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BRONX RIVER WATERSHED MANAGEMENT PLAN

(VOLUME 1)

BRONX RIVER WATERSHED ASSESSMENT AND MANAGEMENT REPORT

WESTCHESTER COUNTY, NEW YORK

Prepared for: **Westchester County Department of Planning**
148 Martine Avenue, Room 432
White Plains, New York 10601-4704

Prepared by: **Center for Watershed Protection, Inc.**
8390 Main Street, 2nd Floor
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Baltimore, MD 21211

October 2007

WESTCHESTER COUNTY DEPARTMENT OF PLANNING
Gerard E. Mulligan, AICP, Commissioner

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List of Acronyms

BMP ..... Best Management Practice
BRL ..... Bronx River Lower Direct Drainage Subwatershed
BRM ..... Bronx River Middle Direct Drainage Subwatershed
BRU ..... Bronx River Upper Direct Drainage Subwatershed
BRWA ..... Bronx River Watershed Association
CB ..... Clove Brook Subwatershed
CLEAR ..... Center for Land Use Education and Research
CM ..... Channel Modification
CSA ..... Comparative Subwatershed Analysis
CWP ..... Center for Watershed Protection
DB ..... Davis Brook Subwatershed
DU ..... dwelling unit
EPA ..... U.S. Environmental Protection Agency
ER ..... Eroded Bank
FB ..... Fulton Brook Subwatershed
FMB ..... Fox Meadow Brook Subwatershed
GIS ..... Geographical Information System
GSB ..... Grassy Sprain Brook Subwatershed
GSD ..... Grassy Sprain Brook Direct Drainage Subwatershed
H ..... Hotspot
HB ..... Hartsdale Brook Subwatershed
HOA ..... Home Owner's Association
IB ..... Impacted Buffer
IC ..... impervious cover
ICM ..... impervious cover model
KR ..... Kensico Reservoir Subwatershed
MI ..... Miscellaneous
MOA ..... Memorandum of Agreement
MP ..... Manhattan Park Brook Subwatershed
MS4 ..... Municipal Separate Stormwater Sewer Systems
N ..... Neighborhood
NEA ..... Northern Ecological Associates
NEMO ..... Nonpoint Education for Municipal Officials
NPDES ..... National Pollutant Discharge Elimination System
NWI ..... National Wetlands Inventory
NYS DEC ..... New York State Department of Environmental Conservation
NYS DOT ..... New York State Department of Transportation
OT ..... Outfall
P ..... Pervious Area
R ..... Retrofit
RCH ..... Reach
S ..... Riparian Corridor Restoration
SB ..... Sprain Brook Subwatershed
SC ..... Stream Crossing

SMP.....Stormwater Management Plan
SPDES..... State Pollutant Discharge Elimination System
SSO .....Sanitary Sewer Overflow
TB .....Troublesome Brook Subwatershed
TN .....Total Nitrogen
TP..... Total Phosphorus
TR .....Trash and Debris
TSS.....Total Suspended Solids
USACE ..... U.S. Army Corps of Engineers
USGS .....U.S. Geological Survey
UT .....Utility
WCDP.....Westchester County Department of Planning
WPR..... White Plains Reservoirs Subwatershed
WTM.....Watershed Treatment Model

Executive Summary

E.1 Introduction

The Bronx River and its tributaries drain approximately 48 square miles of urbanized land in Westchester County before flowing through the Bronx Borough to the East River, and ultimately, the Long Island Sound. The Westchester County Department of Planning (WCDP) is spearheading the development of a comprehensive watershed management plan for the Bronx River. As part of this effort, the County has contracted with the Center for Watershed Protection (the Center) and Biohabitats, Inc., to develop the *Bronx River Watershed Assessment and Management Report (Report)*.

The *Report* is the culmination of nearly two years of extensive desktop analyses and field assessments conducted by the Center and Biohabitats. The scope of work for the Center and Biohabitats consisted of three major tasks:

1. Perform a baseline watershed assessment;
2. Identify stream restoration, pollution prevention, and retrofit opportunities; and
3. Craft a *Watershed Assessment and Management Report*.

The *Report* specifies priority actions and identifies candidate stormwater retrofit and watershed restoration project locations. The *Report* covers the entire watershed; however, detailed recommendations and strategies are limited to five priority subwatersheds. The *Report* provides a framework for the County to pursue additional investigations and build upon the management plan for those subwatersheds not assessed by the Center and Biohabitats. Ultimately, the *Report* will serve as a technical support document to the watershed plan being developed by Westchester County.

E.2 Management and Restoration Framework for the Bronx River Watershed

The WCDP initiated this watershed planning effort with the overarching goal of *improving water quality in the Bronx River and its tributaries by controlling the volume of polluted stormwater runoff (aka, non-point source pollution) entering these watercourses*. This goal can best be met by improving and installing infrastructure capable of treating polluted stormwater, natural resources restoration and re-establishment, and public education and outreach.

To meet the WCDP's goal and the Coalition's objectives, 15 key actions are recommended for the watershed. These recommendations provide a framework for implementing the numerous management and restoration practices identified through field assessments as well as program and education-related recommendations identified through both desktop analyses and field assessments.

These recommendations are presented in order of implementation priority. Recommendations should be loosely viewed as short-term, mid-term, and long-term implementation priorities. Responsibility for the implementation of each recommendation will fall to one of three entities: Westchester County; municipalities within the Bronx River watershed; or the Bronx River

Watershed Coalition. Implementation recommendations for the Bronx River watershed are as follows:

1. Transition the Bronx River Watershed Coalition into a long-term management structure.
2. Follow-up with recommended discharge investigations and identified infrastructure maintenance issues.
3. Adopt appropriate regulatory protections.
4. Establish a watershed-wide illicit discharge detection and elimination (IDDE) program.
5. Provide construction and post-construction stormwater management guidance for infill and redevelopment projects.
6. Encourage "good housekeeping" at State, County and municipal facilities.
7. Install priority stormwater retrofits, i.e., management practices, for water quality improvement.
8. Implement priority riparian, i.e., stream, corridor restoration projects.
9. Conduct pollution prevention and source control education for property owners and residents of priority private hotspots and neighborhoods, including governmental staff and elected and appointed officials.
10. Restore priority pervious areas, e.g., manage and remove invasive plant species management and removal, amend soils, plant trees and native species, etc.
11. Increase watershed stewardship signs for public educational purposes.
12. Develop a coordinated monitoring and project tracking plan to track the delivery, implementation, and effectiveness of management and restoration practices.
13. Conduct additional assessment in non-priority subwatersheds, large turf areas, and remaining upland forests.
14. Develop a comprehensive management plan for the Bronx River watershed in both Westchester County and New York City.
15. Host an annual meeting to report on implementation progress and plan updates.

More explanation on each recommendation is provided in Section 4.

E.3 Management and Restoration Opportunities in the Bronx River Watershed

This *Report* presents recommendations for applying a variety of management restoration practices within the Bronx River watershed. The Center and Biohabitats identified more than 150 management and restoration opportunities in the watershed. These are focused on reducing the impacts of stormwater runoff and restoring degraded resources in the watershed. They are broadly classified into five major groups:

- Upland stormwater retrofits
- Riparian corridor restoration

- Pervious area management and restoration
- Pollution prevention and source control education
- Municipal practices and programs

Tables E-1 through E-6 present high priority management and restoration opportunities identified for the watershed. Each opportunity is described in more detail in Sections 5, 6, and 7; and the location of each opportunity may be found on the corresponding subwatershed map in Appendix H.

Table E-1: High Priority Upland Stormwater Retrofit Opportunities in the Bronx River Watershed

Location	Opportunity	Site ID	Map
Ardsley (Ardsley Park)	Modified grass channel with infiltration trench; bioretention	GSB-R6	H-8
Greenburgh (Large school complex in Greenburgh)	Bioretention; swales; rooftop disconnection; reforestation; demonstration and educational projects	FB-R3	H-5
Greenburgh (Best Buy shopping center on Central Avenue)	Swale; bioretention	FB-R4	H-5
Greenburgh (Turco's shopping center on Central Avenue)	Swale	FB-R5	H-5
Greenburgh (Veterans Park North)	Rain garden	GSB-R2	H-8
Greenburgh (Hartsdale Train Station)	Perimeter sand filter; bioswale; demonstration project	HB-R1	H-10
Greenburgh (Greenburgh Nature Center)	Porous pavers; bioretention; educational signage	HB-R3	H-10
Greenburgh (Crossroads Plaza on Tarrytown Road)	Bioretention; grass swale; perimeter sand filter; expanded tree pits; underground sand filter; remove a concrete slab over stream; planter boxes at downspouts; covered storage for sand/salt; tree planting	MP-R1	H-12
Greenburgh (Greenburgh Elementary School on Hillside Avenue)	Remove impervious cover; incorporate more efficient parking and bus lanes; increase landscaping; stormwater treatment practices; demonstration site	MP-R4	H-12
Greenburgh (Greenburgh Town Hall)	Pervious paving; bioretention / rain gardens	MP-R5	H-12
Greenburgh (Greenburgh Library)	Perimeter sand filters; bioretention; revegetation of slopes with native plant demonstration area; permeable paving	MP-R6	H-12
Greenburgh (Westchester Community College)	Pervious pavers; curb cuts; enhance pervious areas on campus	MP-R20	H-12
Mount Vernon (Pennington Grimes Elementary School)	Rain gardens; extended tree pit; trash management; storm drain stenciling; bioswale	BRM-R7	H-2
Yonkers (Public park along Paxton Avenue immediately south of its intersection with Stone Place)	Biofilter	BRM-R16	H-2
Yonkers (City of Yonkers Water Works Building / Sign Shop)	Move traffic operations maintenance to different location; pollution prevention; perimeter sand filter	SB-R1	H-13

