Inc	301 Hartford Avenue	Newington	--	Reporter
Turbine Controls Inc	2 Old Windsor Rd	Bloomfield	Large Quantity Generators	Reporter
Turbotec Products Incorporated	125 Old Iron Ore Rd.	Bloomfield	--	Reporter
Ultra Vac Metallizing Corporation	195 W. Newberry Rd.	Bloomfield	--	Reporter
Wood Group Pratt & Whitney Industrial Turbine Service LLC	1460 Blue Hills Ave	Bloomfield	Large Quantity Generators	--

Sources: EPA Geospatial Data Access Project. Featured Environmental Interests. http://www.epa.gov/enviro/geo_data.html. Updated January 1, 2009 and Department of Environmental Protection. Commercial Hazardous Waste and Connecticut Regulated Waste Facilities In Connecticut. http://www.ct.gov/dep/cwp/view.asp?a=2718&q=325490&depNav_GID=1646. Updated October 21, 2008.

A former municipal landfill is located immediately adjacent to the western boundary of the West Hartford Reservoir subwatershed. The closed landfill, which is now a leaf compost facility operated by the Town of West Hartford, is located off of Route 44 on the southwest side of West Hartford Reservoir No. 6. The facility is identified as a significant potential contamination source in the MDC Water Supply Plan (2008).

6 Water Quality

6.1 Classifications, Standards, and Impairments

The North Branch Park River is impaired for recreational uses and habitat for fish, other aquatic life, and wildlife due to physical alteration and elevated levels of indicator bacteria.

The Federal Clean Water Act (CWA) was developed to protect the nation's surface waters. Through authorization of the CWA, the United States Congress declared as a national goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water wherever attainable." The CWA requires states to:

1. Adopt Water Quality Standards,
2. Assess surface waters to evaluate compliance with Water Quality Standards,
3. Identify those waters not currently meeting Water Quality Standards, and
4. Develop Total Maximum Daily Load (TMDL) analysis and other management plans to bring water bodies into compliance with Water Quality Standards.

Connecticut Water Quality Standards are established in accordance with Section 22a-426 of the Connecticut General Statutes and Section 303 of the CWA. The Water Quality Standards are used to establish priorities for pollution abatement efforts. Based on the Water Quality Standards, Water Quality Classifications establish designated uses for surface and ground waters and identify the criteria necessary to support these uses. The Water Quality Classification system classifies inland surface waters into four different categories ranging from Class AA to D. *Table 6-1* summarizes the Connecticut Surface Water Quality Classifications.

Table 6-1. Connecticut Inland Surface Water Quality Classifications

<table>
<tr><th>Designated Use</th><th>Class AA</th><th>Class A</th><th>Class B</th><th>Class C</th><th>Class D</th></tr>
<tr><td>Existing/proposed drinking water supply</td><td>•</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Potential drinking water supply</td><td>•</td><td>•</td><td></td><td></td><td></td></tr>
<tr><td>Fish and wildlife habitat</td><td>•</td><td>•</td><td>•</td><td colspan="2" rowspan="3">Class C and D waters may be suitable for certain fish and wildlife habitat, certain recreational activities, industrial use, and navigation</td></tr>
<tr><td>Recreational use</td><td>•</td><td>•</td><td>•</td></tr>
<tr><td>Agricultural and industrial use</td><td>•</td><td>•</td><td>•</td></tr>
</table>

Figure 6-1 depicts the Water Quality Classifications of surface waters in the North Branch Park River watershed. The North Branch Park River is classified as C/A meaning that the river is currently only meeting Class C criteria or designated uses but has a goal of Class A. The North Branch Park River is also listed as impaired for recreational uses and habitat for fish, other aquatic life, and wildlife in the *2008 List of Connecticut Waterbodies Not Meeting Water Quality Standards*. *Table 6-2* summarizes the location and nature of the impairment. Multiple factors are identified as responsible for the impairment, including physical habitat alteration and elevated levels of *Escherichia coli* (*E.Coli*). The potential source of the *E. Coli* contamination is combined sewer overflows and urban stormwater.

Table 6-2. North Branch Park River Watershed Impaired Waters

Waterbody Name/ Segment ID	Location Description	Waterbody Segment Length	Impaired Designated Use	Cause	TMDL Priority/ Category	Potential Source
North Branch Park River-01/ CT4404-00_01	From mouth at confluence with Park River just downstream of I84 crossing, upstream to entrance of conduit (entire segment in pipe) near Farmington Avenue, Hartford	0.51 miles	Habitat for Fish, Other Aquatic Life and Wildlife	Physical substrate habitat alterations	N/4C	Channelization
			Recreation	Physical substrate habitat alterations	N/4C	Channelization
			Recreation	Escherichia coli	L/5	Combined Sewer Overflows
North Branch Park River-02/ CT4404-00_02	From downstream side of Farmington Avenue (at entrance of conduit), upstream to confluence with Wash Brook (just downstream of confluence of Wash Brook and Beamans Brook), Bloomfield	5.39 miles	Habitat for Fish, Other Aquatic Life and Wildlife	Unknown	L/5	Unspecified Urban Stormwater, Combined Sewer Overflows
			Recreation	Escherichia coli	L/5	Unspecified Urban Stormwater, Combined Sewer Overflows

Source: CTDEP, 2008

[1] TMDL Priority Definitions (i.e., Potential for TMDL Development within 3 Years):

H – high priority for which there is assessment information that suggests that a TMDL may be needed to restore the water quality impairment; TMDLs may be developed within 3 years.

M – medium priority indicates that there may be insufficient information to assess the impairment or that other programs are likely to remedy the water quality impairment; TMDLs may be developed within 3-7 years.

L – low priority; may be reassigned to another EPA category or TMDLs may be developed in 7-11 years.

N – not applicable; the impact to the stream is not being caused by a pollutant.

[2] TMDL Category Definitions for Waterbodies Not Meeting State Water Quality Standards:

4A – A TMDL to address a specific pollutant combination has been approved or established by EPA.

4B – A use impairment caused by a pollutant is being addressed by the State through pollution control requirements other than a TMDL.

4C – A use is impaired, but the impairment is not caused by a pollutant.

5 – Available data and/or information indicate that at least one designated use is not being supported and a TMDL is needed.

Figure 6-1

Total Maximum Daily Loads (TMDLs) provide the framework to restore impaired waters by establishing the maximum amount of a pollutant that a water body can assimilate without adverse impact to aquatic life, recreation, or other public uses. The *2008 List of Connecticut Waterbodies Not Meeting Water Quality Standards* includes a priority ranking system for development of a TMDL specific to the contaminants in each impaired segment: high (H), medium (M), low (L), under study (T), or Not Applicable (N). CTDEP has identified the need for a TMDL to address the impairment for Escherichia coli, although the priority is low at this time.

Other tributaries, lakes and ponds throughout the North Branch Park River watershed are classified as Class A with the exception of Tumbledown Brook, Beamans Brook, and Wash Brook, which are classified as Class B/A; the West Hartford Reservoir No. 6, which is classified as B/AA; and Hoe Pond in the upper northwest portion of the watershed, which is classified as AA since it feeds West Hartford Reservoir No. 6.

Currently, there is a statewide advisory that recommends limiting the consumption of freshwater fish due to elevated levels of mercury in some species. However, only those designated uses specifically identified in the Connecticut Water Quality Standards are assessed. In making water quality assessments, each designated use of a waterbody is assigned a level of support (e.g., full support, not supporting, or not assessed), which characterizes the degree to which the water is suitable for that use. The North Branch Park River is designated full support for fish consumption, although this designation is superseded by the statewide advisory.

6.2 Water Quality Monitoring

Water quality monitoring within the North Branch Park River watershed is conducted by the CTDEP and by the Trinity College Environmental Science program. Both water quality monitoring programs are described in the following sections, followed by a discussion of the monitoring results.

6.2.1 CTDEP Monitoring Program

The CWA requires each state to monitor, assess and report on the quality of its waters relative to attainment of designated uses established by the State's Water Quality Standards. For assessing statewide water quality conditions and complying with the CWA monitoring requirements, the CTDEP relies on monitoring data collected by two programs, the Ambient Monitoring Program and the Rapid Bioassessment in Wadeable Streams & Rivers by Volunteer Monitors (RBV) Program.

The determination of the supported uses in rivers across the state relies on the collection of physical, chemical and biological monitoring data of stream water quality. In 2005 a new Comprehensive Ambient Water Quality Monitoring Strategy was adopted. The strategy incorporates a composite of targeted and probabilistic sampling designs to assess aquatic life use support. The monitoring includes a mix of sites visited on five-year, two-year and annual basis.

The RBV program is a citizen-based water quality-monitoring program developed by the CTDEP ambient monitoring program. The RBV program is a standardized screening bioassessment method that identifies sections of streams with pollution sensitive organisms. Organisms are categorized as Least Sensitive, Moderately Sensitive, or Most Sensitive, which together with chemical monitoring data can serve as an indicator of overall stream health.

Table 6-3 provides a summary of the CTDEP water quality monitoring programs within the North Branch Park River watershed. The monitoring locations are depicted in *Figure 6-1*. The Ambient Monitoring Program conducted water quality monitoring of the North Branch Park River at Albany Avenue and a second location at Upper Campus Road (on the University of Hartford campus) in the winter, spring and summer of 1999. Additional water quality samples were collected and analyzed from a monitoring location on the North Branch Park River at Farmington Avenue (behind 19 Woodland Street) in June, July, August, and September of 2008. Sampling was not coordinated with wet or dry weather. Ambient monitoring results are also available for other locations within the watershed. Bioassessments in the North Branch Park River were performed by the RBV program in September of 2008.

Table 6-3. Summary of DEP Ambient Water Quality Monitoring Program

Stream	Location	Program	Parameters Monitored	Dates
North Branch Park River	Farmington Avenue behind 19 Woodland Street	AMP1	Temperature, DO, ORP, BOD5, pH, TDS, TSS, Turbidity, Alkalinity, Hardness, Total P, Total N, NO3, NO2, Org-C, TKN, Ca, Mg, E. coli	6/13/2008 6/16/2008 7/1/2008 7/10/2008 8/28/2008 9/2/2008 9/22/2008 10/8/2008
		RBV2	Macroinvertebrates	9/20/2008
	Watkinson School	RBV2	Macroinvertebrates	9/20/2008
	Albany Avenue	AMP1 - Quarterly Monitoring	Temperature, DO, ORP, BOD5, pH, TSS, Turbidity, Alkalinity, Hardness Total N, NO3, NO2, Ammonia, Org N, TKN, PO43-Cd, Cl, Cr, Cu, Pb, Ni, Zn, Fe Total Coliform, Enterococci, E. coli	3/30/1999 6/16/1999 9/27/1999
		AMP1 – Ambient Fish Community Sampling	Fish Species	8/22/2000
	Sunny Reach Drive	AMP1	DO, pH, TDS, water depth, Temperature	9/17/2008
	Upper Campus Road at University of Hartford	AMP1 - Quarterly Monitoring	Temperature, DO, ORP, BOD5, pH, TSS, Turbidity, Alkalinity, Hardness, Total N, NO3, NO2, Ammonia, Org N, TKN, PO43, Cd, Cl, Cr, Cu, Pb, Ni, Zn, Fe, Total Coliform, Enterococci, E. coli	3/30/1999 6/16/1999 9/27/1999
Wash Brook	US Cottage Grove Road (Route 218)	AMP1 - Ambient Fish Community Sampling	Fish Species Ammonia, NO3, NO2, pH, TSS, TKN, Total Solids, Turbidity, NOX, Org N, Ca, Mg, PO4-3, Alkalinity, Cl, PO4-2, K, Na, Total N, Hardness, SO4	6/13/2008

6.2.2 Trinity College Monitoring Program

Dr. Jonathan Gourley of the Trinity College Environmental Science Program is conducting an ongoing water quality monitoring project in the North and South Branches of the Park River. During the summer of 2008 a team of five undergraduate research students collected water quality samples at twelve locations from the headwaters of the North Branch Park River watershed through the main stem of the North Branch Park River (*Figure 6-1*). The samples were analyzed for temperature, pH, conductivity, total dissolved solids (TDS), salinity, dissolved oxygen (DO), hardness, major anions (chloride, nitrates and sulfates), fecal coliform, and macroinvertebrates. Sampling was not coordinated with wet or dry weather.

6.3 CTDEP Monitoring Results

The following sections summarize the CTDEP water quality monitoring results for the North Branch Park River watershed. Water quality monitoring results for additional parameters that were analyzed during the 1999 and 2008 sampling events are summarized in *Appendix C*.

6.3.1 Turbidity

Turbidity, a measure of the scattering of light through water, is a common indicator of suspended particulate and colloidal material and is typically included in ambient water quality monitoring programs (EPA, 2000). Turbidity can be caused by any small, undissolved material in water such as suspended algal cells or by inorganic suspended soils. Turbidity is typically reported in either Nephelometric Turbidity Units (NTUs) or Formazin Turbidity Units (FTUs) (although the NTU and FTU units are not necessarily synonymous, for the purposes of this report they are used interchangeably).

Turbidity levels can vary significantly in the environment and may depend on the surficial soils, level of development, nutrient loadings, and other watershed characteristics as well as rainfall conditions prior to sampling. EPA suggests a reference criteria level of 3.04 FTU for the Eastern Coastal Plain Ecoregion (Ecoregion XIV), which includes the majority of Connecticut (EPA, 2000b). The Connecticut Water Quality Standards turbidity criteria for waters in Class AA through B do not allow an increase in turbidity of more than 5 NTU above ambient conditions. Elevated turbidity can be symptomatic of excessive nutrients loads, resulting in algal growth, or sediment loads from soil erosion.

Figure 6-3 presents turbidity results for the CTDEP Ambient Monitoring Program data within the watershed. Turbidity levels measured in 1999 generally ranged from 1 to 3 NTU, with one measurement approaching 4.5 NTU at Albany Avenue. In 2008, measured turbidity levels varied from 1.6 to 6.7 NTU.

6.3.2 Total Suspended Solids

Similar to turbidity, Total Suspended Solids (TSS) describes the quantity of particulate matter suspended in the water column. TSS attenuates light and reduces transparency, whether the source is algae, algal detritus or inorganic sediment. Unlike turbidity, TSS is directly measured; water is filtered directly to remove the suspended material, and then the material is weighed. Solids that pass the filter are assumed to be dissolved.

During high streamflow, the concentration of suspended solids (and water clarity) is more strongly influenced by inputs of inorganic sediment or channel erosion in streams than by algae, especially in urbanized and agricultural watersheds. As shown in *Figure 6-4*, the Albany Avenue sampling location had the highest average TSS levels of the four sampling locations. However, the sample with the single highest measured TSS concentration was collected at the Farmington Avenue sample location.

There are no numerical state or federal water quality criteria for TSS. The Connecticut Water Quality Standards require that suspended and settleable solids not be present in concentrations or combinations that would impair designated uses, alter the composition of the water body substrate, or impact aquatic organisms.

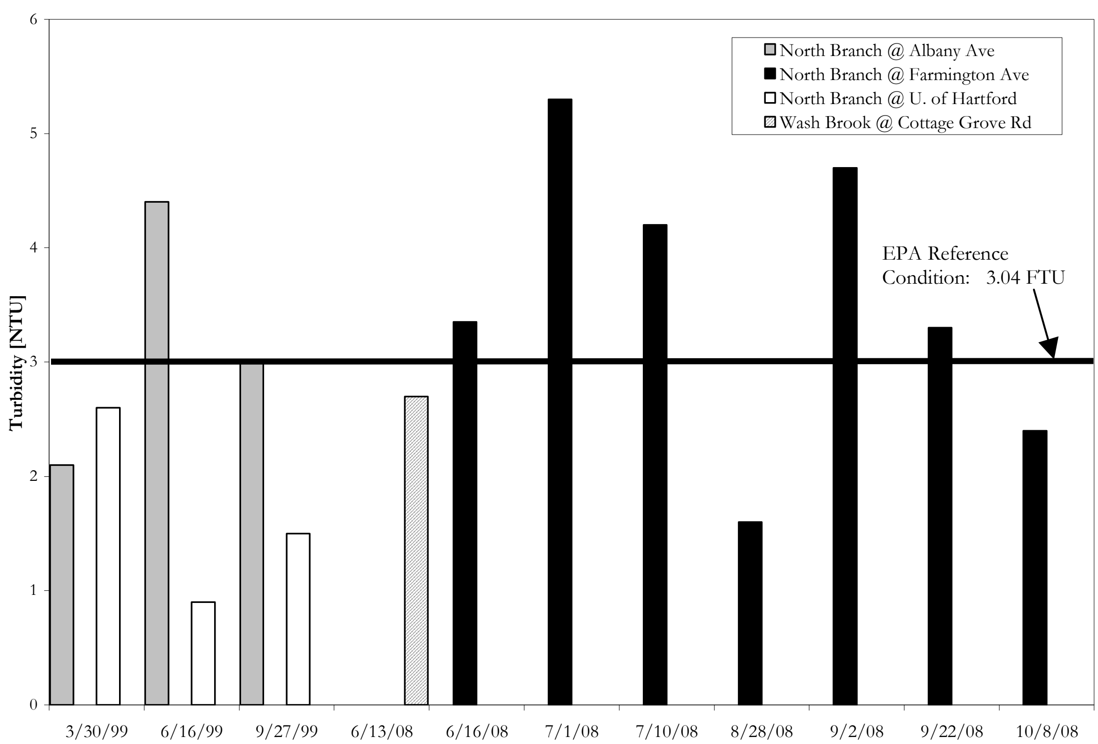


Figure 6-3. Turbidity – North Branch Park River Watershed

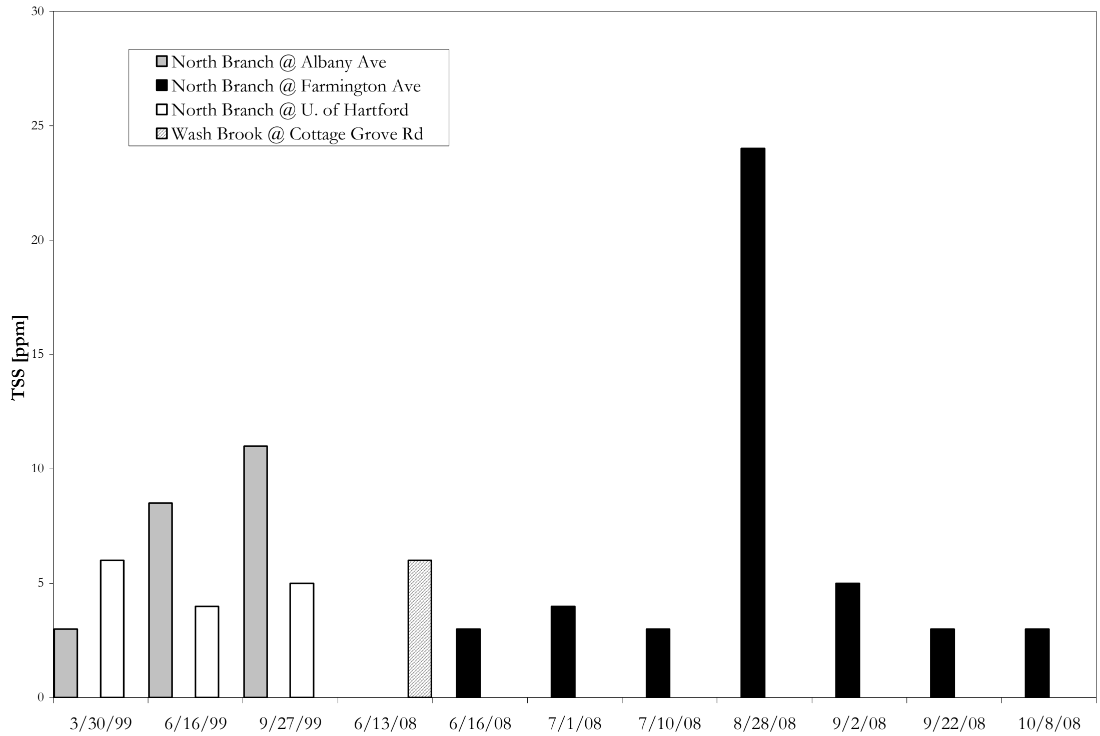


Figure 6-4. Total Suspended Solids (TSS) – North Branch Park River Watershed

6.3.3 Metals

Metals occur naturally in the environment, but human activities can alter their distribution. When metals are released into the environment in higher than natural concentrations they can be toxic and disrupt aquatic ecosystems. Metals in their dissolved form are typically more harmful (i.e., bioavailable) to aquatic organisms.

Dissolved copper was measured at two locations within the watershed on three occasions in 1999, and has not been sampled since. Both locations, at Albany Avenue and the University of Hartford, were found to have levels above the Connecticut Water Quality Standards freshwater chronic aquatic life limit of 4.8 micrograms per liter *(Figures 6-5*) during two of the three monitoring events. Biological integrity can be impaired when the ambient concentration of dissolved copper exceeds this value on more than 50 percent of days in any year (Connecticut Water Quality Standards, 2002). These elevated copper levels may result from stormwater runoff and combined sewer overflows.

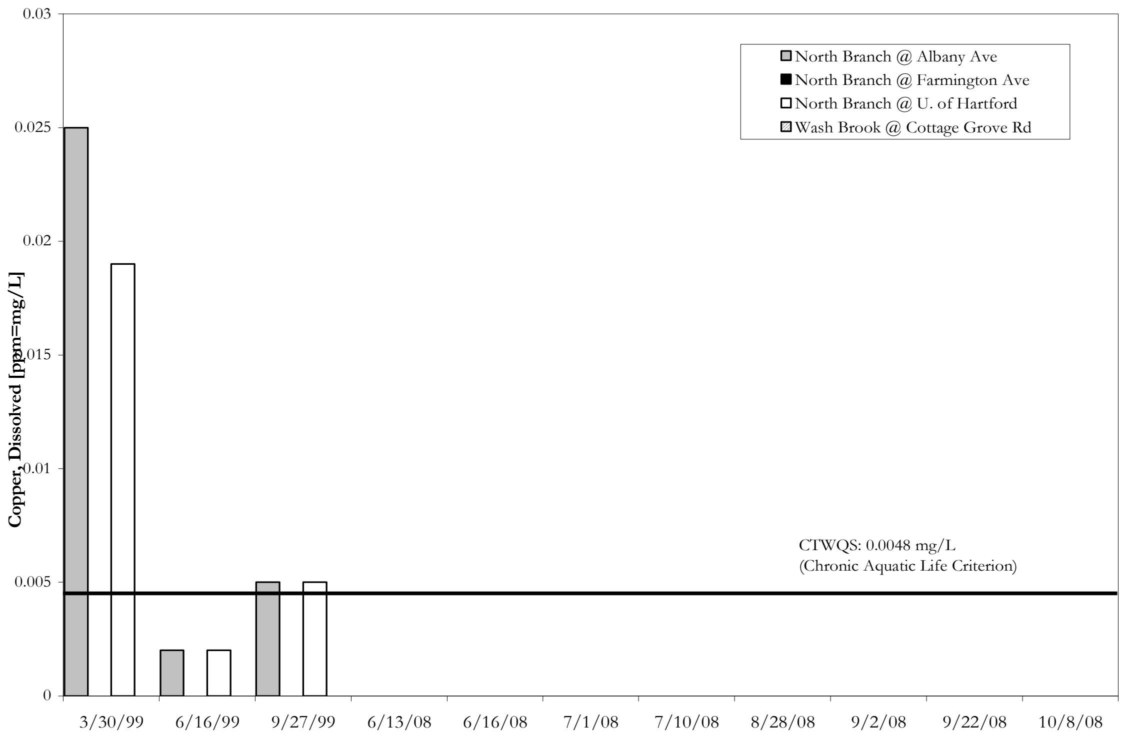


Figure 6-5. Dissolved Copper – North Branch Park River Watershed

Figure 6-6 summarizes dissolved lead concentrations at watershed sampling locations relative to the freshwater chronic aquatic life criterion of 1.2 micrograms per liter. None of the measured dissolved lead concentrations exceeded the criterion. Dissolved zinc concentrations were measured on three dates at two locations (Albany Avenue and University of Hartford) in 1999 (*Figure 6-7*). Of the six samples, two (one at each location) exceeded the freshwater chronic aquatic life criterion of 6.5 micrograms per liter.

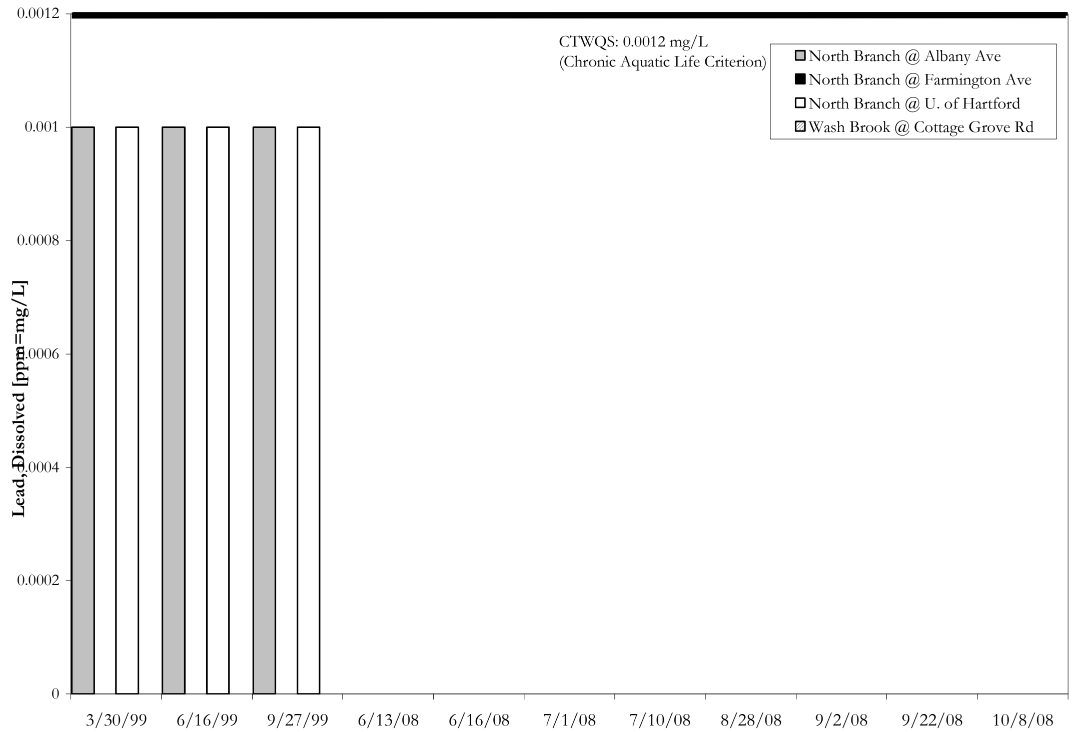


Figure 6-6. Dissolved Lead – North Branch Park River Watershed

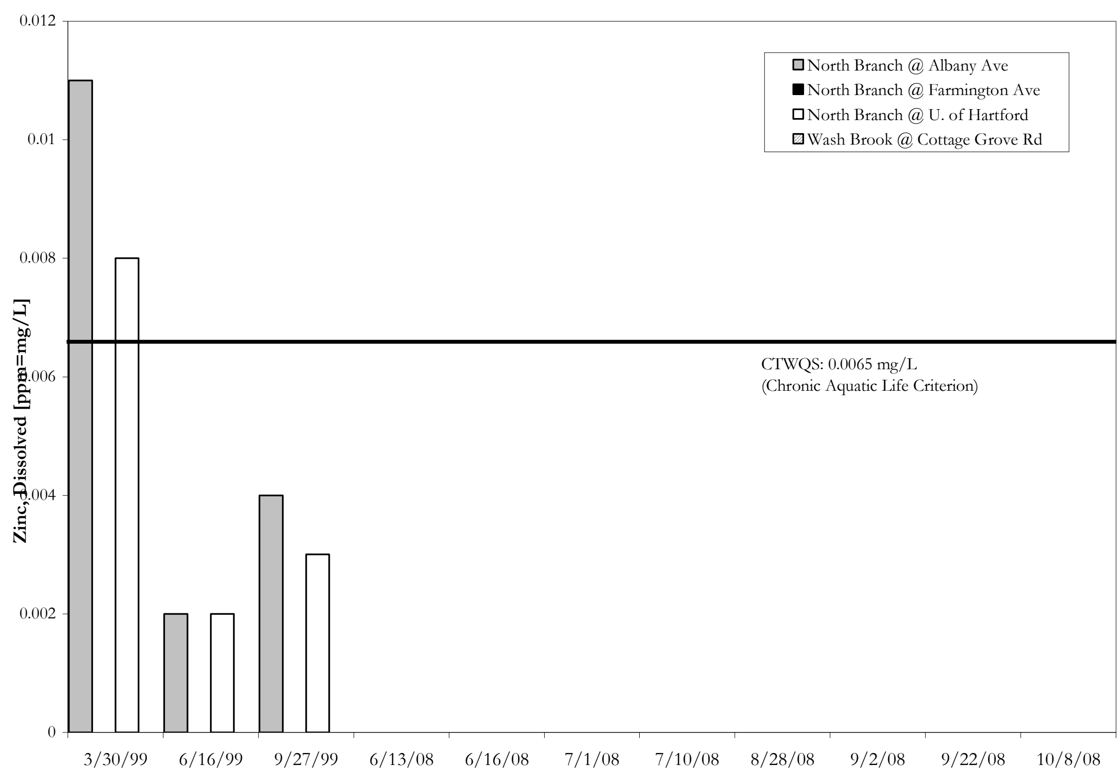


Figure 6-7. Dissolved Zinc – North Branch Park River Watershed

6.3.4 Nitrogen

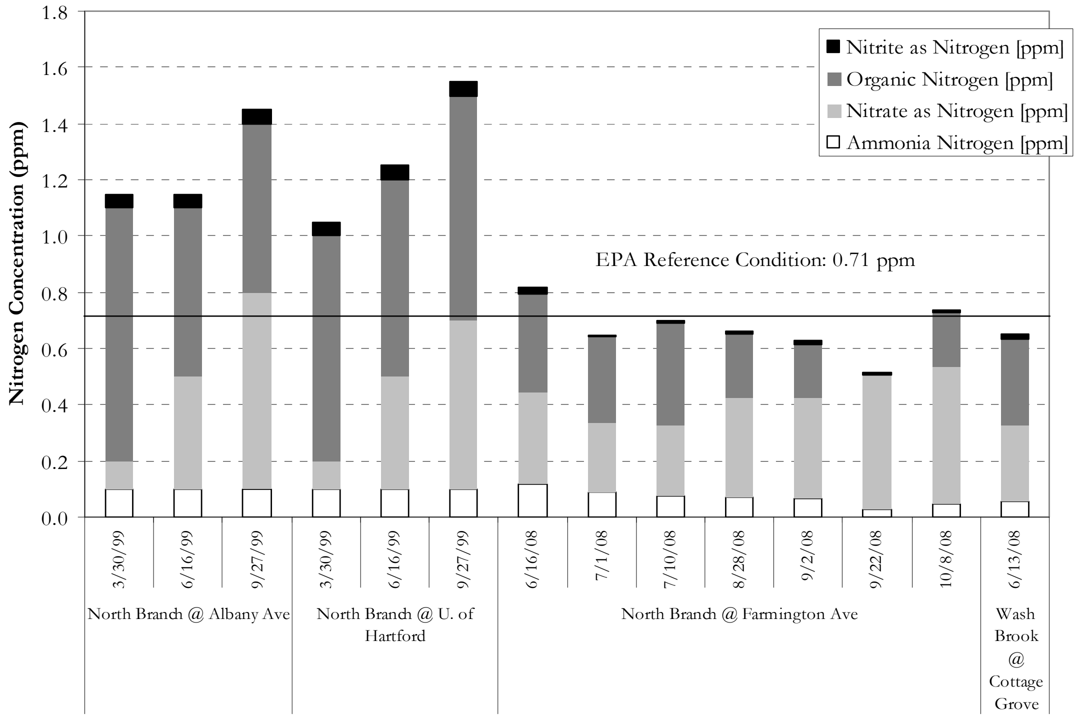
Nitrogen and phosphorus are the primary nutrients that enrich streams and rivers and cause nuisance levels of algae. Nutrients, especially phosphorus, are frequently the key stimulus to increased and excess algal biomass in many freshwaters. Nitrogen is more of a concern in marine systems and estuaries, such as the Lower Connecticut River and Long Island Sound to which the North Branch Park River eventually discharges.

The nitrogen species monitored within the watershed include ammonia, nitrate, nitrite, total nitrogen, nitrate and nitrite, and organic nitrogen. Total nitrogen can be calculated as the sum of ammonia, nitrate, and organic nitrogen, in addition to nitrite, which is rapidly converted to nitrate in surface waters. Total nitrogen levels measured at many of the monitoring locations exceeded the EPA reference criterion for rivers in Ecoregion XIV of 0.71 mg/L. This may reflect the significant contribution of nitrogen from sources in the watershed such as precipitation and atmospheric deposition, urban stormwater runoff, septic system effluent, and sewer overflows. *Figure 6-8* presents a subset of the total nitrogen data set for comparison with the EPA reference condition.