Table E-2: High Priority Riparian Corridor Restoration Opportunities in the Bronx River Watershed			
Location	**Opportunity**	**Site ID**	**Map**
Eastchester / Yonkers (Near Garth Woods, along the Bronx River north of Strathmore Road / Harney Road)	Bank stabilization; widen riparian buffer; remove and manage invasive plant species; expand floodplain area; stormwater retrofit; stabilize stormwater outfall; realign Bronx River	BRM-S1	H-2
Greenburgh (Along Manhattan Park Brook at the Old Tarrytown Park, south of Old Tarrytown Road)	Redesign channel; replace culvert and/or daylight stream; remove and manage invasive plant species	MP-S1	H-12
Greenburgh / White Plains (Between Old Kensico Road and the Bronx River Parkway under the Interstate 287 crossing)	Stormwater retrofit; reforestation; remove and manage invasive plant species; widen buffer	BRU-S1	H-3
Mount Pleasant (Westchester County DPW Grasslands facility)	Remove and manage invasive plant species; expand/enhance floodplain; realign stream; stormwater retrofit	DB-S1	H-5
Mount Vernon / Yonkers (Along the Bronx River south of Midland Avenue, north of Scout/Parkway Field)	Replant riparian buffer; remove and manage invasive plant species; stormwater retrofit	BRM-S2	H-2

Table E-3: High Priority Pervious Area Management and Restoration Opportunities in the Bronx River Watershed			
Location	**Opportunity**	**Site ID**	**Map**
Ardsley (Veterans Park)	Reforestation; invasive plant species management	GSB-P2	H-8
Ardsley (Our Lady of Perpetual Help)	Reforestation; stream buffer enhancement	GSB-P3	H-8
Eastchester (Leewood Golf Course)	Perimeter reforestation	BRM-P2	H-2
Eastchester (Eastchester Park)	Invasive plant species removal; trash cleanup; native plantings	BRM-P3	H-2
Greenburgh (Greenburgh Housing Authority complex on Manhattan Avenue)	Native species plantings with signage; benches; pathways	MP-P3	H-12
Yonkers (Old Macy's Distribution Center)	Reforestation	GSB-P6	H-8

Table E-4: High Priority Neighborhood Source Control Opportunities in the Bronx River Watershed			
Location	**Opportunity**	**Site ID**	**Map**
Greenburgh (Single family residential neighborhood along Secor Road)	Lawn care education; storm drain cleanout; downspout disconnection	GSB-N1	H-8
Greenburgh (Single family residential neighborhood east of North Central Avenue, north of East Hartsdale Avenue, and south of Jane Street)	Buffer replanting along stream in open lots; rain gardens and rain barrels; storm drain stenciling; homeowner education on lawn care practices	HB-N3	H-10
Greenburgh (Single family residential neighborhood bounded by Thomas Street, South Healy Avenue, Marion Avenue, and North Healy Avenue)	Homeowner education on lawn care practices; downspout disconnection / rain barrels / rain gardens; check for potential swimming pool discharges	HB-N5	H-10
Greenburgh (Single family residential neighborhood bounded by Hillside Avenue, North Road, Winnetou Road, and the Manhattan Park Brook subwatershed boundary)	Rain barrels / downspout disconnection; lawn conversion, storm drain stenciling; household hazardous waste education; stream buffer management education and replanting	MP-N3	H-12

Table E-4: High Priority Neighborhood Source Control Opportunities in the Bronx River Watershed			
Location	**Opportunity**	**Site ID**	**Map**
Greenburgh (Single family residential neighborhood bounded by Mclean Avenue, Hillside Avenue, I-287, and Manhattan Avenue)	Downspout disconnection / rain barrels; turf conversion; storm drain stenciling; household hazardous waste education	MP-N4	H-12
Greenburgh (Greenburgh Housing Authority Apartments off of Old Tarrytown Road)	Storm drain stenciling; dumpster management; downspout disconnection; lawn conversion - increased landscaping; catch basin cleanouts	MP-N5	H-12
Yonkers (Single family residential neighborhood along Mountaindale Road)	Storm drain stenciling; household hazardous waste management (mobile oil recycling); pet waste management; no dumping signs	GSB-N3	H-8

Table E-5: High Priority Privately Owned Hotspot Management Opportunities in the Bronx River Watershed			
Location	**Opportunity**	**Site ID**	**Map**
Greenburgh / White Plains (Light industrial strip along Fulton Street)	Containment at fueling operation; pollution prevention education; pollution prevention plan review; stormwater retrofits	FB-H4	H-5
Mount Vernon (Lincoln BBQ Restaurant)	Secondary containment for grease storage; waste storage and wash water disposal education	BRL-H4	H-1
North Castle (Metro North Welfare Facility on Fisher Lane)	Follow-up site investigation; pollution prevention plan review	BRU-H2	H-3

Table E-6: High Priority Publicly Owned Hotspot Management Opportunities in the Bronx River Watershed			
Location	**Opportunity**	**Site ID**	**Map**
Eastchester (Eastchester Municipal Maintenance Yard)	Stormwater retrofit; catch basin inserts; pollution prevention education; pollution prevention plan review	BRM-H2	H-2
Eastchester / Scarsdale (Garth Road Village Center)	Storm drain stenciling	BRM-H3	H-2
Elmsford (Elmsford Maintenance Facility)	Retrofit fueling island with underground practice, cover, or catch basin insert	MP-H6	H-12
Greenburgh (Greenburgh Maintenance Yard)	Good examples of compliance, use for demonstration site; upgraded trap in washing area; covered fueling islands	GSB-H6	H-8
Mount Pleasant (Westchester County DPW Grasslands facility)	Underground practice maintenance; pollution prevention plan review; wetland / buffer encroachment and dumping education	DB-H4	H-5
Scarsdale (Bronx River Reservation Maintenance Facility)	Follow-up site investigation; invasive plant species management; stormwater retrofit at fueling area	BRM-H8	H-2
Tuckahoe (Tuckahoe Maintenance Yard on Marbledale Road)	Pollution prevention plan review; stormwater retrofit; covered material storage	BRM-H5	H-2
Tuckahoe (Westchester County Crestwood Maintenance Facility)	Review stormwater retrofits maintenance plans; perform retrofit maintenance	BRM-H7	H-2
Yonkers (Sprain Brook Golf Course)	Materials storage and disposal education; covered fueling island; buffer enhancement	GSB-H5	H-8
Yonkers (City of Yonkers Water Works Building / Sign Shop)	Covered storage; stormwater retrofit; materials storage and proper disposal of paint and asphalt education; increased stewardship of Sprain Brook	SB-H1	H-13

E.4 Report Organization

The *Report* is organized as follows:

Section 1. Introduction – provides an introduction to the Bronx River Watershed Assessment and Management Report as well as the project history.

Section 2. Baseline Conditions in the Bronx River Watershed – describes the baseline, or current, conditions of natural features, community features, and land use and cover in the Bronx River watershed. Also provides an introduction to the Watershed Treatment Model and the Comparative Subwatershed Analysis.

Section 3. Stream Corridor and Upland Assessments Protocols and General Findings – provides an overview of stream and upland assessment methodologies and key findings.

Section 4. Watershed Goals and Recommendations – presents the goal and objectives for managing the Bronx River watershed along with 15 implementation recommendations based on extensive desktop analysis and watershed assessments conducted by the Center and Biohabitats

Section 5. Management and Restoration Practices Applicable to the Bronx River Watershed – describes watershed management and restoration practice opportunities in the Bronx River watershed. These include upland stormwater retrofits, riparian corridor restoration, pervious area management and restoration, pollution prevention and source control education, and municipal practices and programs.

Section 6. Subwatershed Management Strategies – describes management strategies for each of the five subwatersheds selected for detailed assessment and planning.

Section 7. Other Subwatersheds – summarizes information collected for the 10 remaining subwatersheds, including a basic description and any management and restoration practice opportunities identified.

Section 1. Introduction

1.1 Process for Developing the *Watershed Assessment and Management Report*

The *Bronx River Watershed Assessment and Management Report* is the culmination of nearly two years of extensive desktop analyses and field assessments conducted by the Center and Biohabitats. The scope of work for the Center and Biohabitats consisted of three major tasks:

1. Perform a baseline watershed assessment;
2. Identify stream restoration, pollution prevention, and retrofit opportunities; and
3. Craft a *Watershed Assessment and Management Report*.

The initial task in developing this *Report* was to develop an understanding of the baseline, or current, conditions of the Bronx River watershed. To accomplish this, the Center first reviewed existing watershed data, studies, and reports. In addition, the Center analyzed extensive watershed Geographical Information System (GIS) data.