Organic nitrogen was the dominant nitrogen species at the Albany Avenue and University of Hartford sampling locations in 1999, although nitrate levels were similar to or greater than organic nitrogen levels at the Farmington River sampling location and in Wash Brook in 2008. However, organic nitrogen generally accounted for up to approximately 50% of all nitrogen in the collected samples.

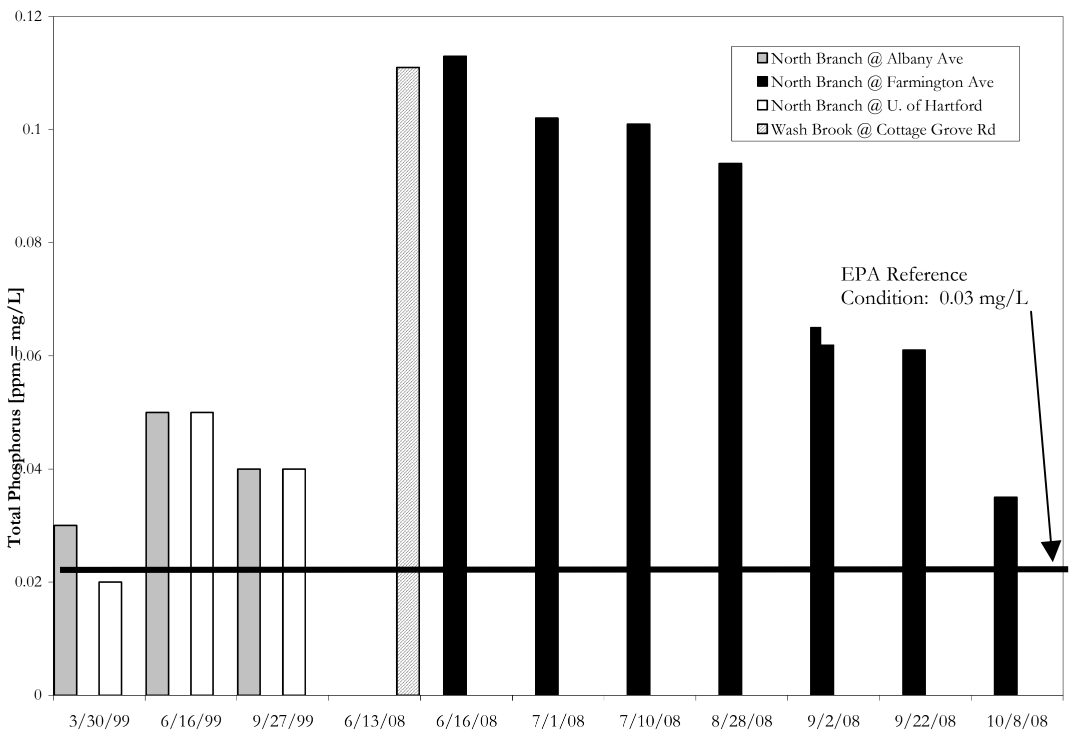
6.3.5 Phosphorus

Elevated phosphorus levels are an indicator of potential organic enrichment, which can enhance algal growth and impair aquatic life support and contact recreation under certain conditions. Total phosphorus concentrations measured at the four sampling locations (*Figure 6-9*) consistently exceeded the EPA reference criterion of 0.03 mg/L, which is also the Connecticut Water Quality Standards summer phosphorus concentration for lakes that would be expected to fully support contact recreational uses.



Note: Organic nitrogen data were unavailable for 9/22/08 at the Farmington Avenue sampling site.

Figure 6-8. Total Nitrogen – North Branch Park River Watershed



*Note: Samples dated 3/30/99-9/27/99 were analyzed using EPA Method 365.1 (Determination of Phosphorus by Semi-Automated Colorimetry), samples collected 6/13/08-10/8/08 we analyzed using EPA Method 365.4 (Phosphorous, Total (Colorimetric, Automated, Block Digester AA II)), both for Total Phosphorus

Figure 6-9. Total Phosphorus – North Branch Park River Watershed

6.3.6 Indicator Bacteria

Elevated levels of indicator bacteria (*Escherichia coli*) were measured at all monitoring locations sampled by the CTDEP (Wash Brook at Cottage Grove Road was not sampled for *Escherichia coli*). *Figure 6-10* presents *Escherichia coli* monitoring results. According to the Connecticut Water Quality Standards, Class AA, A, or B waters designated for freshwater recreational use have a single sample maximum criterion of 235 Colony Forming Units or CFU/100 ml of *Escherichia coli* for designated bathing areas, 410 CFU/100 ml for non-designated swimming areas, and 576 CFU/100 ml for other recreational uses. Since the North Branch Park River is not considered a bathing area (designated or non-designated), sample results are compared against the latter criterion (576 CFU/100 ml). Additionally, the maximum geometric mean criterion is 126 CFU/100 ml.

Determining the potential sources of indicator bacteria is difficult, especially since precipitation conditions prior to and during the sampling events are not known. Elevated bacteria levels during wet weather suggest stormwater runoff and other non-point sources (sewer overflows, pet waste, waterfowl, septic systems, etc.) as likely contributors of pathogens in the North Branch Park River and its tributaries. Alternately, elevated dry weather concentrations may be related to illicit discharges, septic system failures, or natural sources of bacteria such as waterfowl or wildlife. Samples collected at the Farmington Avenue (6/16/08) and University of Hartford (6/16/99) monitoring locations exceeded the single sample water quality standard of 576 CFU/100 ml.

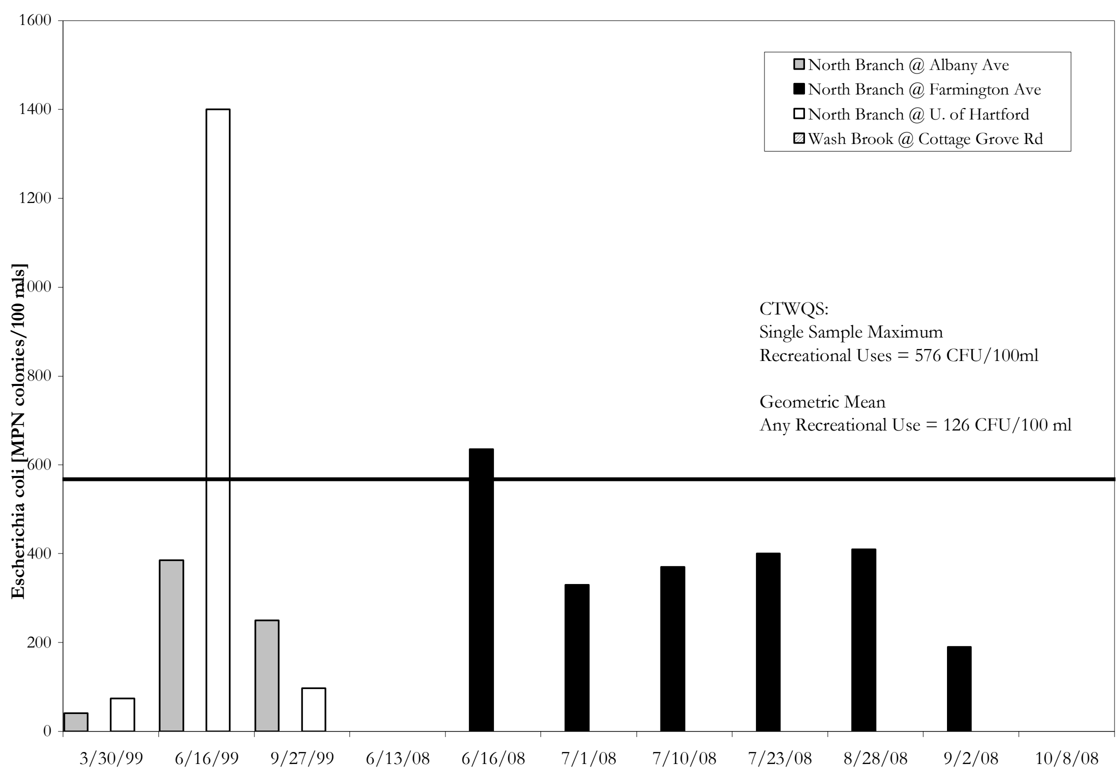


Figure 6-10. *Escherichia coli* – North Branch Park River Watershed

6.3.7 Bioassessments

The September 2008 RBV data generally indicate impacted water quality at the North Branch Park River monitoring locations, which suggests that the river is not fully supporting the state water quality standard for aquatic life. This finding is consistent with the impaired status of the North Branch Park River. No "most wanted" and a total of six "moderately wanted" macroinvertebrate types were found at the two assessment sites located on the North Branch Park River (Farmington Avenue and Watkinson School), while a total of nine "least wanted" types were noted. The CTDEP considers those locations where samples document 4 or more types of organisms in the "most wanted" category as fully supporting the state water quality standard for aquatic life.

6.4 Trinity College Monitoring Results

The results of the 2008 water quality monitoring project conducted by the Trinity College Environmental Science program (*Appendix D*) indicate relatively good water quality throughout most of the North Branch Park River watershed, except for Filley Brook where degraded water quality was observed (elevated chemical parameters, low dissolved oxygen, and physical observations of turbid water and a pungent odor). Chloride, nitrate and sulfate levels generally increased from the headwaters to the main stem of the North Branch Park River. Anion concentrations were elevated in Tumbledown Brook just downstream of the Wampanoag Golf Course, which may reflect impacts from golf course fertilizer runoff.

The Trinity College bioassessment results indicate fair to good water quality throughout the watershed. There was also little variability in the number (e.g., biotic index) or diversity of species (e.g., taxa richness) throughout the length of the river or over the duration of the monitoring event. Findings indicated that Wash Brook was the healthiest section of the watershed for both the number and diversity of aquatic macroinvertebrates. In general, the Beamans Brook and Tumbledown Brook tributaries were observed to have the greatest impacts. The Trinity College findings also indicate that the water quality in the North Branch Park River compared favorably to water quality measured by the program in the South Branch Park River (Gourley et al., 2008).

7 Land Use and Land Cover

The type and distribution of land use and land cover within a watershed has a direct impact on nonpoint sources of pollution and water quality. This section describes the current and potential future land use and land cover patterns in the watershed, and the implications for water quality and stream health.

7.1 Current Conditions

7.1.1 Land Use

Figure 7-1 depicts the generalized land use in the North Branch Park River watershed. The data in *Figure 7-1* are parcel-based land use categories for the watershed communities, provided by the Capital Region Council of Governments (CRCOG). The data include 20 land use categories, 14 of which are found in the watershed (*Table 7-1*). Approximately 63% of the watershed consists of developed land uses, with single-family residential comprising the largest percentage (27.3%). Highways and roads comprise approximately 8.2% of the watershed area. Commercial land use accounts for approximately 11% of the watershed area, with the majority of the commercial areas concentrated in the central and northern portions of the watershed along the Route 187/305 and Route 218 corridors in Bloomfield. Approximately 14% of the watershed is classified as undeveloped, while another 22.9% is classified as resource/recreation land use, including golf courses, conservation land, and other protected and unprotected open space. Large portions of the riparian areas adjacent to the North Branch Park River are located within resource/recreation areas.

Approximately 63% of the watershed consists of developed land uses, with single-family residential comprising the largest percentage (27.3%)

Development patterns and densities in the watershed are highly varied. The far western portion of the watershed is sparsely developed, with large undeveloped tracts of land in the West Hartford Reservoir subwatershed and Talcott Mountain State Forest area. The northern portions of the watershed are moderately developed, characterized by areas of low-density residential development, agricultural areas, golf courses, and flood control reservoirs. The northeast portion of the watershed contains large areas of former agricultural land that has been converted to commercial and industrial/office park land use along Route 187. The central and southern portions of the watershed are more densely developed with residential, institutional, and industrial land uses.

Figure 7-1

Table 7-1. Watershed Land Use

Land Use Category	Acres	Percent of Watershed
Agriculture	408	2.2%
Cemetery	27	0.1%
Commercial	1,947	10.6%
Government/Non-Profit	1,302	7.1%
Group Quarters	14	0.1%
Health/Medical	96	0.5%
Mixed Use	20	0.1%
Right-of-Way (ROW)	1,495	8.2%
Residential Multi-Family	1,132	6.2%
Residential Single-Family	5,010	27.3%
Resource/Recreation	4,192	22.9%
Undeveloped	2,600	14.2%
Unknown	7	0.0%
Water	71	0.4%

Source: Capitol Region Council of Governments (CRCOG), 2003

7.1.2 Zoning

Figure 7-2 depicts the existing zoning in the North Branch Park River watershed, which is based on a generalized compilation, prepared by the Capitol Region Council of Governments, of zoning districts and designations established by the watershed municipalities. The specific zoning districts across the watershed are highly variable because they are defined at the city or town level. The pattern of existing zoning largely reflects the existing pattern of residential, commercial, office, and industrial uses in the watershed. The majority of the watershed (76.7%) is zoned as residential (*Table 7-2*).

Table 7-2. Watershed Zoning

Zoning Category	Acres	Percent of Watershed
1-3 Unit Residential, Low Density	4,567	24.9%
1-3 Unit Residential, Medium Density	4,589	25.1%
1-3 Unit Residential, Medium-Low Density	4,895	26.7%
General Mixed Use	760	4.1%
Industrial	2,290	12.5%
Multi-Family	255	1.4%
Neighborhood Scale Commercial	63	0.3%
Planned Area Development Including Residential	55	0.3%
Planned Residential	487	2.7%
Public Land	1	<0.1%
Recreation	84	0.5%
Town Scale Commercial	265	1.4%

Source: Capitol Region Council of Governments (CRCOG), 2003

Figure 7-2

7.1.3 Land Cover

Figure 7-3 depicts the generalized land cover in the watershed. The data shown in *Figure 7-3* are land cover types derived from 2006 Landsat satellite imagery with a ground resolution of 30 meters. The land cover data in the watershed are classified into eleven categories (*Table 7-3*), which are used in the Connecticut Land Cover Map Series and described following the table (University of Connecticut Center for Land Use Education and Research).

Table 7-3. Watershed Land Cover

Land Cover Type	1985		2006		Relative Change in Percent of Watershed (%)[1]	Relative Change in Acreage (%)[2]
	Acres	Percent of Watershed	Acres	Percent of Watershed		
Developed	5,118	28%	5,966	33%	5%	17%
Turf & Grass	3,046	17%	3,361	18%	1%	10%
Other Grasses	413	2%	790	4%	2%	91%
Agriculture	2,261	12%	1,292	7%	-5%	-43%
Deciduous Forest	5,757	31%	5,200	28%	-3%	-10%
Coniferous Forest	861	5%	813	4%	-1%	-6%
Water	280	2%	255	1%	-1%	-9%
Non-forested Wetland	19	0%	20	0%	0%	6%
Forested Wetland	395	2%	364	2%	0%	-8%
Tidal Wetland	0	0%	0	0%	0%	0%
Barren Land	85	0%	174	1%	1%	105%
Utility ROWs	87	0%	88	0%	0%	1%

[1]Calculation = % land cover 2006 - % land cover 1985
[2]Calculation = (acres land cover 2006 - acres land cover 1985) / acres land cover 1985
Source: University of Connecticut Center for Land Use Education and Research (CLEAR)

The characteristics of each of these land cover types include the following:

- Barren Land– Mostly non-agricultural areas free from vegetation, such as sand, sand and gravel operations, bare exposed rock, mines, and quarries. Also includes some urban areas where the composition of construction materials spectrally resembles more natural materials. Also includes some bare soil agricultural fields.

- Coniferous Forest – Includes Southern New England mixed softwood forests. May include isolated low density residential areas.

- Deciduous Forest – Includes Southern New England mixed hardwood forests. Also includes scrub areas characterized by patches of dense woody vegetation. May include isolated low density residential areas.

Figure 7-3

* Developed – High density built-up areas typically associated with commercial, industrial and residential activities and transportation routes. These areas contain a significant amount of impervious surfaces, roofs, roads, and other concrete and asphalt surfaces.

* Forested Wetland – Includes areas depicted as wetland, but with forested cover. Also includes some small watercourses due to spectral characteristics of mixed pixels that include both water and vegetation.

* Non-forested Wetland – Includes areas that predominantly are wet throughout most of the year and that have a detectable vegetative cover (therefore not open water). Also includes some small watercourses due to spectral characteristics of mixed pixels that include both water and vegetation.

* Other Grasses – Includes non-maintained grassy areas commonly found along transportation routes and other developed areas and also agricultural fields used for both crop production and pasture.

* Turf & Grass – A compound category of undifferentiated maintained grasses associated mostly with developed areas. This class contains cultivated lawns typical of residential neighborhoods, parks, cemeteries, golf courses, turf farms, and other maintained grassy areas. Also includes some agricultural fields due to similar spectral reflectance properties.

* Utility ROWs – Includes utility rights-of-way. This category was manually digitized on-screen from rights-of-way visible in the Landsat satellite imagery. The class was digitized within the deciduous and coniferous categories only.

* Water – Open water bodies and watercourses with relatively deep water.

Between 1985 and 2006, the watershed experienced a 5% increase in developed land cover and a corresponding loss of agricultural land and forest.

A comparison of watershed land cover between 1985 and 2006 (*Table 7-2*) shows a moderate increase in watershed development during this period (9% increase in developed cover types) and a corresponding loss of agriculture (5% decrease) and forest (4% decrease). There was a significant percentage loss of barren land cover and percentage increase in other grasses; however these land cover categories comprise a very small percentage of the watershed area and could reflect construction or agricultural activity at the time the satellite data was obtained.

The North Branch Park River watershed is characterized by roughly equal amounts of forested and developed land cover. These land cover types are described below.

7.1.4 Forest Cover

Approximately 35% of the watershed consists of deciduous and coniferous forest cover, which is associated with open space, wooded portions of low-density residential properties, and forested wetlands. *Table 7-4* compares the total acreage and percentage of forest cover by subwatershed. The percent forest cover in each subwatershed ranges from a low of approximately 13% in the Filley Brook subwatershed to a high of approximately 80% in the West Hartford Reservoir subwatershed.

Table 7-4. Forest Cover - North Branch Park River Watershed

Subwatershed Name	Forest Cover in Subwatershed (acres)	Percent Forest Cover in Subwatershed	Developable Forest Cover in Subwatershed (acres)	Percent of Forest Cover that is Developable
Beamans Brook East	51	31%	20	39%
Beamans Brook West	195	16%	31	16%
Blue Hills Reservoir	411	40%	94	23%
Cold Spring Reservoir	646	56%	168	26%
Filley Brook	54	13%	15	28%
North Branch Park River	792	20%	166	21%
Tumbledown Brook	330	21%	68	21%
Tumbledown Brook South	486	30%	61	13%
Tunxis Reservoir	376	43%	67	18%
Wash Brook North	257	34%	102	40%
Wash Brook South	360	23%	93	26%
Wash Brook West	448	44%	79	18%
West Hartford Reservoir	1,645	80%	203	12%
Wintonbury Reservoir	326	37%	129	40%
Watershed (total)	**6,377**	**35%**	**1,297**	**20%**

Source: University of Connecticut's Center for Land Use Education and Research (CLEAR)

Based on literature threshold values documented in several studies (CLEAR, 2007), watershed forest cover of 65% or greater is typically associated with a healthy aquatic invertebrate community. Only one of the fourteen subwatersheds, West Hartford Reservoir, meets or exceeds this threshold value of 65%.

Based on a recommendation of the American Forests organization, 40% forest cover is a reasonable overall threshold goal for urban areas. The recommended tree canopy goal in suburban residential zones is 50%; the recommended goal for urban residential zones is 25%; and the recommended goal for central business districts is 15% due to constraints on open space typical of the urban environment (American Forests, 2009).

Watershed forest cover of 65% or greater is typically associated with a healthy aquatic invertebrate community, while 40% forest cover is a reasonable overall threshold goal for urban areas (American Forests, 2009).

Table 7-5 compares the existing forest cover in each subwatershed with the tree canopy goals recommended by American Forests for urban land use. The green shaded cells indicate subwatersheds that are currently at or above the 40% general tree canopy goal for urban areas and at or above their respective goal for specific urban land uses (i.e., suburban residential, urban residential, central business district). The gray shaded cells indicate subwatersheds that are currently below the 40% general tree canopy goal and below their respective goal for specific urban land uses. The watershed as a whole (35%) is slightly below the 40% tree canopy goal for urban areas. Note that while this analysis provides preliminary insight into the existing forest cover in the watershed and potential priorities for establishing urban tree canopy goals for the watershed, the results should be refined using more detailed tree canopy information gathered from field inventories or higher-resolution satellite imagery due to the relatively coarse resolution of the CLEAR land cover data.

Table 7-5. Comparison of Forest Cover and Tree Canopy Goals

Subwatershed Name	Percent Forest Cover in Subwatershed	American Forests Tree Canopy Goal
Beamans Brook East	31%	>50%
Beamans Brook West	16%	25-50%
Blue Hills Reservoir	40%	25-50%
Cold Spring Reservoir	56%	>50%
Filley Brook	13%	15-25%
North Branch Park River	20%	15-25%
Tumbledown Brook	21%	25-50%
Tumbledown Brook South	30%	25-50%
Tunxis Reservoir	43%	25-50%
Wash Brook North	34%	25-50%
Wash Brook South	23%	15-25%
Wash Brook West	44%	>50%
West Hartford Reservoir	80%	>50%
Wintonbury Reservoir	37%	25-50%
Watershed (total)	**35%**	**40%**

Source: Forest cover estimated from data provided by University of Connecticut's Center for Land Use Education and Research (CLEAR). Tree canopy goals recommended by American Forests, 2009.

7.1.5 Developed Areas

Developed land cover, characterized by significant amounts of impervious surfaces such as roofs, roads, and other concrete and asphalt surfaces, accounts for approximately 33% of the watershed. When considered together with the turf/grass land cover category (primarily cultivated lawns typical of residential neighborhoods, parks, cemeteries, golf courses, turf farms, and other maintained grassy areas), approximately 51% of the watershed land area consists of developed land cover types. The percentage of developed land cover (not including turf/grass) in each subwatershed (*Table 7-6*) ranges from approximately 5% in the West Hartford Reservoir subwatershed to approximately 57% in the North Branch Park River subwatershed.

Table 7-6. Developed Land Cover by Subwatershed

Subwatershed Name	Developed Land Cover in Subwatershed (acres)	Percent Developed Land Cover in Subwatershed (%)
Beamans Brook East	32	20%
Beamans Brook West	466	39%
Blue Hills Reservoir	299	29%
Cold Spring Reservoir	237	21%
Filley Brook	208	52%
North Branch Park River	2,295	57%
Tumbledown Brook	466	30%
Tumbledown Brook South	477	29%
Tunxis Reservoir	181	21%
Wash Brook North	226	30%
Wash Brook South	615	39%
Wash Brook West	168	16%
West Hartford Reservoir	96	5%
Wintonbury Reservoir	198	22%
Watershed (total)	**5,966**	**33%**

Source: University of Connecticut's Center for Land Use Education and Research (CLEAR)

7.1.6 Impervious Cover

Impervious cover has emerged as a measurable, integrating concept used to assess the overall condition of a watershed. Numerous studies have documented the cumulative effects of urbanization on stream and watershed ecology (Center for Watershed Protection, 2003; Schueler et al., 1992; Schueler, 1994; Schueler, 1995; Booth and Reinelt, 1993, Arnold and Gibbons, 1996; Brant, 1999; Shaver and Maxted, 1996). Research has also demonstrated similar effects of urbanization and watershed impervious cover on downstream receiving waters such as lakes, reservoirs, estuaries, and coastal areas.

Impervious cover has emerged as a measurable, integrating concept used to assess the overall condition of a watershed. These research findings have been integrated into a general watershed planning model known as the Impervious Cover Model (ICM).

The correlation between watershed impervious cover and stream indicators is due to the relationship between impervious cover and stormwater runoff, since streams and receiving water bodies are directly influenced by stormwater quantity and quality. Although well-defined imperviousness thresholds are difficult to recommend, research has generally shown that when impervious cover in a watershed reaches between 10 and 25 percent, ecological stress becomes clearly apparent. Between 25 and

60 percent, stream stability is reduced, habitat is lost, water quality becomes degraded, and biological diversity decreases (NRDC, 1999). Watershed imperviousness in excess of 60 percent is generally indicative of watersheds with significant urban drainage. *Figure 7-4* illustrates this effect. These research findings have been integrated into a general watershed planning model known as the Impervious Cover Model (ICM) (CWP, 2003).

Figure 7-4 also demonstrates the wide variability in stream response found in less-urban watersheds at lower levels of impervious cover (generally less than 10 percent). Stream quality at lower range of impervious cover is generally influenced more by other watershed metrics, such as forest cover, road density, extent of riparian vegetative cover, and cropping practices. Less variability exists in the stream quality at higher levels of impervious cover because most streams in highly impervious, urban watersheds exhibit fair or poor stream health conditions, regardless of other conditions (CWP, 2008).

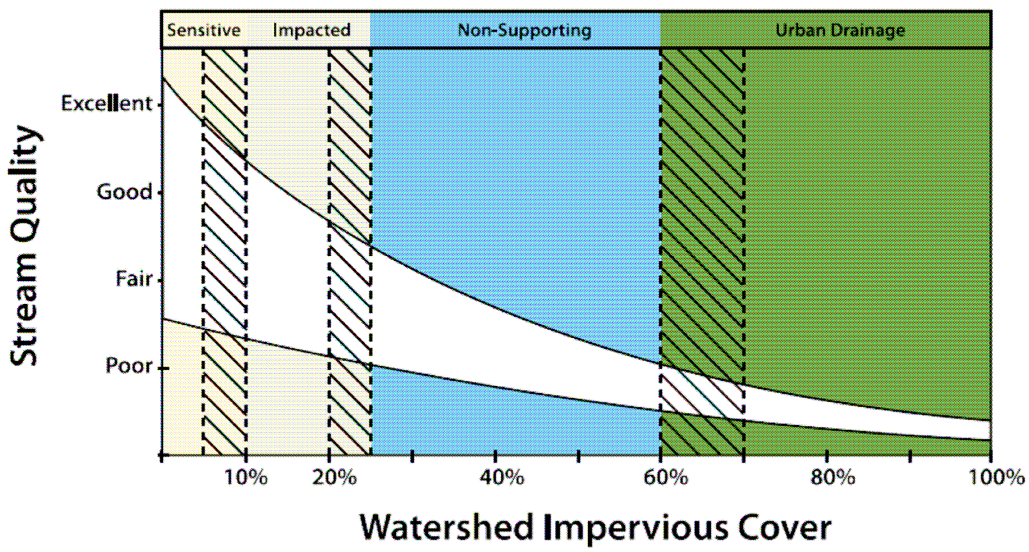


Figure 7-4. Conceptual Model Illustrating Relationship Between Watershed Impervious Cover and Stream Quality

A GIS-based impervious cover analysis was performed for the North Branch Park River watershed. The impervious cover acreage was calculated through direct measurement of buildings, parking lots, and roads from available GIS mapping of the watershed. Driveway areas in residential subdivisions were estimated using typical driveway dimensions based on parcel sizes and building density. The percent imperviousness by basin was calculated using the subwatershed GIS layer. *Figure 7-5* graphically summarizes the results of this analysis.

The overall impervious cover of the North Branch Park River watershed is estimated at approximately 15% (*Table 7-5*), which exceeds the 10% threshold in the ICM where ecological stress and stream impacts become apparent. As shown in *Figure 7-5*, impervious cover is generally highest (20% to 36%) in the urbanized central (Bloomfield) and southeastern portion (Hartford) of the watershed. Impervious cover in most of the residential areas of the watershed generally ranges from less than 10% up to 19.9%.

Figure 7-5

Figure 7-5 and *Table 7-7* summarize estimates of impervious cover by subwatershed. Most of the subwatersheds fall into the "impacted" category (impervious cover between 10 and 25%) according to the ICM. Several of the subwatersheds have significantly less than 10% impervious cover, including the Wash Brook West and West Hartford Reservoir subwatersheds. The North Branch Park River subwatershed has the highest impervious cover (27.9%), which is consistent with the high-density development in this portion of the watershed and indicative of degraded stream conditions according to the ICM.

Table 7-7. Existing Subwatershed Impervious Cover

Subwatershed	Percent Impervious Cover[1]
Beamans Brook East	9.6%
Beamans Brook West	16.6%
Blue Hills Reservoir	14.9%
Cold Spring Reservoir	6.2%
Filley Brook	22.6%
North Branch Park River	27.9%
Tumbledown Brook	13.5%
Tumbledown Brook South	11.5%
Tunxis Reservoir	9.3%
Wash Brook North	18.2%
Wash Brook South	17.5%
Wash Brook West	5.7%
West Hartford Reservoir	1.1%
Wintonbury Reservoir	13.2%
Watershed (total)	**15.0%**

Source: Metropolitan District Commission GIS data, CT DEP GIS data.
[1]Percent impervious cover calculated based on total impervious area (TIA).

The results of this analysis provide an initial diagnosis of potential stream and receiving water quality within the watershed study area. The analysis method and ICM are based on several assumptions and caveats, which limits its application to screening-level evaluations. Some of the assumptions of the ICM include:

- Requires accurate estimates of percent impervious cover, which is defined as the total amount of impervious cover over a subwatershed area.
- Predicts potential rather than actual stream quality.
- Does not predict the precise score of an individual stream quality indicator but rather predicts the average behavior of a group of indicators over a range of impervious cover.
- The 10 and 25% thresholds are approximate transitions rather than sharp breakpoints.
- Does not currently predict the impact of watershed best management practices (treatment or non-structural controls).

- Does not consider the geographic distribution of the impervious cover relative to the streams and receiving waters. Effective impervious cover (impervious cover that is hydraulically connected to the drainage system) has been recommended as a better metric, although determining effective impervious cover requires extensive and often subjective judgment as to whether it is connected or not.
- Impervious cover is a more robust and reliable indicator of overall stream quality beyond the 10 percent threshold. The influence of impervious cover on stream quality is relatively weak compared to other potential watershed factors such as percent forest cover, riparian community, historical land use, soils, agriculture, etc. for impervious cover less than 10 percent.
- Use should be restricted to 1st to 3rd order alluvial streams with no major point sources of pollutant discharge and no major impoundments or dams.
- Stream slope, as measured across the subwatershed, should be in the same range for all subwatersheds.
- Management practices in the contributing watershed must be good (e.g. no deforestation, acid mine drainage, major point sources, intensive row crops, etc.).

7.1.7 Open Space

Open space areas were identified based on data compiled and published by the CTDEP, including federal land, state-owned property, and other municipal and private open space. Additionally, MDC watershed land associated with West Hartford Reservoir No. 6 were included as protected open space. Approximately 23% of the watershed consists of protected open space that is primarily conservation land and public parks (*Figure 7-6*). This land is protected against future development. In addition, recreational open space (golf courses, and private institutional open space) accounts for another 5% to 10% of the watershed area (*Figure 7-1*). Future development of these parcels is unlikely, unless their continued use becomes threatened. Additional privately held natural open space exists on already subdivided parcels and large estates.

The Town of Bloomfield, which comprises the majority of the land area in the watershed, has a total of approximately 1,800 acres set aside as open space, including school and park land that is used for both active and passive recreation. In addition to locally-controlled land, the state owns and manages a number of areas within the Town including Penwood State Park, West Hartford Reservoir No. 6, Talcott Mountain State Park, Cold Spring Flood Water Retention Reservoir and Dam, and the Wintonbury Flood Water Retention Reservoir and Dam. Public open space constitutes approximately 20% of the Town of Bloomfield.