The Watershed Treatment Model (WTM) was then used to estimate existing and future nutrient and sediment loads within the Westchester County portion of the Bronx River watershed. This information was used, in part, to target specific subwatersheds for more detailed and intensive field assessments.

Finally, a Comparative Subwatershed Analysis (CSA) was completed for Bronx River watershed to identify priority subwatersheds for restoration. The CSA uses subwatershed "metrics" to screen subwatersheds within a watershed to identify the ones with greatest restoration potential. Metrics are single numeric values that characterize the relative restoration potential of a subwatershed.

The major outcomes of the baseline assessment task were 1) an understanding of the current conditions of the watershed; 2) estimates of current and build-out sediment and nutrient loading in the Westchester County portion of the watershed; 3) relative "restorability" of the 15 subwatersheds; and 4) selected subwatersheds for detailed assessment and planning. Work completed as part of the baseline assessment task is documented in the report, *Bronx River Watershed Baseline Assessment* (CWP, 2006a), and summarized in Section 2 of this *Report*.

The next major task in developing this *Report* was to identify stream restoration, pollution prevention, and retrofit opportunities in the watershed. The Center and Biohabitats conducted stream and upland field assessments in the Westchester County portion of the Bronx River watershed in 2005 and 2006. During this assessment period, field crews assessed approximately 20 miles of stream, 25 residential neighborhoods and 42 potential hotspot locations in the Bronx River watershed. In addition, 16 open space lots or natural area remnants, 15 riparian corridor restoration sites, and 59 potential retrofit sites were evaluated.

Due to the large size of the watershed, field efforts were targeted to priority stream reaches and subwatersheds identified through the Comparative Subwatershed Analysis, conducted during the baseline watershed assessment task. The findings of this fieldwork are summarized in Section 3

of this *Report* and were presented in detail in three technical memorandums. These documents are available for viewing online at www.westchestergov.com/planning under "Bronx River Coalition."

- *Summary of Findings from the Bronx River Watershed Stream Corridor and Upland Assessments, Fall 2005: Technical Memorandum* (CWP, 2006b)
- *Bronx River Fluvial Geomorphic Assessment: Technical Memorandum Summarizing Findings of the Stream Corridor Assessment* (Rauhofer, et al., 2006)
- *Bronx River Fluvial Geomorphic Assessment: Technical Memorandum Summarizing Findings of the Riparian Corridor Restoration and Retrofit Inventory* (Salladin, 2006)

Opportunities that were identified during the field assessments were organized into five categories of restoration and management practices:

- Upland Stormwater Retrofits – Structural practices installed in upland areas to capture and treat stormwater runoff before it is delivered to the storm drainage system, and ultimately, the Bronx River.
- Riparian Corridor Restoration – Stream repair, stream restoration, stormwater retrofitting, reforestation, and other techniques used to enhance the appearance, structure, or function of riparian corridors.
- Pervious Area Management and Restoration – Application of land reclamation and upland revegetation techniques to improve soil quality, increase stormwater infiltration, and increase urban tree canopy.
- Pollution Prevention and Source Control Education – Provision of educational, enforcement, and technical resources to watershed residents that promote changing resident behaviors or business operations that are causing pollution.
- Municipal Practices and Programs – Improved operation and maintenance of publicly-owned facilities and infrastructure that will reduce pollution generation.

The Center and Biohabitats developed a ranking system to prioritize identified management and restoration practice opportunities within each practice category. Using best professional judgment, each practice location was assigned points and ranked according to several factors, including: water quality benefits; cost; synergy; visibility; feasibility; and potential for community involvement. This resulted in watershed-wide priority list of management and restoration projects, as described in Section 5.

The Center then re-examined all data collected over the course of the project – baseline information, Watershed Treatment Model results, field observations, field assessment results, Bronx River Watershed Coalition restoration objectives, etc. – and developed 15 key recommendations for the watershed, as described in Section 4. These recommendations are the core of this *Report*. They provide a framework for implementing the numerous management and restoration practices identified through field assessments as well as program and education-related recommendations identified through both desktop analyses and field assessments.

Finally, the Center developed specific management strategies for the five subwatersheds selected for detailed assessment and planning (Section 6). In addition, a Subwatershed Treatment

Analysis (STA) was conducted for each priority subwatershed for restoration to examine the extent of subwatershed treatment achieved by the proposed management strategy. The subwatershed management strategies outlined for the priority subwatersheds provide some insight into potential restoration opportunities and management priorities that may be applied in the remaining subwatersheds (Section 7).

1.2 Caveats

It is important to keep in mind that this *Report* is limited in scope and should be updated as more information on the watershed is acquired. Recommendations are based on extensive desktop analysis and observations made during targeted stream and upland assessments.

All stream miles and upland areas were not assessed. Biohabitats assessed approximately 20.1 miles of stream channel in seven subwatersheds, including Clove Brook, Davis Brook, Manhattan Park Brook, Sprain Brook, Bronx River Upper Direct Drainage, Bronx River Lower Upper Direct Drainage, and Bronx River Middle Upper Direct Drainage.

The Center conducted the full range of upland assessments in five of the 15 subwatersheds, including Bronx River Middle Upper Direct Drainage, Fulton Brook, Hartsdale Brook, Manhattan Park Brook, and Grassy Sprain Brook. However, these upland assessments were limited to selected residential, commercial, and institutional areas.

The Center conducted limited upland assessments in additional subwatersheds, including: Bronx River Lower Direct Drainage, Bronx River Upper Direct Drainage, Clove Brook, Davis Brook, Grassy Sprain Brook Direct Drainage, and Sprain Brook. No upland assessments were conducted in the Fox Meadow Brook, Kensico Reservoir, Troublesome Brook, and White Plains Reservoirs subwatersheds.

Section 2. Baseline Conditions in the Bronx River Watershed

2.1 Introduction to the Baseline Assessment

The initial task in developing this *Report* was to develop an understanding of the baseline, or current, conditions of the Bronx River watershed. To accomplish this, the Center:

- Reviewed existing watershed data, studies, and reports;
- Analyzed extensive watershed Geographical Information System (GIS) data;
- Developed a baseline Watershed Treatment Model for existing and future watershed conditions; and
- Conducted a Comparative Subwatershed Analysis.

The results of this baseline assessment are presented in this section and include detail on current watershed conditions for the following categories:

- Natural Features – basic watershed features with consideration of hydrology, geomorphology, water quality, and other watershed data.
- Community Features – historical, community, and jurisdictional characteristics.
- Land Use and Land Cover – current land use and impervious cover.

In addition, the results of the Watershed Treatment Model and the ranking process to compare restorability of the subwatersheds are described.

2.2 Natural Features

2.2.1 Introduction to the Bronx River Watershed

The Bronx River watershed drains approximately 48.3 square miles of urbanized land in Westchester County (Figure 2-1). The Kensico Reservoir is located at the headwaters of the Bronx River, and is one of many components in the New York City water supply system. The Kensico Reservoir has a capacity of 30.6 billion gallons, stores water from the Catskill and Delaware aqueducts, and supplies 85% of Westchester County residents and New York City with drinking water.

Prior to the construction of the Kensico Dam in 1915, the headwaters of the Bronx River were located in the southern portion of New Castle in central Westchester County. The section of channel in the Kensico Reservoir subwatershed is still called the Bronx River, and flows six miles from New Castle into the Kensico Reservoir. According to Malcolm Pirnie, 1975, there is no hydraulic connection between the Kensico Reservoir and the downstream section of the Bronx River. There is, however, a connection between the reservoir and Davis Brook, a tributary to the Bronx River. Also, the large fountain pools in front of the Kensico Dam, when in operation, are filled with water drained from the Kensico Reservoir. This water circulates through the fountain pools and is discharged directly into the Bronx River (Doscher, 2005). A series of wetlands on Davis Brook in Valhalla is now identified as the headwaters of the Bronx River. From this location the Bronx River continues for approximately 23 miles to the East River, at Hunts Point, and then into Long Island Sound (USACE, 2004).