Some of the notable or sizable open space areas within the watershed include:

- Samuel Wheeler Reed Park: (School Street, Bloomfield) hiking trails, passive recreation in the eastern portion of the watershed
- LaSalette Open Space: (120 Mountain Avenue, Bloomfield) located in a central area of the watershed, amenities include fishing, gardens/flowers, hiking trails, passive recreation, pond and Captain Oliver Filley House

Figure 7-6

- Wintonbury Flood Water Retention Reservoir No. 1 and Dam: (Bloomfield) located in the northeastern portion of the watershed
- Blue Hills Water Retention Reservoir No. 2: (Blue Hills Avenue, Bloomfield) located in the eastern section of the watershed, this area includes hiking trails, passive recreation, brooks, a radio-control model airplane flying field operated by Wintonbury Flying Club
- Tunxis Flood Water Retention Reservoir No. 3: (Tunxis Avenue) located in the northern section of the watershed, this area offers fishing, ponds, gardens/flowers, hiking trails, passive recreation, picnic area, tennis courts, and community gardens
- Cold Spring Flood Water Retention Reservoir and Dam: (Bloomfield) located in the western half of the watershed.
- Penwood State Park: (Gun Mill Road, Bloomfield) nearly 800 acres of maintained hiking/cross country skiing trials, biking, and picnic areas located in the western side of the watershed. It contains colorful wildflowers such as trillium, dutchman's breeches, hepatica, bloodroot, and trailing arbutus. Pileated woodpecker, turkey vulture, and bald eagle also inhabit this area.
- Talcott Mountain State Park:(Route 185, Bloomfield) approximately 557 acres of maintained hiking trails including the 1.25-miles Tower Trail leading to the 165 foot, Heublein Tower. Wildlife found in the area includes deer, fox, rabbits, turkey vulture, bald eagle, and pileated woodpecker. Flora includes wildflowers such as trillium, trout lily, wood anemone, and Dutchman's breeches. This state-owned park is located in the western portion of the watershed
- Filley Park: (Tunxis Avenue, Bloomfield) located in the center of the watershed, this park includes an elderly & children's fishing pond, garden/flowers, Scott Trail, winter ice-skating area with warming shelter.
- West Hartford Reservoir No. 6: (Route 44, West Hartford) this 3,000 acre parcel, located in the southwestern portion of the watershed, contains reservoirs, vast woodlands, and hiking, jogging, biking, cross-country skiing, and snow shoeing trails.
- Fisher Meadows Recreation Area: (West Hartford)
- Meadows Park: (West Hartford)
- Eisenhower Park: (Sheep Hill Drive, West Hartford) This parcel contains a playground, basketball courts, and ball fields.
- Elizabeth Park: (corner of Prospect Avenue and Asylum Avenue, West Hartford/Hartford) a horticultural park encompassing 102 acres located in the southern area of the watershed. This parcel contains garden areas, pathways, greenhouses, lawns, a picnic grove, a pond and recreation areas.

The Wintonbury Land Trust maintains various open space areas throughout the watershed with plans to preserve additional areas. The Land Trust's major property holdings in the watershed include Capewell Greene (21 acres, Adams Road, Bloomfield) and Sinnot Farm Knoll (29 acres, Terry Plains, Bloomfield).

7.2 Future Conditions

7.2.1 Watershed Buildout Analysis

A watershed buildout analysis was conducted to estimate future potential land use and impervious cover conditions in the watershed as a result of maximum development allowed by current zoning.

7.2.1.1 Land Use

Watershed lands that could be developed in the future (i.e., "developable" land) were subdivided into two categories, based on the CRCOG parcel-based land use data:

- *New Development* - areas that are currently undeveloped and could be developed in the future. New development parcels include those that are designated as "undeveloped" and "unknown" in the CROCG land use data and not identified as protected open space.

- *Redevelopment* - areas that that have existing development, but are below the allowable maximum lot coverage based on current zoning. Commercial and industrial parcels were included in the analysis. Existing residential lots in well-established subdivisions were excluded from the analysis since they are unlikely to be redeveloped.

Areas having the following physical and/or regulatory constraints were also removed from consideration for future development or redevelopment: water bodies, wetland soils, slopes exceeding 25%, and areas in the FEMA-designated 100-year flood zone. *Table 7-8* and *Figure 7-7* summarize the amount of developable land by subwatershed, including the new development and redevelopment categories.

Table 7-8. Developable Land – North Branch Park River Watershed

Subwatershed	New Development (acres)	New Development Percent in Subwatershed	Redevelopment (acres)	Redevelopment Percent in Subwatershed
Beamans Brook East	12	7.2%	65	39.7%
Beamans Brook West	60	5.0%	90	7.6%
Blue Hills Reservoir	60	5.8%	353	34.1%
Cold Spring Reservoir	166	14.4%	117	10.1%
Filley Brook	20	4.8%	53	13.1%
North Branch Park River	188	4.7%	412	10.2%
Tumbledown Brook	45	2.9%	346	22.1%
Tumbledown Brook South	175	10.8%	12	0.7%
Tunxis Reservoir	27	3.1%	158	18.1%
Wash Brook North	98	12.8%	271	35.6%
Wash Brook South	100	6.4%	347	22.2%
Wash Brook West	112	10.9%	170	16.5%
West Hartford Reservoir	234	11.4%	23	1.1%
Wintonbury Reservoir	126	14.1%	188	21.1%
Watershed (Total)	**1,422**	**7.8%**	**2,605**	**14.2%**

Figure 7-7

The future land use buildout scenario was estimated by assigning new land uses to developable areas, while maintaining the existing land uses for developed and unbuildable land (wetland soils, steep slope soils, floodplains and committed open space). The developable areas were assigned a future land use based on maximum degree of development allowed by existing zoning. Parcels that were developed prior to the promulgation of the existing zoning categories and regulations and may have a land use that is inconsistent with existing zoning. The current land use of these existing, non-conforming parcels is assumed to remain the same under future conditions for the purpose of this analysis.

Table 7-9 summarizes the future land use category assigned to each developable parcel based on the existing zoning. This analysis assumes development of Public Act 490 (which provides tax incentives to preserve farmland, forest and open space land) parcels consistent with the underlying zoning and does not account for future zone changes or future land development regulatory changes.

Table 7-9. Assigned Future Land Use Categories

Zoning Category	Assigned Future Land Use
1-3 Unit Residential, Low Density	Single-Family
1-3 Unit Residential, Medium Density	Single-Family
1-3 Unit Residential, Medium-Low Density	Single-Family
Multi-Family	Multi-Family
Planned Residential	Multi-Family
Planned Area Development Including Residential	Mixed Use
Industrial	Industrial
General Mixed Use	Mixed Use
Neighborhood Scale Commercial	Commercial
Town Scale Commercial	Commercial
Recreation	Resource/Recreation

The results of the watershed buildout analysis are summarized in *Table 7-10*, which compares acreage of existing and future land use in the watershed. Single-family residential and industrial land uses are predicted to increase by 13.5% and 9.4%, respectively. The majority of the increase in industrial land use is anticipated to occur in the northeast portion of the watershed, in an area of Bloomfield along Blue Hills Avenue (State Route 187) that is zoned for industrial use and is now largely undeveloped except for limited commercial development.

Approximately 4.7% of the existing commercial land use could be converted to industrial use in this area. There are also large areas of Bloomfield that are currently undeveloped and are zoned for low to medium density single-family residential use. The overall amount of resource/recreation and undeveloped land in the watershed is predicted to decrease by 42%.

Table 7-10. Watershed Buildout Analysis Results

Land Use	$Acres_{Existing}$	Percent of $Basin_{Existing}$	$Acres_{Future}$	Percent of $Basin_{Future}$	Relative Percent Change[1]
Agriculture	408	2.2%	84	0.5%	-1.8%
Cemetery	27	0.1%	26	0.1%	0.0%
Commercial	1947	10.6%	1086	5.9%	-4.7%
Government/Non-Profit	1302	7.1%	1114	6.1%	-1.0%
Group Quarters	14	0.1%	10	0.1%	0.0%
Health/Medical	96	0.5%	68	0.4%	-0.2%
Industrial	0	0.0%	1721	9.4%	9.4%
Mixed Use	20	0.1%	99	0.5%	0.4%
Multi-Family	1132	6.2%	1147	6.3%	0.1%
Single-Family	5010	27.3%	7478	40.8%	13.5%
Resource/Recreation	4192	22.9%	3570	19.5%	-3.4%
ROW	1495	8.2%	1495	8.2%	0.0%
Undeveloped	2600	14.2%	347	1.9%	-12.3%
Unknown	7	0.0%	7	0.0%	0.0%

[1]Calculation = % land use $_{future}$ - % land use $_{existing}$

7.2.1.2 Impervious Cover

The results of the watershed buildout and existing conditions impervious cover analyses were used to estimate future impervious cover in the North Branch Park River watershed. The difference between existing and future impervious cover was calculated as the potential increase in lot coverage for the developable parcels in the watershed. Future impervious cover for new development and redevelopment parcels was assumed equal to the maximum coverage allowed by zoning.

Table 7-10 presents estimates of existing and future impervious cover by subwatershed. The blue shaded cells in the table highlight the subwatersheds for which impervious cover is predicted to change from "sensitive" (< 10% impervious cover) or "impacted" (10% to 25% impervious cover) to the "non-supporting" (25% to 60% impervious cover) category as described by the Impervious Cover Model. The Beamans Brook East subwatershed has the greatest predicted percent increase in impervious cover at nearly 50%, crossing the threshold from "sensitive" to "non-supporting." The gray shaded cells in the table highlight the subwatersheds for which impervious cover is predicted to change from "sensitive" to "impacted." The Cold Spring Reservoir, Tunxis Reservoir, and Wash Brook West subwatersheds are currently classified as "sensitive" but are predicted to exceed the "impacted" threshold under a future buildout scenario. Based on this analysis, the overall impervious cover in the North Branch Park River watershed is predicted to increase from 15.0% to 22.2% which is approaching the threshold for a "non-supporting" watershed.

Table 7-11. Percent Impervious Cover – Existing and Future Conditions

Subwatershed	Existing Percent Impervious Cover	Future Percent Impervious Cover	Percent Change (IC_{Future} - $IC_{Existing}$)
Beamans Brook East	9.6%	56.5%	46.9%
Beamans Brook West	16.6%	20.4%	3.8%
Blue Hills Reservoir	14.9%	27.3%	12.4%
Cold Spring Reservoir	6.2%	11.9%	5.7%
Filley Brook	22.6%	26.2%	3.6%
North Branch Park River	27.9%	33.0%	5.1%
Tumbledown Brook	13.5%	29.5%	16.0%
Tumbledown Brook South	11.5%	15.2%	3.7%
Tunxis Reservoir	9.3%	12.4%	3.1%
Wash Brook North	18.2%	36.5%	18.3%
Wash Brook South	17.5%	24.0%	6.5%
Wash Brook West	5.7%	13.3%	7.6%
West Hartford Reservoir	1.1%	2.4%	1.3%
Wintonbury Reservoir	13.2%	24.7%	11.5%
Watershed (total)	**15.0%**	**22.2%**	**7.2%**

Another useful metric was developed by Goetz et al. (2003) for the Chesapeake Bay region, which combines subwatershed impervious cover and tree cover within the 100-foot stream buffer. Each of the subwatersheds within the North Branch Park River watershed was analyzed with regard to the combined impervious cover/riparian zone metric, which is summarized in *Table 7-21* by Goetz et al. (2003).

Table 7-12. Impervious Cover/Riparian Zone Metric

Stream Health	% Watershed Impervious Cover	% Natural Vegetation in 100-ft Stream Buffer
Excellent	< = 6%	>=65%
Good	6-10%	60-65%
Fair	10-25%	40-60%
Poor	> 25%	< 40%

The existing areas of natural vegetation were determined using the 2006 CLEAR land cover data. Natural vegetation was defined to include the deciduous forest, coniferous forest, forested wetland, and non-forested wetland categories. The future natural vegetation was determined to be areas within the 100 foot stream buffer that are currently vegetated and are not included in the potentially developable land areas identified in the buildout analysis. The Town of Bloomfield has a recommended riparian buffer of 75 feet along the banks of perennial streams, which was considered protected land in this analysis. (The Town of West Hartford does not have a riparian buffer recommendation in their zoning regulations, and negligible developable land exists within the riparian area in the Hartford portion of the watershed.) *Table 7-13* presents the results of the combined impervious cover/riparian zone metric for existing and future conditions. The color shading in the table corresponds to the metric classifications in *Table 7-11*.

Table 7-13. Impervious Cover/Riparian Zone Metric – Existing and Future Conditions

Subwatershed	Existing		Future	
	% Watershed Impervious Cover	% Natural Vegetation in 100-ft Stream Buffer	% Watershed Impervious Cover	% Natural Vegetation in 100-ft Stream Buffer
Beamans Brook East	10%	48%	56%	38%
Beamans Brook West	17%	48%	20%	43%
Blue Hills Reservoir	15%	61%	27%	56%
Cold Spring Reservoir	6%	64%	12%	58%
Filley Brook	23%	51%	26%	45%
North Branch Park River	28%	48%	33%	37%
Tumbledown Brook	14%	39%	29%	35%
Tumbledown Brook South	12%	40%	15%	32%
Tunxis Reservoir	9%	74%	12%	66%
Wash Brook North	18%	70%	36%	57%
Wash Brook South	18%	44%	24%	36%
Wash Brook West	6%	62%	13%	48%
West Hartford Reservoir	1%	86%	2%	77%
Wintonbury Reservoir	13%	73%	25%	67%
Watershed (total)	**15%**	**55%**	**22%**	**47%**

Currently, the North Branch Park River subwatersheds are highly varied and are categorized as "excellent" to "poor" based on the riparian zone metric published by Goetz et al. (2003). The Cold Spring Reservoir, Tunxis Reservoir, Wash Brook West, and West Hartford Reservoir subwatersheds are rated as "excellent" or "good" based on the combined impervious cover/riparian zone metrics. The North Branch Park River and Tumbledown Brook subwatersheds have a "poor" rating for at least one of the metrics.

Under a watershed buildout scenario, many of the subwatersheds are predicted to experience a decline in stream health as a result of increases in impervious cover and development within the riparian corridor. One or both of the metrics are predicted to decline from a "good" or "fair" rating to a "poor" rating for the Beamans Brook East, Blue Hills Reservoir, Filley Brook, North Branch Park River, Tumbledown Brook, Tumbledown Brook South, Wash Brook North, and Wash Brook South subwatersheds.

8 Existing Watershed Practices

This section summarizes existing management practices in the watershed that could impact water quality in the North Branch Park River and its tributaries, focusing on municipal, institutional, and commercial/industrial practices. Additional information on residential, commercial, and municipal practices gathered through field assessments of upland areas in the watershed will be presented in a separate, companion report to this baseline assessment document.

8.1 Municipal Phase II Stormwater Program

The CTDEP regulates stormwater discharges from municipalities in designated urbanized areas under the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4). The MS4 General Permit requires municipalities to register with CTDEP, develop and implement a Stormwater Management Plan that addresses six minimum control measures, and annually collect stormwater samples for representative industrial, commercial, and residential land uses. The six minimum control measures include public education and outreach, public participation, illicit discharge detection/elimination, construction stormwater management, post-construction stormwater management, and pollution prevention/good housekeeping. The CTDEP is currently in the process of revising and reissuing the MS4 General Permit.

The municipalities within the North Branch Park River watershed are regulated under the General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4).

The municipalities within the North Branch Park River watershed are regulated under the MS4 General Permit. The discussion in this section is limited to the communities of Hartford, West Hartford, and Bloomfield since these municipalities comprise the majority of the watershed land area and have the greatest potential to impact water quality resulting from the discharge of urban stormwater runoff. The following sections summarize current and ongoing municipal stormwater management practices in Hartford, West Hartford, and Bloomfield as described in the Stormwater Management Plans and most recent annual reports prepared by each municipality. An evaluation of local land use regulations, including local stormwater management regulatory requirements, will be presented in a separate, companion report to this baseline assessment document.

8.1.1 Hartford

Much of the City of Hartford's stormwater system is maintained by the Metropolitan District Commission (MDC). Portions of the stormwater system are combined with the sanitary sewer system. The City of Hartford's Stormwater Management Plan applies to the areas in the City that have separate sewer and stormwater drainage systems. Compliance with the MS4 General Permit has been a combined effort between the City of Hartford and the MDC. The City works collaboratively with the MDC in implementing their Stormwater Management Plan. This collaborative effort is documented in a Memorandum of Understanding (MOU) between the City and MDC. The City's stormwater management-related activities and practices are summarized as follows:

- The MDC has developed ordinances against illicit discharges to the stormwater system. Additionally, the City is in the process of developing procedures for eliminating illicit discharges.
- Trash is collected along river corridors during summer months, and the MDC participates as a partner in the annual Connecticut River Watershed Council's volunteer-based "Source to the Sound" cleanup.
- A goal of stenciling or re-stenciling 1,000 catch basins per year, beginning in 2004, is set to identify catch basins which drain to a watercourse. The stenciling is intended to discourage illegal dumping into storm drainage systems.
- The MDC held two household hazardous waste collection days in Hartford in 2008, during which 302 households participated and approximately 30,000 pounds of waste was collected.
- The MDC implements a catch basin inspection and maintenance program. During inspections, the MDC evaluates the catch basin for structural damage and cleanliness. Work Orders are generated as needed for maintenance requirements.
- Catch basins in the drainage system throughout the City are maintained through catch basin cleaning using vacuum trucks. Over 4,000 (more than 60 percent) catch basins were cleaned in 2008.
- Street sweeping is performed regularly throughout the City. Downtown streets are swept three times per week, residential streets once per week, and major City facilities once per year.
- The City conducts annual stormwater training for DPW staff, while the MDC conducts stormwater training for selected operational staff.
- In 2008 the MDC began "the MDC Community Forum Series" to allow communities to meet with MDC management to discuss the Clean Water Project, which includes a component on stormwater management.