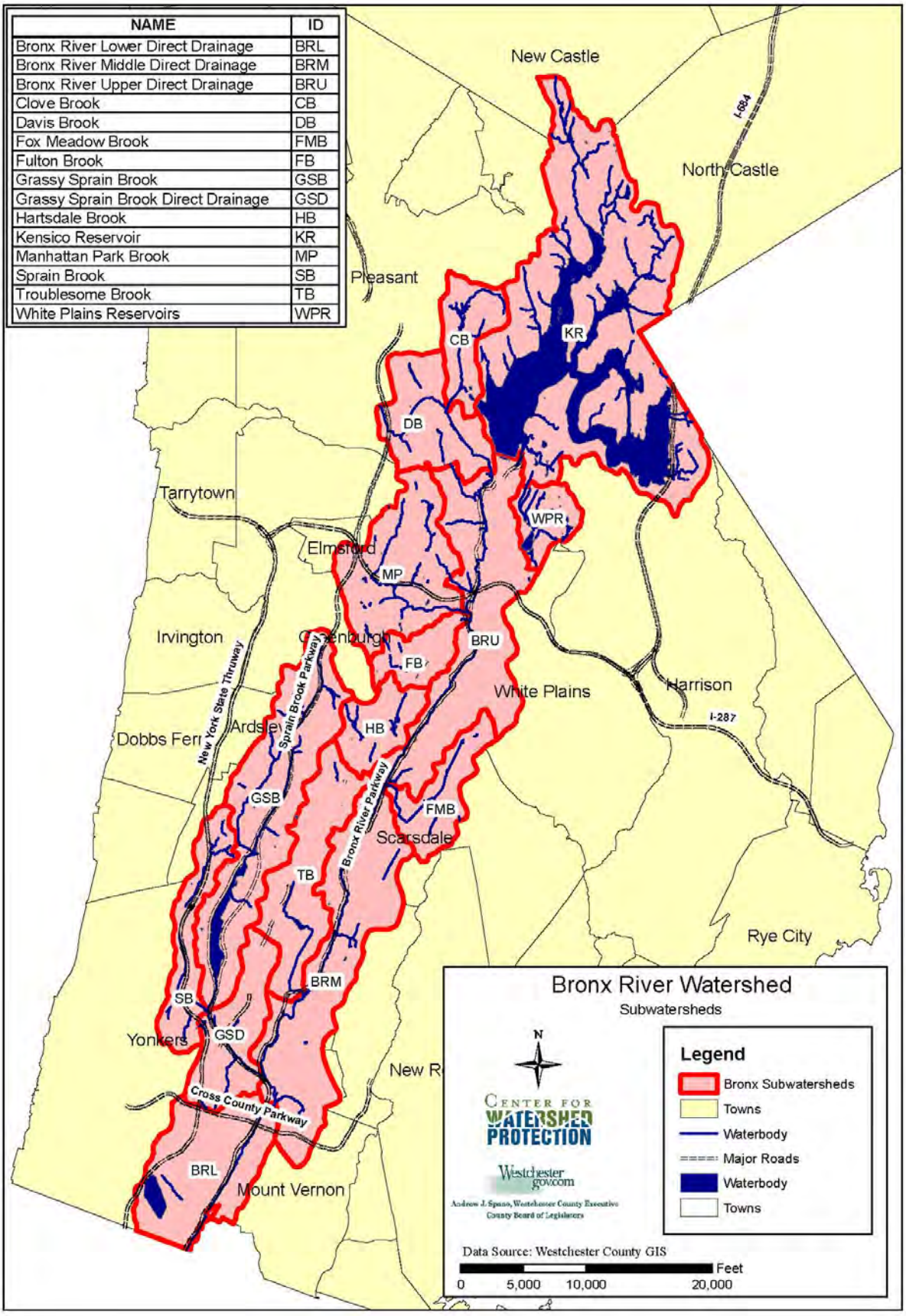


Figure 2-1: Bronx River Watershed and Subwatersheds

A basic profile of the watershed is provided in Table 2-1. Sections 2, 3, and 4 of this *Report* provide more detailed information on the natural features, community features, and land use and land cover of the watershed. The Center reviewed a number of documents while developing this Baseline; a complete listing of all Bronx River related documents obtained and reviewed is provided in Appendix A, along with a list of all GIS data sources used to create maps.

Table 2-1: Basic Profile of the Bronx River Watershed	
Area in Westchester County	• 48.3 square miles (30,932 acres)
Stream Length	• Approx. 53.5 miles (includes Bronx River and its tributaries)
Land Use and Water Coverage	• Residential (44.9%) • Non-Residential (21.5%) • Water (16.2%) • Open Space (12.6%) • Undeveloped (3.3%) • Mixed (1.5%)
Subwatersheds	• 15 subwatersheds
Jurisdictions	• 14 cities, towns, and villages
Water Quality	• 2004 303(d) list for high dissolved oxygen demand and pathogens
Current Impervious Cover	• 20.3% imperviousness (per WCDP, 2005a)
Subwatersheds Selected for Detailed Assessment	• Fulton Brook • Grassy Sprain Brook • Hartsdale Brook • Manhattan Park Brook • Bronx River Middle Direct Drainage
Major Transportation Routes	• Bronx River Parkway, Sprain Brook Parkway, and Cross County Parkway • Cross Westchester Expressway (I-287) • New York State Thruway (I-87) • Harlem Line of the Metro North Railroad System
Significant Natural and Historic Features	• Kensico Reservoir • White Plains Reservoirs • Grassy Sprain Reservoir • Bronx River Parkway Reservation

2.2.2 Hydrology

The natural hydrologic function of the Bronx River has been modified as a result of urbanization, channel relocation, and the construction of impoundments that divert water from the river. The Kensico Dam was constructed in Mount Pleasant on the Bronx River in 1915, reducing the total stream flow by approximately one quarter. The Bronx River basin has three major impoundments below Kensico Dam: White Plains Reservoirs and Grassy Sprain Reservoir, which control approximately 5.3 square miles of Bronx River drainage area (Malcom Pirnie, 1975).

The USGS historically maintained a stream gage on the Bronx River at Bronxville starting in November 1943, though it is currently no longer in operation. Recorded flood flows for the period of operation show a correlation between increasing flood magnitudes and urbanization in the watershed (Malcom Pirnie, 1975). The highest recorded flood on the Bronx River occurred on June 15, 1969, with an estimated flow of 1,580 cfs and a flood stage of 81.1 feet above mean sea level, and an April 2007 storm caused extensive flooding of a nature similar to that in June 1969. The U.S. Army Corps of Engineers (USACE) recently completed a HEC-1 model of the Bronx River based on current land use conditions.

During the construction of the Bronx River Parkway (Parkway) the hydrology of the Bronx River was modified to create ponds, lakes, and other water features deemed to enhance scenic and recreational amenities. The three most significant of these are Bronxville Lake, Scarsdale Lake, and Crestwood Lake, which were created as siltation ponds, and now have accumulated sediment and provide marsh habitat. Crestwood Lake and Bronxville Lake have been identified by Westchester County as in need of periodic dredging to maintain sediment removal efficiencies (Westchester County, 1999).

2.2.3 Subwatersheds in the Bronx River Watershed

The Bronx River watershed has 15 subwatersheds (see Table 2-2 and Figure 2-1), as delineated by the Center. The Center used the following sets of data to define the Bronx River subwatersheds:

- Subwatershed delineations provided by the County, which defined the Kensico Reservoir, the Grassy Sprain, and Bronx River drainages.
- Subwatershed delineations completed by the USACE and provided to the Center as a hard copy drawn onto a USGS topographical map of the area.

The Center refined the subwatershed boundaries based on the following decisions:

- Used the County's overall watershed delineation for the Bronx River watershed, which differed from the delineation completed by the USACE.
- Used the three subwatershed boundaries (Kensico Reservoir, Grassy Sprain, and Bronx River) provided by the County.
- Identified significant tributaries to the Bronx River.
- Reviewed land use and drainage patterns to define subwatershed boundaries within the County's overall Bronx River watershed delineation.
- Field verified suspected diversions not apparent from topographic mapping.[1]

2.2.4 Geomorphology

The form of a river, its channel, banks, and floodplain is the result of an evolving series of processes influenced by climate, natural events, and humans. Before the last ice age it is believed the Bronx River flowed similar to its present day course, with headwaters in upstate New York and terminating in Long Island Sound. The glacier that occupied the Bronx River valley during the last ice age obstructed a portion of the channel, altering the rivers course to its present day alignment (BRA, 2005).

Studies conducted along the Bronx River show that starting before the construction of the Parkway in 1925, the pressures of development filled, rerouted, and altered the course of the original stream channel (Pfizer-Jahnig, 1994). Development influences prior to the Parkway

[1] During October 2005 fieldwork, Biohabitats staff noted that the headwaters of the Sprain Brook subwatershed, as delineated by the USACE, actually drain to Grassy Sprain Brook. The final subwatershed areas and delineations reflect this change.

included railroad construction, factories, mills, sewer lines, and houses built along the river. To accommodate the construction of the Parkway, the natural sinuosity and associated meander bends of the Bronx River at some locations were straightened, deepened or backfilled.

Table 2-2: Bronx River Subwatersheds in Westchester County

Subwatershed	Acronym	Area (acres)	Area (square miles)
Bronx River Lower Direct Drainage	BRL	2,084	3.3
Bronx River Middle Direct Drainage	BRM	3,252	5.1
Bronx River Upper Direct Drainage	BRU	3,213	5.0
Clove Brook	CB	848	1.3
Davis Brook	DB	1,373	2.1
Fox Meadow Brook	FMB	928	1.4
Fulton Brook	FB	628	1.0
Grassy Sprain Brook	GSB	3,120	4.9
Grassy Sprain Brook Direct Drainage	GSD	1,263	2.0
Hartsdale Brook	HB	772	1.2
Kensico Reservoir	KR	7,948	12.4
Manhattan Park Brook	MP	2,118	3.3
Sprain Brook	SB	1,088	1.7
Troublesome Brook	TB	1,725	2.7
White Plains Reservoirs	WPR	576	0.9
Bronx River Watershed		**30,932**	**48.3**

2.2.5 Climate

The Bronx River watershed is located in an area with a temperate and humid climate. Based on historical climate information available from a weather station in White Plains, New York, precipitation is generally well distributed throughout the year with the wettest conditions in April and May and driest in February (worldclimate.com for White Plains, Westchester County). In White Plains, the mean annual precipitation over a 29-year period of record is 48.9 inches, and the 24-hour average temperature ranges from a high of 73.2°F in July to a low of 27.3°F in January.

2.2.6 Water Quality

Water quality in the Bronx River has been degraded, similar to other urban streams, primarily due to the conversion of forested lands to development and impervious surfaces. Pollution enters the Bronx River from non-point and point sources, which include discharges from sewage outfalls. NY State classifies the Bronx River as a Class "C" fresh surface water, "suitable for fishing and fish propagation". The New York State Water Quality Section 305b Report (NYS DEC, 2004) classifies the Bronx River in Westchester County as having impaired segments and the Kensico Reservoir as possibly threatened. The Bronx River in Westchester County is on New York State's 2004 303(d) list of impaired waters for high dissolved oxygen demand and for pathogens (EPA, 2004). Possible pollution sources include effluent from publicly owned

treatment works, sanitary sewer breaks, overflows, and illegal connections or discharges along with urban stormwater runoff.

The Bronx River water quality is generally characterized as moderately to severely impacted based on chemical and biological monitoring efforts (WCDP, 2000). Macroinvertebrate sampling conducted for various studies along the Bronx River have revealed low diversity and occurrences of pollution tolerant species, resulting in a characterization of slightly impacted water quality in the Bronx River near Valhalla to moderately impacted water quality conditions near White Plains, continuing towards New York City (Hudsonia, 1994; NYS DEC, 1998). Floating debris is the most noticeable pollutant in the river, which is primarily originating from street litter washed into storm drains and illegal dumping (WCDP, 2000). A more recent analysis conducted by the USACE in the Bronx River concludes that water quality parameters such as temperature, dissolved oxygen, specific conductivity, salinity, turbidity, pH and redox "fall well within acceptable biological thresholds for supporting aquatic life" (USACE, 2005).

The New York State Department of Environmental Conservation (NYS DEC) has issued Stormwater Phase II permits to 43 communities with Municipal Separate Stormwater Sewer Systems (MS4s) within Westchester County, 14 of which are in the Bronx River watershed. Among the permit requirements the communities must develop a Stormwater Management Plan (SMP), which lists BMPs that will be implemented to reduce stormwater pollution. Ideally, the implementation of SMPs will reduce stormwater pollutant loads entering the Bronx River, improve water quality or prevent further water quality degradation. It has been determined that improving water quality in the Bronx River will also indirectly improve the water quality of Long Island Sound, to which it eventually flows.

2.2.7 Habitat

Habitat in the Bronx River watershed exists primarily in conjunction with urban open spaces, athletic fields, cemeteries, and residential communities. These habitats can consist of ornamental lawns and grasses and upland canopy trees with understory canopy layers. The habitat corridor along the Bronx River and its tributaries is fragmented due to the Parkway, railroad, and adjacent land uses, which inhibit movement and increase the wildlife mortality rate. Wildlife can access the Bronx River Parkway Reservation (Reservation) via its north/south axis, though east/west axis is limited due to urban development.

Within the Reservation, habitat types include deep emergent marsh, successional shrubland, floodplain forest, red maple-hardwood swamp, rich mesophytic forest, and phragmites/purple loosestrife marsh (WCDP, 2000). The remnant forest areas in the Reservation provide habitat for migratory birds.

2.2.8 Wetlands

The Bronx River watershed contains palustrine wetlands, which are primarily broad-leaf deciduous forests. Plant species identified in the Bronx River watershed and common to palustrine wetlands are cattails (*Typha spp*.), common reed (*Phragmites australis*), and spike grass (*Distichlis spicata*).

The Center obtained and reviewed three wetlands-related GIS files from Westchester County: National Wetland Inventory (NWI), Hydric Soil Wetlands from "Soil Survey for Putnam and Westchester Counties, NY", and New York State Designated Freshwater Wetlands. According to these data, approximately 7.2% of the Bronx River watershed is wetlands and/or hydric soils, as displayed in Figure 2-2. Table 2-3 displays wetlands and hydric soils coverage by subwatershed. Please note, however, that these figures are for planning purposes only. The NWI does not incorporate all wetlands, the soil survey's hydric soils mapping is very general in nature, and state wetland mapping generally incorporates only wetlands that are 12.4 acres or greater.

Table 2-3: Wetlands and Hydric Soils Coverage in the Bronx River Subwatersheds

Subwatershed Name	Wetlands Area (acres)	Percent of Subwatershed (%)
Bronx River Lower Direct Drainage	115	5.5%
Bronx River Middle Direct Drainage	312	9.6%
Bronx River Upper Direct Drainage	301	9.4%
Clove Brook	111	13.1%
Davis Brook	119	8.7%
Fox Meadow Brook	72	7.8%
Fulton Brook	59	9.5%
Grassy Sprain Brook	299	9.6%
Grassy Sprain Brook Direct Drainage	32	2.5%
Hartsdale Brook	57	7.4%
Kensico Reservoir	416	5.2%
Manhattan Park Brook	137	6.5%
Sprain Brook	125	11.4%
Troublesome Brook	24	1.4%
White Plains Reservoirs	42	7.3%
Bronx River Watershed	**2,221**	**7.2%**

2.2.9 Forest

Due to the effects of urbanization in the Bronx River watershed, relatively few wooded areas remain. Of those, Garth and Butler Woods in Scarsdale are relatively untouched and represent forested areas that once blanketed the Bronx River basin. These stands include oak and tulip trees, though the hemlock and native flowering dogwoods have been lost due to a wooly adelgid insect infestation. Cranberry Lake Preserve, a 165-acre county park in the Kensico Reservoir subwatershed, is another significant forested area within the Bronx River watershed, as is the water supply protection lands around the Kensico Reservoir.

The Center for Land Use Education and Research (CLEAR) at the University of Connecticut, in partnership with Nonpoint Education for Municipal Officials (NEMO), developed satellite imagery based land cover classifications, circa 2002, for the Long Island Sound basin. The 11 land cover categories depicted include: developed; turf and grass; other grasses and agriculture; deciduous forest; coniferous forest; water; non-forested wetland; forested wetland; tidal wetland; barren land; and utility right-of-ways. These data provide an overview of deciduous and coniferous forest cover across the Bronx River watershed, as displayed in Figure 2-3. According to this data, approximately 9,120 acres, or about 29% of the watershed, is forested.