As discussed in Section5 of this baseline assessment report, the MDC and the City of Hartford are evaluating the use of green infrastructure approaches and low impact development (LID) to further manage wet weather flows, including storm runoff volume and quality. Such practices include the installation of rain gardens, open channels/swales, and pervious pavements which promote the infiltration of runoff into the soil instead of directing it into the storm and/or combined sewer system.

8.1.2 West Hartford

In accordance with their Stormwater Management Plan, the Town of West Hartford has implemented best management practices to meet each of the six minimum control measures, including but not limited to public education, post-construction stormwater management, and pollution prevention and good housekeeping. All paved streets are swept once per year at a minimum, and in 2007 approximately 2,800 catch basins were cleaned. Magnesium chloride is used for roadway de-icing in West Hartford to reduce the use of road sand. An effort to replace existing catch basin covers with new covers labeled "Drains to Watercourse" is underway throughout the town.

8.1.3 Bloomfield

Streets and municipal parking lots in Bloomfield are swept at least once per year as soon as possible after snowmelt. Catch basins throughout the municipality are cleaned at least once per year, and more frequently if needed. Town-owned catch basins located in recreational and high pedestrian traffic areas are targeted for stenciling to identify the catch basin as draining to a watercourse, and will include approximately 30% of the total number of catch basins in Bloomfield. Two MDC-sponsored household hazardous water disposal days are held per year in Bloomfield. As part of the Town's Stormwater Management Plan, stormwater outfalls and structures of the stormwater system have been mapped in support of the Town's illicit discharge detection and elimination program, as required by the MS4 General Permit.

8.2 Source Controls and Pollution Prevention

8.2.1 Regulated Commercial and Industrial Facilities

As discussed in Section 5, there are a number of commercial and industrial facilities within the North Branch Park River watershed that have NPDES discharge permits and/or other regulated waste streams. These facilities are required to comply with the permit conditions and associated regulations/statutes, including source controls, pollution prevention, monitoring, treatment, and other best management practices as specified by the permits. The recent compliance records of these regulated facilities were reviewed to evaluate potential issues related to existing commercial and industrial facility practices in the watershed.

Table 8-1 lists industrial facilities in the watershed, which are registered under the CTDEP General Permit for the Discharge of Stormwater Associated with Industrial Activity, with stormwater sampling results that exceeded the General Permit effluent quality goals between August 2008 and August 2009. The number of facilities with results above the General Permit effluent quality goals (4) represents approximately 27 percent of the industrial facilities in the North Branch Park River watershed.

Table 8-1. Watershed Facilities with Stormwater Sample Results Above the Industrial Stormwater General Permit Effluent Quality Goals (August 2008 to August 2009)

Facility	Address	Subwatershed	Water Quality Parameters Detected Above the General Permit Effluent Quality Goals
Capewell Horsenails, Inc.	1404 Blue Hills Avenue, Bloomfield	Blue Hills Reservoir	Total Zinc, Aquatic Toxicity (LC50)
Finlay Printing, LLC	44 Tobey Road, Bloomfield	North Branch Park River	Chemical Oxygen Demand, Total Suspended Solids, Total Kjeldahl Nitrogen, Total Zinc
Kamatics Corporation	1330 Blue Hills Avenue, Bloomfield	Blue Hills Reservoir	Aquatic Toxicity (LC50)
Pepperidge Farm	1414 Blue Hills Avenue, Bloomfield	Wintonbury Reservoir	Total Kjeldahl Nitrogen

Source: CTDEP, August 2009.

Similarly, three of the four industrial facilities in the watershed with individual NPDES surface water discharge permits also reported violations as of October 2009 (*Table 8-2*).

Table 8-2. NPDES Regulated Facilities in the Watershed – Non-Compliance Record

Facility	Address	Quarters in Non-Compliance	Reasons for Non-Compliance
JDS Uniphase Corp	45 Griffin Road South; Bloomfield, CT	6 of 12	Effluent Violations (2)*, Report Violations (4)
Birken Manufacturing Company, Inc.	3 Old Windsor Road; Bloomfield, CT	4 of 12	Effluent Violations (2)*, Report Violations (2)
Swift Textile Metalizing, LLC	23 Britton Drive; Bloomfield, CT	2 of 12	Effluent Violations (2)*
Eisenhower Park	15 Sheep Hill Road; West Hartford, CT	- -	- -

* Unresolved significant non-compliance violations
Source: EPA, Facility Registry System (FRS), October 2009.

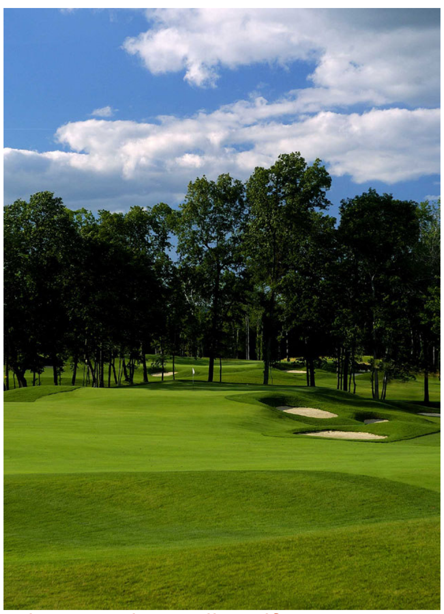
Several commercial properties in the watershed are registered under the CTDEP General Permit for the Discharge of Stormwater Associated with Commercial Activity. The CTDEP recently developed an outreach program for commercial establishments that may be subject to stormwater permitting requirements, waste regulations, pesticide regulations and other compliance requirements. Some examples of such establishments include garden centers, nurseries, greenhouses, hardware stores, and home improvement centers. The *Environmental Best Management Practices Guide for Small Businesses* (CTDEP, 2009) lists specific practices that are recommended for preventing and minimizing groundwater and surface water pollution as a result of day-to-day activities at these commercial facilities.

Facility operating practices were evaluated at several representative industrial and commercial facilities in the watershed to further assess the potential for water quality impacts, improvements in the use of BMPs, and potential retrofit opportunities. The results of this hotspot land use assessment will be discussed in a separate, companion report to this baseline assessment document.

8.2.2 Institutions and Golf Courses

The numerous institutional facilities and golf courses within the North Branch Park River watershed are major land owners that can have a significant impact on the water quality of the North Branch Park River.

The numerous institutional facilities (university campuses, schools, corporate campuses, and hospitals) and golf courses (Wintonbury Hills Golf Course, Tumble Brook Country Club, Gillette Ridge Golf Course, Hartford Golf Club, and Wampanoag Country Club) within the North Branch Park River watershed are major land owners that can have a significant impact on the water quality of the North Branch Park River, through both new development and redevelopment projects, as well as grounds management of these properties, many of which are located adjacent to or nearby the North Branch Park River and its tributaries. Impacts from new development and redevelopment are primarily related to post-construction stormwater runoff, emphasizing the importance of LID and Green Infrastructure approaches such as the use of pervious pavement, rain gardens, green roofs, etc. Grounds management issues include facility operation and maintenance practices with potential for water quality impacts such as landscape maintenance (nutrient and Integrated Pest Management, grass clippings management, leaf/brush waste management, etc.), parking lot and road maintenance (deicing, snow management), drainage system maintenance (catch basins, storm drains, LID and traditional structural stormwater BMPs, etc.), and flooding issues.



The Wintonbury Hills Golf Course is one of five golf courses within the North Branch Park River watershed.

Limited information was available on the existing practices of the institutional facilities and golf courses within the watershed, many of which are privately-owned. The CTDEP guidance document *Best Management Practices for Golf Course Water Use* (July 2006) provides recommended BMPs for golf courses to promote water conservation, preserve or improve water quality, and protect water resources. The document describes BMPs that minimize the potential of pollutants reaching surface or ground water as a result of golf course construction and maintenance operations, thereby minimizing non-point source pollution. Recommended BMPs are presented for vegetative buffers, wetlands and watercourse protection, stormwater management, erosion and sediment control, turf management (nutrient and Integrated Pest Management), equipment maintenance and fueling, chemical storage and handling, waste management, and spill response. Many golf courses in the state have implemented some form of IPM and other BMPs recommended by the CTDEP. The level of adherence to these practices is unknown for the golf courses in the North Branch Park River watershed.

Some of the university campuses and schools in the watershed have begun to implement environmentally-sensitive campus management practices. The University of Connecticut (UConn) is one such example. The UConn Law School follows many of the same initiatives that are practiced at the main UConn campus in Storrs. The UConn Office of Environmental Policy (OEP) promotes environmental responsibility and sustainability. Some of the current OEP initiatives include the development of an initial *Invasive Plant Species Management Plan*, consideration of porous pavers and other permeable pavement options for on-campus parking lots, the installation of rain gardens, and the overall implementation of sustainable design, specifically the implementation of the University's *Guidelines for Sustainable Design*, with provisions for both new and renovation projects. Although not reportedly used on the Law School Campus, IPM is actively utilized at the main Storrs and Depot Campuses in Mansfield, including athletic fields.

Ongoing outreach activities that are being conducted as part of the watershed management plan development for the North Branch Park River include coordination with campus facility managers to identify common issues of concern and more effective facility management approaches that are also sensitive to water quality.

Operating practices were evaluated at several representative institutional facilities in the watershed to further assess the potential for water quality impacts, as well as potential improvements to existing practices and retrofit opportunities. The results of this assessment will be discussed in a separate, companion report to this baseline assessment document.

9 Pollutant Loading

A pollutant loading analysis was performed for the North Branch Park River. A pollutant loading model was applied to the watershed using the land use/land cover data described in Section 7. The model was used to compare existing pollutant loads from the watershed to projected future pollutant loads under a watershed buildout scenario. The predicted change in pollutant loads in each of the subwatersheds is an indicator of their relative vulnerability to future development. The pollutant loading model is also used to identify and rank pollution sources, as well as assist in identifying, prioritizing, and evaluating subwatershed pollution control strategies. It is important to note that the results of this screening-level analysis are intended for the purpose of comparing existing and future conditions and not to predict future water quality. This section summarizes the methods and results of the analysis, which are presented in greater detail in *Appendix E*.

9.1 Model Description

The Watershed Treatment Model (WTM), Version 3.1, developed by the Center for Watershed Protection, was used for this analysis. This model calculates watershed pollutant loads primarily based on nonpoint source (NPS) runoff from various land uses. The model was also used to estimate pollutant loads from other sources, including:

- Combined Sewer Overflows
- Illicit Discharges
- Septic Systems
- Sanitary Sewer Overflows
- Managed Turf
- Road Sanding

Reductions in future pollutant loads in the watershed can be estimated using a range of treatment measures, such as structural and nonstructural best management practices, that are included in the WTM.

Other similar screening-level pollutant loading models were considered for use in development of a watershed management plan for the North Branch Park River, including the Spreadsheet Tool for the Estimation of Pollutant Load (STEPL), the Generalized Watershed Loading Function (GWLF) model, and other similar models. While STEPL was identified as a suitable choice for the North Branch Park River, it was determined that the WTM is better suited for modeling bacterial loads and provides a larger suite of best management practices for urban areas. The ArcView GIS version of the GWLF model was also considered for use in the evaluation, although the AVGWLF model has limited capability for modeling CSOs when using the urban runoff module RUNQUAL within the GWLF model. Again, the WTM model was determined to be better suited for modeling CSOs than the AVGWLF model.

The pollutants modeled in this analysis are the default pollutants contained in the WTM model: total phosphorus, total nitrogen, total suspended solids, and total fecal coliform bacteria. These pollutants are the major NPS pollutants of concern in environmental systems. Additional loadings from combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) were simulated where such wet weather discharges are known to exist (i.e., North Branch Park River subwatershed).

9.2 Model Inputs

9.2.1 Nonpoint Source Runoff

The land use and land cover data described in Section 7 were adapted for use in the WTM to simulate pollutant loadings under existing and potential future (watershed buildout) conditions. The WTM uses the Simple Method to calculate nutrient, sediment, and bacteria loads from various land uses. The user specifies several model parameters for each land use in the watershed to estimate runoff quantity and pollutant levels. These parameters include Event Mean Concentrations (EMCs), which are literature values for the mean concentration of a pollutant in stormwater runoff for each land use, and an average impervious cover percentage for each land use.

A literature review was conducted to determine EMC values and impervious percentage values for use in the evaluation. EMC values were selected to reflect the relative difference in NPS pollutant characteristics between existing and future land uses. The default impervious cover coefficients in the WTM were adjusted to better reflect local conditions in the North Branch Park River watershed. Impervious cover estimates for each land use category were modified based on measured total impervious area (TIA) for representative parcels or areas within each land use.

9.2.2 Other Pollutant Sources

In addition to nonpoint source runoff pollutant loads, the WTM also provides the capability to model other pollutant sources including point sources and subsurface contributions. The following sections summarize the model inputs for other pollutant sources within the North Branch Park River watershed.

9.2.2.1 Combined Sewer Overflows

The WTM uses a modification of the Simple Method to calculate annual loads from CSOs. The primary assumption is that CSO discharges occur when the combined volume of stormwater and wastewater exceeds the total system capacity. The MDC system experiences approximately 50 CSO discharge events annually in the North Branch Park River (MDC, 2009). Statistical analysis of 15 years of precipitation data at a nearby weather station reveals that the approximate critical depth of rainfall to cause 50 CSO discharge events per year is 0.3 inches.

The volume of a typical CSO is based on the median storm event. In the WTM, any rainfall beyond the system capacity contributes to the CSO volume. Thus, this volume is calculated as the runoff caused by the difference between the median storm event depth and the rainfall depth that causes CSOs (assumed to be 0.3 inch). The runoff volume from this storm event is determined using the Simple Method. The resulting CSO pollutant load is the product of the CSO volume, the number of CSO events, and typical CSO pollutant concentrations.

9.2.2.2 Illicit Discharges

The WTM default assumptions for illicit discharges were used (i.e., a fraction of the total sewage flow contributes to illicit connections). The WTM makes separate assumptions for residential and business illicit connections. For residential connections, the WTM's default assumption is that one in every 1,000 sewered individuals is connected to the sewer system via an illicit connection. This value is then multiplied by the number of individuals connected to the system, and then by typical per capita flow and pollutant concentrations for raw sewage. For businesses, it is assumed that 10% of businesses have illicit connections, and approximately 10% of those have direct sewage discharges.

9.2.2.3 Septic Systems

Although the majority of the North Branch Park River watershed is served by sanitary sewers, portions of the western and northwestern sections of Bloomfield are on private septic systems (Thiesse, pers. comm., December 18, 2009). The number of unsewered dwelling units in each subwatershed was estimated using GIS data including the mapped sewer service area, impervious cover, and aerial photographs. The WTM default values were used for septic system failure rate (30%) and effluent concentrations from both working and failing septic systems.

9.2.2.4 Sanitary Sewer Overflows

There is currently one sanitary sewer overflow (SSO) discharge location in the North Branch Park River subwatershed. WTM default assumptions were used since detailed information on the volume and frequency of overflow was unavailable.

The WTM estimates the SSO load as a product of total flow from SSOs and pollutant concentrations of raw sewage. Unlike most urban pollutant sources, which can be classified as either storm loads or non-storm loads, SSOs can occur both during and between storms. Some are initiated by storm events, such as when the cause of the overflow is lack of capacity, or infiltration of rainfall into the sanitary system. SSOs can also be caused by pipe breakage or blockage, resulting in flow between storm events. The WTM default assumption is that 50% of the load from SSOs occurs as a storm load, with the remainder as a non-storm load.

Based on the MDC GIS data, there are 82 miles of sanitary sewer that convey wastewater to the SSO location in the North Branch Park River subwatershed. An estimated 12 overflows occur per year by assuming the default rate of 140 SSOs per 1,000 miles of sewer.

9.2.2.5 Managed Turf

In urban watersheds, subsurface flow constitutes a relatively small fraction of total annual flow, and most constituents have a relatively low concentration in groundwater. One possible exception is nitrogen, which can leach from urban lawns and other managed turf grass. The annual nitrogen load from managed turf areas is calculated as the product of its concentration and the annual infiltration volume. The area of managed turf in each subwatershed is based on the land cover data described in Section 7 and includes residential lawns, golf courses, parks, and other areas with grass or turf.