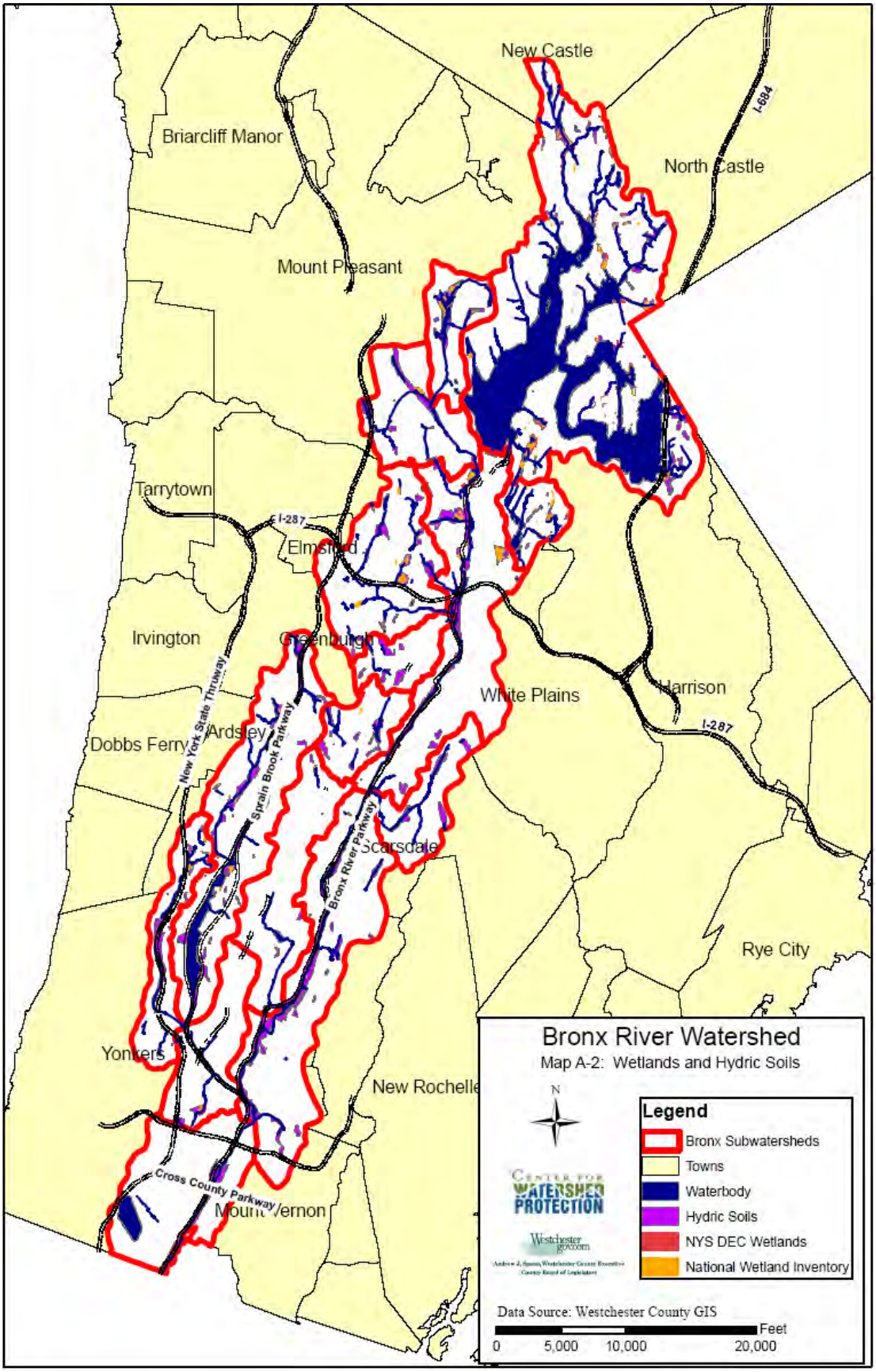


Figure 2-2: Wetlands and Hydric Soils Coverage in the Bronx River Watershed

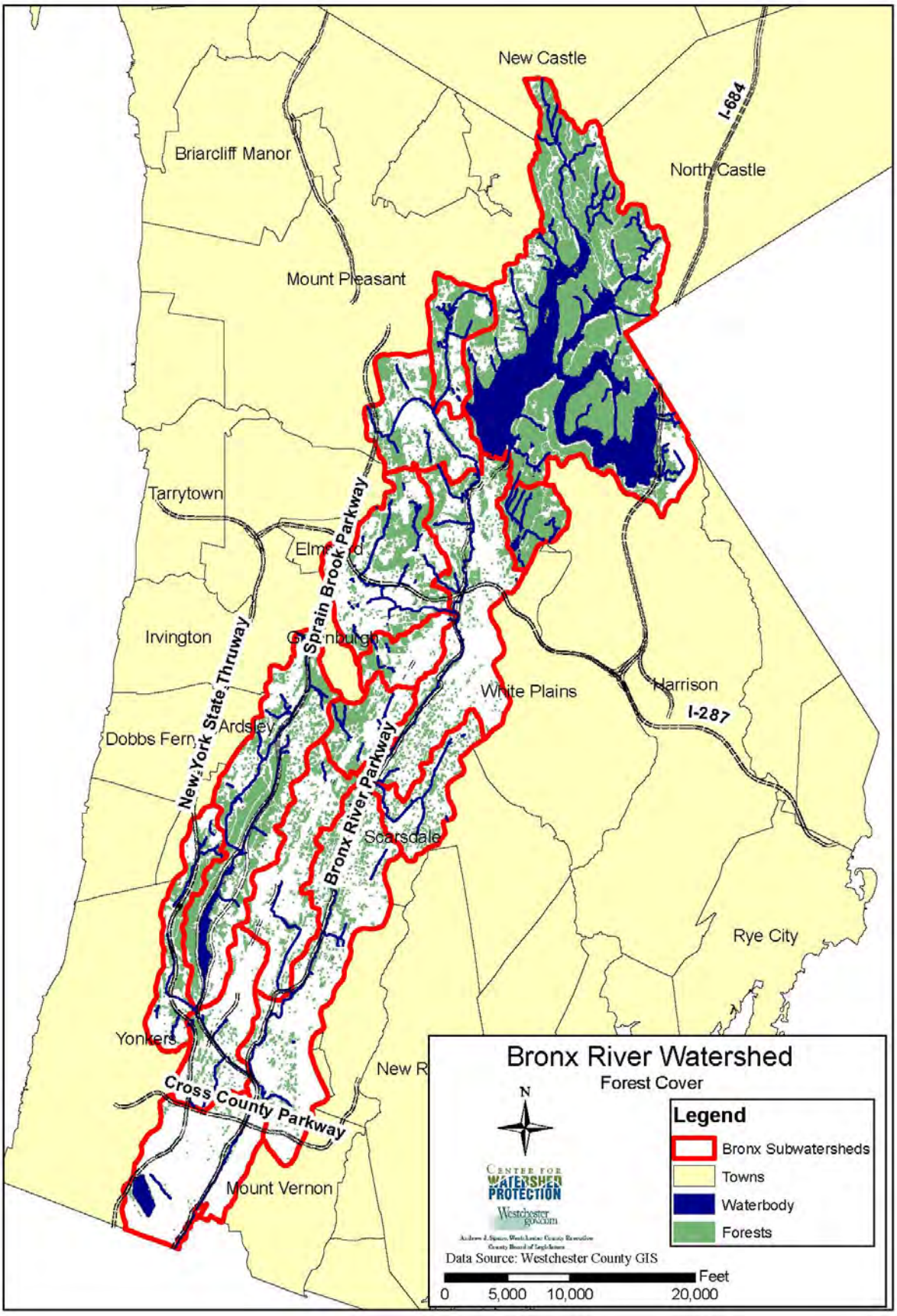


Figure 2-3: Forest Cover Across the Bronx River Watershed

2.2.10 Flora and Fauna

A study conducted in the vicinity of White Plains, investigating the restoration of the Woodland Viaduct, identified and described riparian wetland and floodplain communities along the Bronx River (Pfizer-Jahnig, 1994). Riparian wetlands are predominantly forested with ash-leaved maple and box elder species. Floodplain communities consist of canopy, vine, shrub, and herbaceous layers with a combination of native and non-native species. Red maple, American elm, and speckled alder are common species identified in the floodplain canopy. Common vines in the floodplain include wild grape, Japanese honeysuckle, poison ivy, and Asiatic bittersweet. The two most common shrub species identified in the floodplain are invasive species, the multiflora rose and Morrow's honeysuckle. Common herbaceous layer species include jewelweed, skunk cabbage, common reed, purple loosestrife, mugwort, falde hellebore, and lesser celandine. The most commonly reported invasive plant species along the Bronx River include the Asiatic bittersweet vine that chokes wooded areas, purple loosestrife (an invasive non-native wetland plant), and Tree of Heaven and Norway maple, both of which displace native forest species.

The USACE Draft Scoping Document for the Bronx River basin (USACE, 2004) details a comprehensive list of mammal, avian, reptile, and waterfowl and waterbird species identified in the Bronx River watershed based upon studies by the US Fish and Wildlife Service and the National Oceanic and Atmospheric Administration. Identified mammal species include eastern gray squirrel, eastern cottontail, house mouse, muskrat, Norway rat, raccoon, and white-tailed deer. Common avian species include red-winged blackbird, blue jay, American robin, marsh wren, house sparrow, American goldfinch, American crow, and mourning dove. Wooded areas and wetlands in the watershed provide habitat for reptilian species such as the eastern painted turtle, common garter snake, common snapping turtle, and red-eared slider. Observed waterfowl and waterbirds include mallard, black duck, herring gull, and snowy egret. Generally wildlife is limited to available habitat in the urbanized watershed and the diversity of species is low. Additional species identified along the Bronx River during a 2005 survey include meadow vole and white-footed mouse mammal species, and Canada goose, gray catbird, black-capped chickadee, great blue heron, white throated sparrow, and rock dove avian species (USACE, 2005).

During a June 1994 sampling event in White Plains, six species of fish were identified in the Bronx River: blacknose dace, white sucker, mummichog, redbreast sunfish, pumpkinseed, and tessellated darter (Hudsonia, 1994). With the exception of the blacknose dace, which was caught in low numbers, all are considered pollution tolerant species. Of the sampled fish, numerous specimens had parasitic and/or bacterial infections. The results of the sampling revealed degraded diversity and density, which was attributed to poor water quality. A sampling event conducted in September 1998 identified many of the same species as well as fathead minnow and bluegill (NYS DEC, 1998). A more recent study in the Bronx River revealed a very low diversity of fish species at all sampled sites, though based on observed site and water quality conditions the study concludes "there may be as many as several dozen fish species that could be candidates for the fish fauna of the Bronx River" (USACE, 2005).

2.2.11 Rare, Threatened, or Endangered (RTE) Species

Numerous avian, mammal, plant, reptile and amphibian species listed by Federal, State or County jurisdictions as threatened or endangered are known to occur in Westchester County, though their occurrence in the Bronx River watershed has not been confirmed. Of those, the bog turtle and bald eagle are two federally listed threatened or endangered species identified within Westchester County, whose occurrence in the Bronx River watershed is uncertain (USACE, 2004).

2.3 Community Features

2.3.1 History of the Area

Starting before the arrival of Europeans in the 1600s, the Bronx River provided Native Americans who lived along the river a source of food, water, and spiritual inspiration. Tribes that were known to have lived in the area include Mohegan, Weckquasgeek, and Siwanoy. The Siwanoy Indians called the river valley "Laaphawachking" or "Place of Stringing Lakes" because of the multiple beaver dams and ponds built along it, while the Mohegan Indians called the river "Aquehung" or "River of High Bluffs."