9.2.2.6 Road Sanding

Sediment loads from road sanding are calculated based on the quantity of sand applied to roads in a typical year. Data from the West Hartford Public Works Department was extrapolated to the rest of the watershed since more detailed data was unavailable. A sanding application rate for typical roads was calculated based on the average rate in West Hartford in pounds per mile per year. The local roads GIS layer was used to calculate the total length of roads in each subwatershed and the total amount of sand applied to the roads in an average year. Default delivery ratios were used for various road types since not all road sand that is applied will reach the receiving water body.

9.3 Existing Pollutant Loads

Table 9-1 presents the existing modeled pollutant loads for the North Branch Park River watershed. Nonpoint source runoff accounts for approximately 71% of the total nitrogen load, 89% of the total phosphorus load, 33% of the total suspended solids load, and 7% of the fecal coliform bacteria load for the entire watershed. Road sanding accounts for nearly the entire balance of the total suspended solids load, while CSOs and SSOs contribute more than 90% of the fecal coliform load for the watershed. *Table 9-2* presents a breakdown of estimated annual loadings of total nitrogen, total phosphorus, TSS, and fecal coliform by subwatershed.

Table 9-1. Modeled Existing Pollutant Loads by Source Type

Source	N (lb/yr)	P (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)
Nonpoint Source Runoff	97,441	15,234	3,686,296	883,935
Other Sources	38,949	1,874	7,487,076	11,170,230
Septic Systems	14,487	182	7,274	0
SSOs	516	86	3,441	390,550
CSOs	3,653	731	73,054	10,654,285
Illicit Discharges	1,004	586	9,416	125,395
Managed Turf	19,288	289	0	0
Road Sanding	0	0	7,393,891	0
Watershed Total	**136,389**	**17,108**	**11,173,372**	**12,054,165**

Table 9-2. Modeled Existing Pollutant Loads

Subwatershed	N (lb/yr)	P (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	N (lb/ac-yr)	P (lb/ac-yr)	TSS (lb/ac-yr)	Fecal Coliform (billion/ ac-yr)
Beaman Brook East (163 ac)	778	112	65,702	18,530	4.8	0.7	403	113.8
Beaman Brook West (1,185 ac)	8,917	1,096	892,088	63,816	7.5	0.9	753	53.9
Blue Hills Reservoir (1,035 ac)	6,740	1,115	500,837	27,292	6.5	1.1	484	26.4
Cold Spring Reservoir (1,155 ac)	8,825	822	499,416	95,667	7.6	0.7	432	82.8
Filley Brook (404 ac)	4,349	543	454,764	30,696	10.8	1.3	1,126	76.0
North Branch Park River (4,033 ac) (excluding CSOs and SSOs)	37,808	5,121	3,537,838	279,377	9.4	1.3	877	69.3
CSOs and SSOs	4,169	817	76,495	11,044,834	1.0	0.2	19.0	2,738.4
Tumbledown Brook (1,561 ac)	15,486	1,660	1,112,424	93,446	9.9	1.1	713	59.9
Tumbledown Brook South (1,622 ac)	10,149	937	895,817	84,370	6.3	0.6	552	52.0
Tunxis Reservoir (874 ac)	7,142	672	381,828	41,445	8.2	0.8	437	47.4
Wash Brook North (762 ac)	5,187	845	527,067	26,722	6.8	1.1	692	35.1
Wash Brook South (1,559 ac)	13,603	1,778	1,263,600	111,061	8.7	1.1	810	71.2
Wash Brook West (1,029 ac)	6,680	602	329,983	68,767	6.5	0.6	321	66.8
West Hartford Reservoir (2,048 ac)	1,839	332	246,421	33,749	0.9	0.2	120	16.5
Wintonbury Reservoir (894 ac)	4,719	657	389,091	34,393	5.3	0.7	435	38.5
Watershed Total (18,323 ac)	**136,389**	**17,108**	**11,173,372**	**12,054,165**	**7.4**	**0.9**	**610**	**657.9**

Because the study subwatersheds vary in size, pollutant loads were also evaluated in terms of loading rates (i.e., pollutant loads per acre of land area, as shown in *Table 9-2*). A higher loading rate indicates relatively greater pollutant sources per unit area, which suggests that implementation of best management practices (BMPs) in these areas may be more effective in reducing pollutant loads. The highest loading rates for nitrogen and phosphorus are associated with the North Branch Park River, Filley Brook, Wash Brook South, Tumbledown Brook, and Wash Brook North subwatersheds. Filley Brook has the loading rates of total suspended solids, while the North Branch Park River subwatershed has the largest fecal coliform loading rate due to contributions from CSOs and SSOs.

- *North Branch Park River.* The North Branch Park River subwatershed is the largest subwatershed by area. It also has the largest amount of commercial/industrial, institutional, and transportation land uses. The nutrient loads in this subwatershed are approximately 3 times greater than the next highest subwatershed, primarily due to the comparatively large size and highly urban nature of the subwatershed. The estimated nitrogen loading rate (excluding CSO and SSO contributions) is the second highest of the subwatersheds at 9.4 lb/ac-year, while the phosphorus loading rate is the highest of the subwatersheds at 1.3 lb/ac-year. The estimated fecal coliform loading due to nonpoint source runoff is 279,377 billion per year, while the contribution of fecal coliform from sewer overflows is approximately 2 orders of magnitude larger than the nonpoint source runoff contribution.

- *Wash Brook South*. Wash Brook South ranks among the top four subwatersheds in annual pollutant loading and loading rates. The high loading is due to the proportionally high commercial/industrial, residential, and roadway land uses in this subwatershed.

- *Filley Brook*. The Filley Brook subwatershed has the highest TSS loading rate in the watershed and is among the 4 highest subwatersheds in terms of pollutant loading rates for nitrogen, phosphorus, and fecal coliform bacteria. However, the total loading of each pollutant is among the lowest in the watershed due to its small size. The high pollutant loading rates reflect the large percentage of medium density residential (50%) and commercial/industrial (20%) development in the subwatershed.

Table 9-3 summarizes the contribution of nonpoint source pollutant loads by land use for the entire watershed. The majority of the nitrogen and phosphorus loads are from roadway, commercial/industrial, and residential land uses. The majority of the TSS loads is due to roadway (41.8%) and commercial/industrial (31.1%) land use. Residential land use accounts for approximately 81% of the nonpoint source bacterial load. Other modeled pollutant sources contribute significantly to the watershed pollutant loads, particularly CSOs and SSOs, which are the predominant source of the fecal coliform loads in the watershed.

Table 9-3. Modeled Existing Pollutant Loads by Land Use

Land Use	N (lb/yr)	P (lb/yr)	TSS (lb/yr)	Fecal Coliform (billion/yr)	N	P	TSS	Fecal Coliform
Agriculture	274	37	3,506	416	0.3%	0.2%	0.1%	0.0%
Commercial/Industrial	25,239	4,589	1,147,223	73,199	25.9%	30.1%	31.1%	8.3%
Forest	389	195	136,280	4,436	0.4%	1.3%	3.7%	0.5%
Institutional	7,112	1,185	264,709	25,209	7.3%	7.8%	7.2%	2.9%
Medium Density Residential	18,778	2,209	336,905	437,981	19.2%	14.5%	9.1%	49.5%
Multi-family/High Density Residential	8,071	897	142,590	118,528	8.3%	5.9%	3.9%	13.4%
Open Space (Urban)	2,109	211	28,126	3,205	2.2%	1.4%	0.8%	0.4%
Roadway	30,887	5,148	1,544,327	65,691	31.7%	33.7%	41.8%	7.4%
Single-family/Low Density Residential	4,713	785	86,793	155,719	4.8%	5.1%	2.4%	17.6%
Watershed Total	**97,572**	**15,256**	**3,690,458**	**884,382**	**100%**	**100%**	**100%**	**100%**

9.4 Future Pollutant Loads

Anticipated future land use due to new development and redevelopment within the watershed was used in the WTM model to simulate potential future pollutant loads under a watershed buildout scenario. Future land use categories were derived from the watershed buildout scenario presented in Section 7. Future controls or best management practices were not considered in the calculation of future pollutant loads. Therefore, the predicted future pollutant loads reflect a potential worst-case scenario against which potential watershed management pollution control strategies may be evaluated. Additionally, future pollutant loads were modeled with and without CSO and SSO mitigation to evaluate the potential reductions in pollutant loads that could be achieved by the MDC's ongoing and planned sewer overflow mitigation projects.

Table 9-4 presents projected future pollutant loads in terms of loading rate increase and percent increase in total loads under a watershed buildout scenario. Significant increases in pollutant loads are predicted in many of the subwatersheds. The watershed as a whole is predicted to experience a 13% increase in nitrogen loads, a 16% increase in phosphorus loads, and a 20% increase in TSS loads under a future buildout scenario and assuming completion of the ongoing and planned CSO and SSO mitigation projects. Overall, fecal coliform loads for the entire watershed are predicted to decrease by 64%, primarily as a result of the MDC sewer overflow mitigation projects. However, these projects will only affect pollutant loads in the North Branch Park River subwatershed. Almost all of the other subwatersheds are predicted to experience significant increases in fecal coliform loads (generally 20% to 80% increases) under a watershed buildout scenario due to nonpoint source runoff. Several of the subwatersheds are predicted to experience significantly higher increases in pollutant loads and loading rates under a watershed buildout scenario. These subwatersheds, which include the Beamans Brook East, Wash Brook North, Wash Brook West, and Wintonbury Reservoir subwatersheds, correspond to areas with significant developable land.

Table 9-4. Modeled Future Pollutant Loading Rate Increases and Load Increases

Subwatershed	Projected Future Loading Rate*				Projected Load Increase* (%)			
	N (lb/ac-yr)	P (lb/ac-yr)	TSS (lb/ac-yr)	Fecal Coliform (billion/yr)	N	P	TSS	Fecal Coliform
Beamans Brook East (163 ac)	11.2	1.2	638	169	134%	75%	58%	49%
Beamans Brook West (1,185 ac)	8.4	1.0	845	65	11%	12%	12%	21%
Blue Hills Reservoir (1,035 ac)	7.8	1.3	581	36	20%	20%	20%	35%
Cold Spring Reservoir (1,155 ac)	8.3	0.8	499	105	9%	14%	15%	27%
Filley Brook (404 ac)	12.0	1.6	1315	82	11%	18%	17%	8%
North Branch Park River (4,033 ac) (excluding CSOs and SSOs)	10.4	1.4	990	83	11%	12%	13%	19%
CSOs and SSOs	0.4	0.1	5.4	757	-66%	-67%	-72%	-72%
Tumbledown Brook (1,561 ac)	11.0	1.2	804	73	11%	13%	13%	22%
Tumbledown Brook South (1,622 ac)	7.1	0.7	695	78	13%	19%	26%	50%
Tunxis Reservoir (874 ac)	8.8	0.9	503	65	8%	11%	15%	36%
Wash Brook North (762 ac)	10.5	1.8	1099	46	54%	61%	59%	32%
Wash Brook South (1,559 ac)	9.8	1.3	912	92	13%	11%	13%	29%
Wash Brook West (1,029 ac)	6.1	0.8	453	113	-7%	30%	41%	70%
West Hartford Reservoir (2,048 ac)	1.2	0.2	163	29	37%	32%	36%	77%
Wintonbury Reservoir (894 ac)	8.4	1.3	733	57	59%	71%	68%	48%
Watershed Total* (18,323 ac)	**8.4**	**1.1**	**729**	**239**	**13%**	**16%**	**20%**	**-64%**

*Reflects completion of ongoing and planned CSO and SSO mitigation projects.

10 Comparative Subwatershed Analysis

A Comparative Subwatershed Analysis was performed for the North Branch Park River subwatersheds to identify the subwatersheds with the greatest vulnerability and restoration potential. Subwatershed "metrics" were used to conduct this analysis. Metrics are numeric values that characterize the relative vulnerability and restoration potential of a subwatershed. The results of this analysis will be used to prioritize field assessment efforts in future phases of this study and to guide plan recommendations.

The analysis involves a screening-level evaluation of selected subwatershed metrics that are derived by analyzing available GIS layers and other subwatershed data sources. The basic approach used to conduct the Comparative Subwatershed Analysis consisted of:

1. Delineation of subwatershed boundaries and review of available data.
2. Selection and calculation of metrics that best describe subwatershed vulnerability and restoration potential. (The metrics used to rank subwatershed vulnerability were selected separately from the metrics used to rank subwatershed restoration potential.)
3. Developing weighting and scoring rules to assign values to each metric.
4. Computing aggregate scores and developing subwatershed rankings.

Subwatersheds with higher aggregate "vulnerability" scores are more sensitive to future development and should be the focus of watershed conservation efforts to maintain existing high-quality resources and conditions. Subwatersheds with higher aggregate "restoration potential" scores are more likely to have been impacted and have greater potential for restoration to improve upon existing conditions. This approach enables watershed planners to allocate limited resources on subwatersheds where restoration and conservation efforts have the greatest chances of success. The Comparative Subwatershed Analysis was performed for the following North Branch Park River subwatersheds:

- Beamans Brook East
- Beamans Brook West
- Blue Hills Reservoir
- Cold Spring Reservoir
- Filley Brook
- North Branch Park River
- Tumbledown Brook
- Tumbledown Brook South
- Tunxis Reservoir
- Wash Brook North
- Wash Brook South
- Wash Brook West
- West Hartford Reservoir
- Wintonbury Reservoir

The following sections present the metrics used, the rationale for their selection, how numerical values for the various metrics were calculated, and the results of the analysis. Available GIS and other data were used to assign a value for each metric.

10.1 Priority Subwatersheds for Conservation

Eight metrics were used to evaluate each subwatershed for vulnerability to future development, with a numerical value assigned for each metric based on the analyses presented in previous sections of this Baseline Watershed Assessment. *Table 10-1* presents the metrics used for determining the relative vulnerability of each subwatershed. Many of the metrics evaluate the potential changes in watershed in land use, land cover, impervious cover, and pollutant loading between existing and future conditions, as presented in previous sections of this report. Note that the pollutant loading metric does not account for combined sewer overflow loading in the watershed, and is comparing the loading from non-point sources (land use) only. Each metric was assigned a value of between 1 and 10, with 1 indicating the lowest vulnerability and 10 indicating the highest vulnerability to future development. The scores for each of the metrics were then added to arrive at an overall score for each subwatershed. The total number of points possible for each subwatershed is 80.

Table 10-1. Summary of Subwatershed Vulnerability Metrics

Subwatershed Metric	How Metric is Measured	Indicates Higher Vulnerability Potential When	Metric Points
1. Impervious Cover Change	% increase in impervious cover in subwatershed	**Predicted increase in IC is high**, suggesting greater development potential and stream impacts	Add 1 pt for each 2% increase in impervious cover, up to 10 pts
2. Impervious Cover Threshold	Comparison of current and future IC relative to ICM threshold	**Predicted increase in IC crosses "impacted" (10%) threshold**, development could result in significant stream impacts	Add 5 pts for each exceedance into higher category (0-10%; 10-25%; 25-60%, >60%)
3. Stream Order	% of subwatershed streams that are 1st or 2nd order	**Subwatershed contains lower order streams**, suggesting greater vulnerability of headwater streams to future development	Add 1 pt for each 10% of streams in subwatershed that are 1st or 2nd order
4. Pollutant Loading	Average % increase of N, P, TSS, and bacterian pollutant loading in subwatershed	**Predicted increase in pollutant loads is high,** suggesting greater water quality impacts from future development	Award 1 pt for each 10% increase in the average pollutant loading
5. Commercial & Industrial Land Use Change	% increase of commercial & industrial land in subwatershed	**Predicted increase in commercial & industrial land use is high**, suggesting greater potential for water quality impacts from pollutant hot spot	0% = 0 pts; 1 to 10% = 3 pts; 11 to 50% = 5 pts; 51 to 100% = 7 pts, > 100 % = 10 pt

Table 10-1. Summary of Subwatershed Vulnerability Metrics

Subwatershed Metric	How Metric is Measured	Indicates Higher Vulnerability Potential When	Metric Points
6. Developable Forest Cover	% of subwatershed with developable forest cover	**Area of developable forest cover is high**, suggesting greater potential for future reductions in forested land	Add 1 pt for each 5% of developable forest cover
7. Stream Corridor Forest Cover and Public Ownership	% of stream corridor that is developable forest	**Stream corridor forest cover is high and public ownership within stream corridor is low**, suggesting greater potential for future reductions in vegetated riparian areas	Award 1 point for each 1% of stream corridor that is developable forest
8. Road Crossings	number of road crossings / square mile	**Number of road crossings is high**, suggesting greater potential for direct stormwater discharges from roadways	Add 3 pts for each stream crossing /sq mi

The results of the vulnerability analysis are summarized in *Table 10-2*. The overall subwatershed vulnerability scores range from 22 to 68 points out of a possible 80 points. The highlighting identifies subwatersheds with high (orange), moderate (yellow), and low (green) relative vulnerability in the North Branch Park River watershed.