The bountiful beaver populations along the river first attracted European traders in the 1600's. A Swedish settler by the name of Jonas Bronck purchased 500 acres of land from the Mohegan Indians in 1639, and over the next 100 years the power of the "Bronck's River" was utilized by as many as 12 mills to produce commodities such as tapestries, pottery, flour, paper, snuff and barrels.

In 1776, the Bronx River basin was the location of the Revolutionary War Battle of White Plains. During the battle, and for some time following, General George Washington's military headquarters were located in the Jacob Purdy House in Northern White Plains. The Jacob Purdy House and monuments to the battle have been preserved in and around White Plains.

Well into the 1800's the river remained thickly forested and was even considered as a potential water source for New York City. Conditions in the Bronx River precipitously deteriorated over the next 75 years as construction of the New York Central Railroad in the 1840's created an industrial corridor along the Bronx River, leading one official to describe the river as an "open sewer."

In 1905, Westchester County initiated the construction of the Bronx River Valley Sewer District to control the major sewer sources entering the river. The Sewer District did not solve all the pollution problems, so the Bronx River Parkway Commission began consolidating properties along the river to create a buffer from burgeoning development and pollution sources, establishing what is today the 807-acre Reservation. Another component in this effort involved the construction of the Parkway, within the Reservation, which was completed in 1925.

The Parkway was the first roadway in the country designed to integrate the landscape and offer a scenic recreational driving experience for city residents. The Parkway was based on designs

made popular by Fredrick Law Olmstead and Calvert Vaux in New York's Central Park and in Boston, Massachusetts, which were originally modeled after the tree-lined boulevards in Paris and Berlin. The Bronx River Parkway Commission coordinated a collaborative design effort led by Jay Downer, the Commission's Chief Engineer, Arthur G. Hayden, the Design Engineer, and Hermann Merkel, the Chief Landscape Architect. Elements of the design required channelization of the Bronx River, reforestation of the riverbanks and surrounding Reservation areas, and the future management of the river, roadway, and parkland as one cohesive unit.

2.3.2 Watershed Jurisdictions

The Bronx River watershed is almost entirely contained within Westchester County and the Bronx Borough of New York City. Within Westchester County, 14 jurisdictions – three cities, six towns, and five villages – encompass the watershed (Table 2-4). Almost half of the watershed falls within two jurisdictions – Greenburgh and Yonkers.

Only three subwatersheds are entirely contained within a single jurisdiction – Clove Brook (in Mount Pleasant), Grassy Sprain Brook Direct Drainage (in Yonkers), and Hartsdale Brook (in Greenburgh). The remaining subwatersheds cross multiple jurisdictional boundaries, with the most (seven jurisdictions) being in the Bronx River Middle Direct Drainage. Table 2-5 displays the jurisdictions the subwatersheds are in.

Table 2-4: Jurisdictions in the Bronx River Watershed

Jurisdiction	Area within the Watershed (square miles)	Percent of Watershed
Town of Greenburgh	10.8	22.3%
City of Yonkers	9.8	20.3%
Town of North Castle	8.1	16.8%
Town of Mount Pleasant	6.8	14.1%
City of White Plains	3.2	6.7%
Village of Scarsdale	2.7	5.7%
Town of Harrison	1.4	2.9%
Town of Eastchester	1.2	2.5%
City of Mount Vernon	1.2	2.5%
Village of Bronxville	0.9	1.8%
Village of Ardsley	0.6	1.2%
Town of New Castle	0.6	1.2%
Village of Tuckahoe	0.6	1.2%
Village of Elmsford	0.4	0.8%
Bronx River Watershed	48.3	100%

Table 2-5: Bronx River Subwatersheds and Jurisdictions			
Subwatershed	**Jurisdiction**	**Area (square miles)**	**Percent of Subwatershed**
Bronx River Lower Direct Drainage	Mount Vernon	0.6	19.5%
	Yonkers	2.6	80.5%
Bronx River Middle Direct Drainage	Bronxville	0.9	16.8%
	Eastchester	1.2	23.4%
	Greenburgh	0.4	7.0%
	Mount Vernon	0.6	11.4%
	Scarsdale	0.6	12.3%
	Tuckahoe	0.6	11.5%
	Yonkers	0.9	17.7%
Bronx River Upper Direct Drainage	Greenburgh	1.1	22.7%
	Mount Pleasant	0.2	4.4%
	North Castle	0.6	12.6%
	Scarsdale	0.8	15.9%
	White Plains	2.2	44.4%
Clove Brook	Mount Pleasant	1.3	100.0%
Davis Brook	Greenburgh	0.0	1.0%
	Mount Pleasant	2.1	99.0%
Fox Meadow Brook	Scarsdale	1.3	91.4%
	White Plains	0.1	8.6%
Fulton Brook	Greenburgh	0.8	76.8%
	White Plains	0.2	23.2%
Grassy Sprain Brook	Ardsley	0.6	11.8%
	Greenburgh	2.8	57.4%
	Yonkers	1.5	30.8%
Grassy Sprain Brook Direct Drainage	Yonkers	2.0	100.0%
Hartsdale Brook	Greenburgh	1.2	100.0%
Kensico Reservoir	Harrison	1.2	9.9%
	Mount Pleasant	3.2	25.4%
	New Castle	0.6	4.6%
	North Castle	7.4	59.9%
	White Plains	0.0	0.1%
Manhattan Park Brook	Elmsford	0.4	12.1%
	Greenburgh	2.9	87.6%
	Mount Pleasant	0.0	0.3%
Sprain Brook	Greenburgh	0.5	29.3%
	Yonkers	1.2	70.7%
Troublesome Brook	Greenburgh	1.1	40.8%
	Yonkers	1.6	59.2%
White Plains Reservoirs	Harrison	0.2	16.7%
	North Castle	0.1	11.4%
	White Plains	0.7	72.0%

2.3.3 Community Features

The communities of people who live, work, or play in the Bronx River watershed fill an important role as advocates for restoring and protecting the rivers valuable resources. In 1974, prompted by degraded conditions in the Bronx River, local residents formed the Bronx River Restoration Project, Inc., which succeeded in numerous stream clean ups and community outreach efforts. The Bronx River Alliance was formed in 2001 to continue and expand upon these efforts by partnering with local and regional stakeholders in the Bronx River watershed.

The Reservation was designed to provide numerous recreational opportunities, starting with the scenic drive along the Bronx River Parkway to the ball fields and Boy Scout facilities that continue to attract the community. The most prominent of these facilities include the Westchester County Center and the Kensico Dam Plaza and Park. Unfortunately, some of the community access to the Bronx River has led to compacted soils, litter, and localized areas of bank erosion.

The most common recreation activities along the Bronx River are canoeing, kayaking, and fishing, though water quality conditions in the river generally prevent primary contact recreation such as swimming. Concurrent with the construction of the Parkway, the Bronx River Pathway was created within the Reservation, which allows walkers to access and enjoy the river. Another popular activity that occurs during the spring and autumn are Bike & Skate Sundays. On these Sundays a portion of the Parkway closes to vehicular traffic and is open to pedestrians, bicycles and skaters.

2.3.4 Transportation Corridors

Two-thirds of the Bronx River Parkway is listed on the National Register of Historic Places, and is valued for its small roadway size, its contained views, and modest speed limits. It has been estimated that traffic-related alterations have destroyed the historic integrity of the remaining one-third of the Parkway (Pfizer-Jahnig, 1994). Not only does the Parkway fulfill its original purpose as a scenic highway, as the population of Westchester County has grown, it also serves as an important transportation corridor into New York City and for local destinations.

Other important transportation corridors that cross or parallel the Bronx River watershed include the Cross Westchester Expressway (I-287), NY State Thruway (I-87), Sprain Brook Parkway and Cross County Parkway. The Harlem line of the Metro North Railroad System is also located in the Bronx River watershed with stations in Mt. Vernon, Bronxville, Tuckahoe, Crestwood, Scarsdale, Hartsdale, White Plains, North White Plains, Valhalla and Mt. Pleasant. Major transportation corridors in the watershed are displayed in map Figure 2-4.