Table 10-2. Results of Subwatershed Vulnerability Analysis

Subwatershed	Impervious Cover Change	Impervious Cover Threshold	Stream Order	Pollutant Loading	Commercial & Industrial Land Use Change	Developable Forest Cover	Stream Corridor Forest Cover and Public Ownership	Road Crossings	Total	Rank
Wash Brook North	9	5	10	5	10	7	7	9	**62**	**1**
Beaman Brook East	10	10	10	8	0	7	4	6	**55**	**2**
Wintonbury Reservoir	5	0	10	6	10	7	7	5	**50**	**3**
Blue Hills Reservoir	6	5	10	2	5	4	6	4	**42**	**4**
Filley Brook	1	5	10	1	5	5	5	6	**38**	**5**
Tumbledown Brook	7	5	5	1	0	4	3	10	**35**	**6**
Beaman Brook West	1	0	10	1	5	3	4	10	**34**	**7**
Cold Spring Reservoir	2	5	6	2	0	5	6	8	**34**	**8**
Wash Brook West	3	5	10	5	0	3	6	2	**34**	**9**

Table 10-2. Results of Subwatershed Vulnerability Analysis

Subwatershed	Impervious Cover Change	Impervious Cover Threshold	Stream Order	Pollutant Loading	Commercial & Industrial Land Use Change	Developable Forest Cover	Stream Corridor Forest Cover and Public Ownership	Road Crossings	Total	Rank
Tunxis Reservoir	1	5	6	2	3	3	7	4	**31**	**10**
Wash Brook South	3	0	3	2	3	5	4	10	**30**	**11**
West Hartford Reservoir	0	0	10	4	0	2	8	2	**26**	**12**
Tumbledown Brook South	1	0	6	3	0	2	4	9	**25**	**13**
North Branch Park River	2	0	2	1	5	4	4	6	**24**	**14**

As shown in *Table 10-2*, the following subwatersheds are considered most vulnerable to future development impacts and should be given higher priority for conservation efforts to maintain existing resource conditions:

- *Wash Brook North* – The Wash Brook North subwatershed is ranked as the most vulnerable subwatershed to future development. The subwatershed contains headwater streams (1st and 2nd order streams), which are important components of ecosystem health because they are a critical food source for the river, influence downstream conditions, and support biodiversity. The subwatershed is predicted to experience a significant increase in impervious cover from existing to future watershed conditions, with a large potential increase in commercial and industrial land uses. The percentage of developable forest cover in the subwatershed is moderate to high. There is also a high density of stream crossings in this watershed, which suggests a potential for increased stormwater runoff from roads as the subwatershed becomes more developed.

- *Beamans Brook East* – The Beamans Brook East subwatershed is the smallest subwatershed in land area, at only 163 acres. However, this subwatershed is predicted to experience significant land use changes under a buildout scenario. The majority of the subwatershed is within a "planned residential" zoning area and much of the existing land is forested. Impervious cover is predicted to increase by almost 50% under a future buildout scenario.

- *Wintonbury Reservoir* – The northern portion of the Wintonbury Reservoir subwatershed is currently undeveloped and is located in an area zoned for industrial use along Blue Hills Avenue (Route 187). Potential future development in this area is predicted to increase the amount of impervious cover and industrial land use in the subwatershed, while decreasing forest cover. The subwatershed contains a 1st order stream that flows through an area of potential industrial development, which may be impacted by these potential future changes in land cover and land use.

- *Blue Hills Reservoir* – The Blue Hills Reservoir subwatershed is adjacent to the Wintonbury Reservoir subwatershed. Similar to the Wintonbury Reservoir subwatershed, potential future development is anticipated along the industrial-zoned areas of the Route 187 corridor, resulting in the conversion of forest and open space to additional industrial land use. Therefore, the hydrology and water quality of the headwater streams in this subwatershed are vulnerable to future industrial development.

- *Filley Brook* –Filley Brook is a headwater (1st order) stream that joins Tumbledown Brook near the confluence with the North Branch Park River. Although there is a limited amount of developable land within the Filley Brook subwatershed, the remaining developable land is generally located along the Filley Brook stream corridor.

10.2 Priority Subwatersheds for Restoration

Ten metrics were used to evaluate each subwatershed for restoration potential, with a numerical value assigned for each metric based on the analyses presented in previous sections of this Baseline Watershed Assessment. *Table 10-3* presents the metrics used for determining the relative restoration potential of each subwatershed. Each metric was assigned a value of between 1 and 10, with 1 indicating the lowest restoration potential and 10 indicating the highest restoration potential. The scores for each of the metrics were then added to arrive at an overall score for each subwatershed. The total number of points possible for each subwatershed is 100.

Table 10-3. Summary of Subwatershed Restoration Potential Metrics

Subwatershed Metric	How Metric is Measured	Indicates Higher Restoration Potential When	Metric Points
1. Existing Impervious Cover	% impervious cover in subwatershed	**Current impervious cover is low**, suggesting range of possible sites for storage retrofits and stream repairs	< 10% = 10pts; 10 to 25% = 7 pts; 26 to 40 = 5 pts; 41 to 60% = 3 pts; > 60% = 1 pts
2. Forest Cover	% forest cover in subwatershed	**Forest cover is low**, suggesting greater potential for upland and riparian reforestation	< 20% = 10 pts; 21 to 30% = 7 pts; 31 to 40% = 5 pts; 41 to 60% = 3 pts, > 60 % = 1 pt
3. Subwatershed Development Potential	% of subwatershed that is developable	**The amount of potential future development is low,** suggesting stable conditions and greater potential for stream repairs and storage retrofits	Award 1 pt for each 10% percent below 100%

Table 10-3. Summary of Subwatershed Restoration Potential Metrics

Subwatershed Metric	How Metric is Measured	Indicates Higher Restoration Potential When	Metric Points
4. Publicly-owned land	% of subwatershed that is publicly owned	**Public land ownership is high**, providing range of potential sites for restoration practices	Award 1 pt for ea 2% in public ownership (up to 10 pts)
5. Single-family Residential Land	% of subwatershed residential land use	**Detached residential land is high**, suggesting greater potential for neighborhood source controls, on-site retrofits and upland forestry	Award 1 pt for each 5% single-family land use
6. Commercial Land	% of subwatershed commercial land use	**Commercial land use is high**, suggesting greater potential for source controls, discharge prevention, and on-site retrofits	Award 1 pt for each 2% of subwatershed classified as commercial land use
7. Stream Corridor Forest Cover and Public Ownership	% of stream corridor that is publicly-owned and not forested	**Stream corridor forest cover is low and public ownership within stream corridor is high,** suggesting greater potential for riparian reforestation, stream restoration, and storage retrofits	Award 2 pt for each 10% of stream corridor area
8. Stream Density	stream miles / square mile	**Stream density is high**, suggesting greater potential for stream corridor practices	Award 3 pts for each mile of stream/sq mi
9. Regulated Site Density	regulated sites / sq mi. (CTDEP General Permits)	**Regulated site density is high,** suggesting greater potential to implement source controls, discharge prevention and on-site retrofits	0 to 1 = 1 pt; 1 to 2 = 3 pts; 2 to 5 = 5 pts; 5 to 10 = 7 pts; > 10 = 10 pts
10. Road Crossings	crossings / stream mile	**Number of road crossings is high**, suggesting greater potential for stream and potential fish passage restoration	Award 3 pts for each road crossing /sq mi

The results of the subwatershed restoration potential analysis are summarized in *Table 10-4*. The restoration potential scores range from 31 to 63 points out of a possible 100 points. The highlighting identifies subwatersheds with high (orange), moderate (yellow), and low (green) relative restoration potential in the North Branch Park River watershed.

Table 10-4. Results of Subwatershed Restoration Potential Analysis

Subwatershed	Existing Impervious Cover	Forest Cover	Subwatershed Development Potential	Publicly-owned land	Single-family Residential Land	Commercial Land	Stream Corridor Forest Cover and Public Ownership	Stream Density	Regulated Site Density	Road Crossings	Total	Rank
Beamans Brook West	7	10	8	8	5	2	3	5	5	10	**63**	**1**
Tumbledown Brook	7	7	7	2	5	6	6	8	5	10	**63**	**1**
Filley Brook	7	10	8	2	9	6	1	6	7	6	**62**	**3**
North Branch Park River	5	10	8	7	5	3	6	4	7	6	**61**	**4**
Wash Brook South	7	7	7	2	7	5	1	8	7	10	**61**	**4**
Tumbledown Brook South	7	7	8	2	6	0	7	7	3	9	**56**	**6**
Wash Brook North	7	5	5	2	2	8	2	9	7	9	**56**	**6**
Blue Hills Reservoir	7	5	6	3	0	10	5	4	10	4	**54**	**8**
Cold Spring Reservoir	10	3	7	0	9	0	5	7	1	8	**50**	**9**
Wash Brook West	10	3	7	0	9	0	9	7	3	2	**50**	**9**
Tunxis Reservoir	10	3	7	1	5	3	3	4	5	4	**45**	**11**
Wintonbury Reservoir	7	5	6	0	3	4	5	3	7	5	**45**	**11**
Beamans Brook East	10	7	5	0	3	0	2	6	1	6	**40**	**13**
West Hartford Reservoir	10	1	8	1	1	0	2	5	1	2	**31**	**14**

As shown in *Table 10-4*, the following subwatersheds are considered to have the greatest restoration potential:

- *Beamans Brook West* – The Beamans Brook West subwatershed has a high percentage of developed land, impervious cover, and few remaining forested areas, suggesting a stable subwatershed with the potential for a variety of retrofits. Additionally, this subwatershed has a high percentage of publicly-owned land, thereby providing greater retrofit opportunities.

- *Tumbledown Brook* – The Tumbledown Brook subwatershed ranked moderate to high in many of the evaluation categories. The subwatershed has a high density of streams and road crossings, providing numerous opportunities for stream restoration, stormwater retrofits, and stream cleanups.

- *Filley Brook* – Filley Brook ranks among the subwatersheds with the greatest restoration potential in the North Branch Park River watershed. Forest cover in the subwatershed is low, suggesting the potential for upland and riparian reforestation practices. Single-family residential neighborhoods comprise a large percentage of the land use in the subwatershed, providing opportunities for neighborhood source controls and on-site residential retrofits. The subwatershed has a moderate to high density of streams, permitted commercial and industrial facilities, and road crossings which may provide a variety of potential restoration opportunities.

- *North Branch Park River* – The North Branch Park River subwatershed is highly developed with a mix of residential, commercial, institutional, and recreational uses. Despite the dense development in this subwatershed, there are publicly-owned undeveloped areas that are potentially suitable for restoration projects. The watershed has high visibility since the runoff drains directly to the North Branch Park River and it encompasses the urban areas of Hartford and West Harford.

- *Wash Brook South* – The Wash Brook South subwatershed has a high restoration potential since much of its land area is developed, with a high percentage of impervious cover and relatively little buildable land. The subwatershed also has a high stream density and numerous road crossings, which could yield potential opportunities for stormwater retrofits and stream restoration. Potential reforestation opportunities also exist along the stream corridor and in upland areas.

10.3 Subwatersheds Recommended for Field Assessments

The Comparative Subwatershed Analysis results were used to identify "priority subwatersheds" that are targeted for subsequent field assessments. The objective of the field assessments is to further evaluate subwatershed conditions and identify potential candidate restoration sites and opportunities. Based on the Comparative Subwatershed Analysis results, the priority subwatersheds include those subwatersheds that are ranked "high" in terms of potential vulnerability to future development or restoration potential. *Figure 10-1* depicts the resulting priority subwatersheds.

The following priority subwatersheds are therefore recommended for detailed field assessments, including stream corridor assessments, stream corridor restoration and recapture investigation, upland subwatershed site reconnaissance (neighborhood source assessment, hotspot confirmation, and streets and storm drain assessment), and upland stormwater retrofit inventories:

- Filley Brook
- Wash Brook North and South
- Beamans Brook East and West
- Tumbledown Brook
- North Branch Park River
- Blue Hills Reservoir
- Wintonberry Reservoir

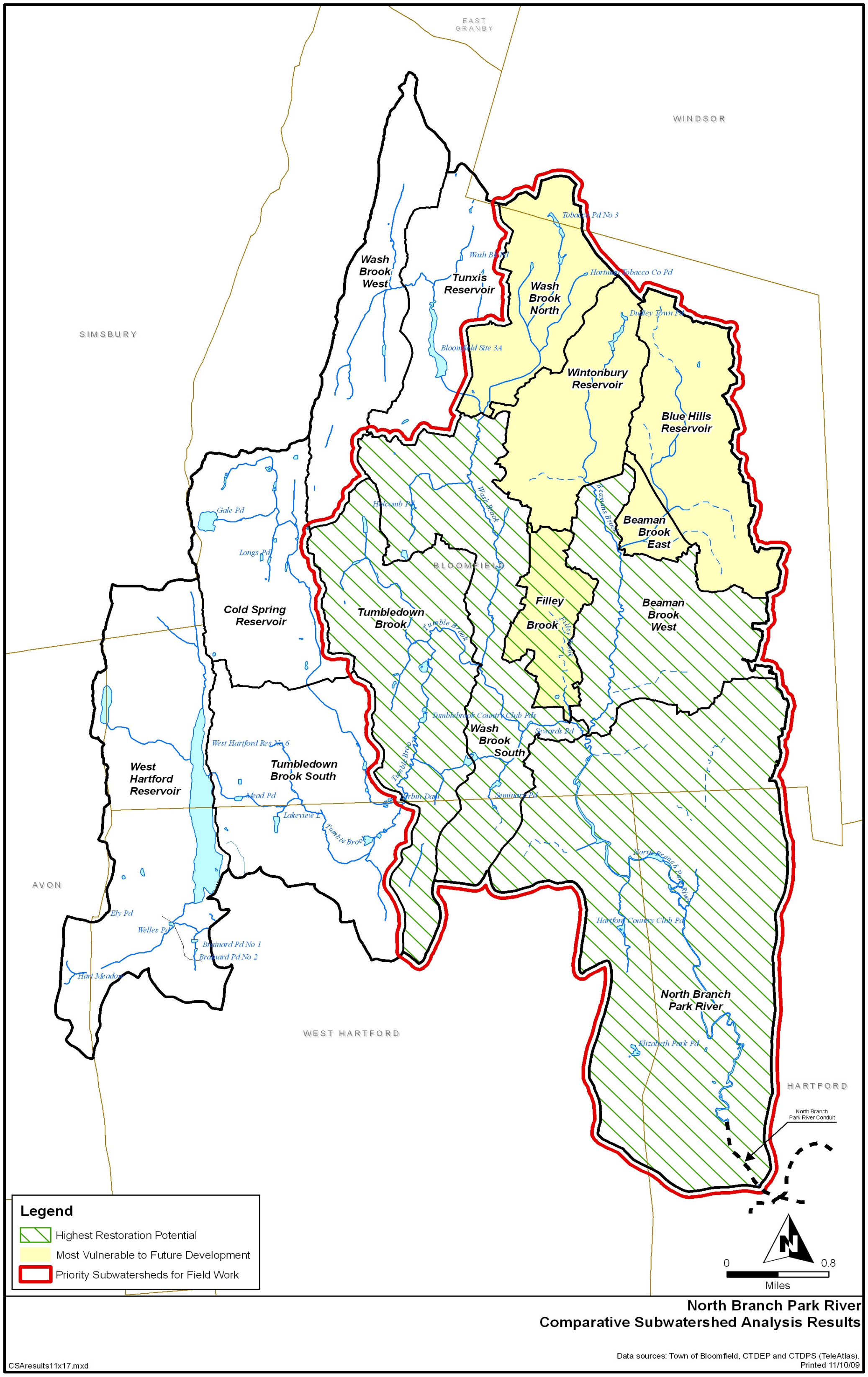


Figure 10-1. Priority Subwatersheds Based on Comparative Subwatershed Analysis

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Appendix A

Wetlands Field Assessment

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Appendix B

Species Lists

Appendix C

CTDEP Water Quality Monitoring Results

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Appendix D

Trinity College Water Quality Monitoring Results

Appendix E

Pollutant Loading Analysis