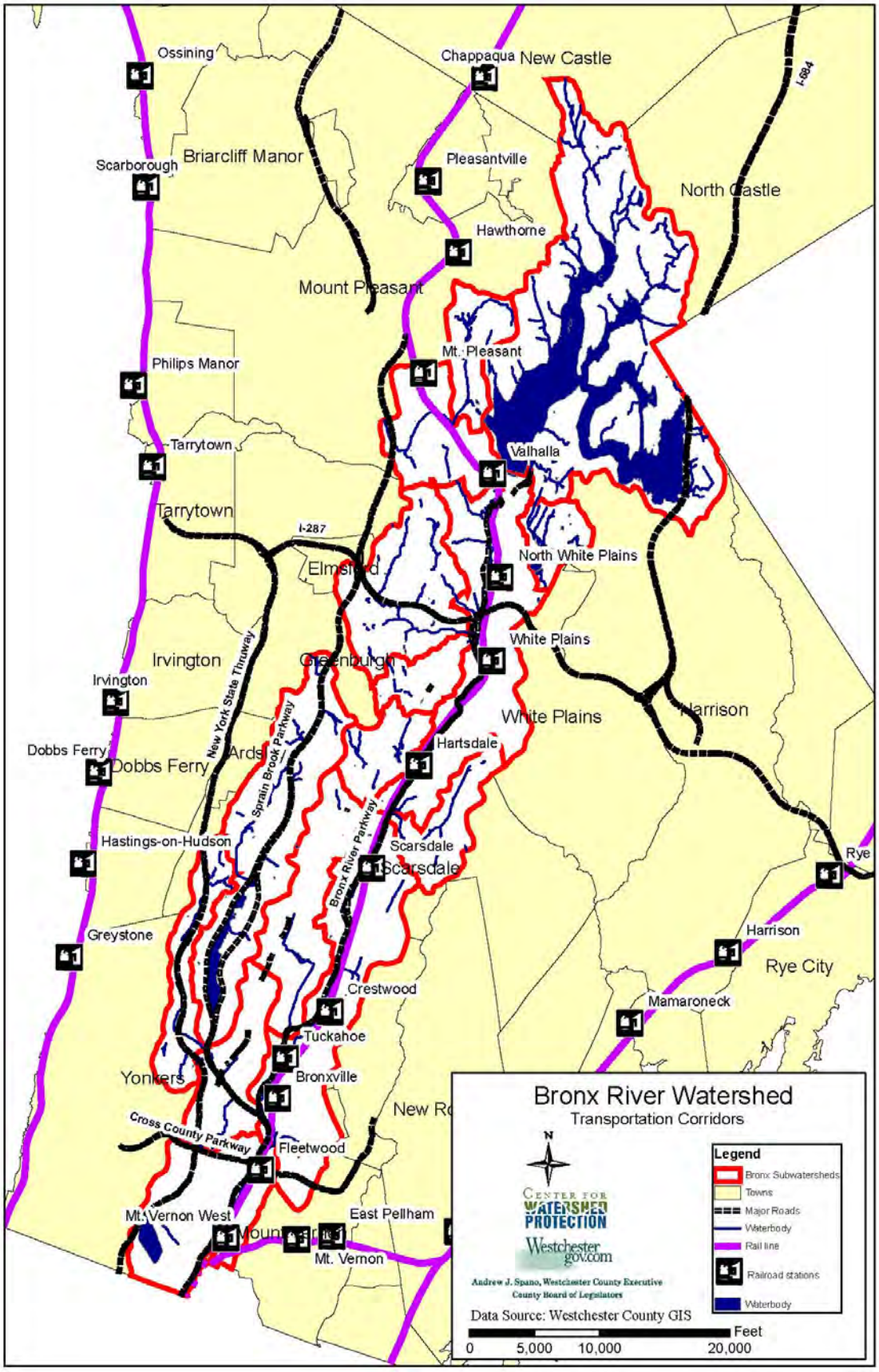


Figure 2-4: Major Transportation Corridors in the Bronx River Watershed

2.3.5 Utilities

One of the reasons the Reservation was initially conceived, as early as 1885, was due to uncontrolled sewage discharges entering the river. The Bronx Valley Sewer District was constructed in 1907 and includes a sanitary sewer trunk line that parallels, and in some locations crosses, the Bronx River servicing an area of approximately 21,980 acres. The Bronx Valley Sewer District did not stop all pollution from entering the river, since dumping from riverbanks remained unrestricted, and private landowners were not required to connect to the new sewer.

Utility companies consider the Reservation a desirable location for utility lines for many reasons, including minimal disruption of local roads, low relative cost to restore parkland as opposed to roadways, easy access for repairs particularly when located in an unpaved area, and minimal disruption to nearby property owners (WCPD, 2000). The most significant utility operators include Consolidated Edison (Con Edison) Gas Company (subsurface gas electric and gas lines), Tennessee Gas Transmission Company (natural gas), and UA Columbia Cablevision (cable line).

2.4 Land Use and Land Cover

2.4.1 Current Land Use

In the summer of 2005, Westchester County staff analyzed and confirmed current land use in the watershed using 2000 aerial photos. County staff created a new GIS layer (WCDP, 2005b) that identified three categories of current land use: *Level I Land Use*, *Level II Land Use,* and *Environmental Function.* These land use codes are summarized in Table 2-6.

It should be noted that, once the GIS layer was developed, it did not align with the County's Bronx River watershed boundary. This is due to the slight variations in GIS data from different sources. County staff shifted the land use GIS layer by hand so that it aligned with the watershed boundary.

Land use in the watershed, identified by the Level I Land Use categories, is displayed in Table 2-7. Residential land use is the dominant land use in the watershed, covering about 45% of the watershed. This is followed by non-residential land use at 21.5%, open water at 16.2%, and open space at 12.6%. The most significant open space parcel in the Bronx River watershed is the 807-acre Reservation. The watershed is largely built-out, with only 3.3% identified as undeveloped.

Level II Land Use and land use categorized by Environmental Function can be found in Appendix B.

Table 2-6: Categorization of Land Use Codes (Source: WCDP, 2005c)		
Residential	**Non-Residential cont.**	**Open Space cont.**
RHD Residential High Density	**MIXED Mixed Use**	**PR Public Recreation**
Residential High Density	*Mixed Use*	*Camp*
RLD Residential Low Density	**OFF Office**	*Club/Center*
Residential Low Density	*Office*	*Conservation Land*
RMD Residential Medium Density	**TCU Transportation Utility**	*Golf*
Residential Medium Density	*Transportation General*	*Historic*
RVLD Residential Very Low Density	*R.O.W. Easements*	*Homeowners Assoc.*
Residential Very Low Density	*Utilities*	*Marina*
Non-Residential	**STP Sewage Treatment Plant**	*Open Space General*
AGR Agriculture	*Sewage Treatment Plant*	*Park*
Farm	**Open Space**	*Private Recreation General*
Live Stock / Stables	**NATPR Nature Preserve**	**PUB Public Non-Park Land**
Nursery	*Preserve*	*Conservation Land*
Other	**PPA Public Park Active**	*R.O.W. Easements*
CEM Cemetery	*Beach*	*Landfill*
Cemetery	*Club/Center*	*Marina*
CR Commercial	*Open Space General*	*Non-Park Lands General*
Commercial General	*R.O.W. Easements*	**PUR Public Recreation**
Hotels, Motels and Resorts	*Historic*	*Golf*
Motor Vehicle Services	*Marina*	*Club/Center*
IPA Institutional	*Park*	**Undeveloped**
Institutions	**PPP Public Park Passive**	**U Undeveloped**
MIW Manufacturing	*Open Space General*	*Undeveloped*
Manufacturing/Warehouse	*R.O.W. Easements*	**Water**
MIN Mining and Quarrying	*Marina*	**IWB Waterbody**
Mining and Quarrying	*Park*	*Waterbody*
	Camp	**W-SUP Water Supply**
		Water Supply

Level I Land Use Codes: highlighted in gray
Level II Land Use Codes: bold faced
Environmental Function: italicized

Table 2-7: Bronx River Watershed Current Level I Land Use and Water Coverage		
Level I Land Use	**Area (square miles)**	**Percent of Watershed**
Residential	21.7	44.9%
Non-Residential	10.4	21.5%
Water	7.8	16.2%
Open Space	6.1	12.6%
Undeveloped	1.6	3.3%
Mixed	0.7	1.5%
Bronx River Watershed	48.3	100.0%

2.4.2 Impervious Cover

In 2005, Westchester County staff conducted an impervious surface analysis of the Bronx River watershed (WCDP, 2005a). Impervious surfaces were defined as structures (buildings, tanks, train stations, train platforms, and miscellaneous structures) and transportation features (paved roads, paved alleys, driveways, sidewalks, and paved parking). Staff utilized existing structure and transportation datasets from the County's 2000 Base Mapping Project and confirmed questionable features using orthophotos. A complete description of the methodology and datasets used are provided in Appendix C.

Based on this data, the watershed has a current impervious cover of 20.3% (Table 2-8). Imperviousness of the subwatersheds ranges from 43.7% in the Bronx River Lower Direct Drainage subwatershed, to 1.7% in the White Plains Reservoirs subwatershed. Impervious cover generally decreases moving from south to north in the watershed. The imperviousness of all subwatersheds is displayed in Table 2-8 and in Figure 2-5.

Subwatershed imperviousness is a valuable indicator of the impacts of urbanization on streams. When evaluating the direct impact of urbanization on streams, researchers have emphasized hydrologic, physical, and biological indicators to define urban stream quality. In recent years, impervious cover has emerged as a key paradigm to explain and sometimes predict how severely these stream quality indicators change in response to different levels of watershed development. The Center has integrated these research findings into a general watershed-planning model, known as the impervious cover model (ICM). The ICM predicts that most stream quality indicators decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25% impervious cover.

Table 2-8: Bronx River Subwatersheds Impervious Cover

Subwatershed Name	Impervious Area (acres)	Imperviousness (%)
Bronx River Lower Direct Drainage	912	43.7%
Grassy Sprain Brook Direct Drainage	437	34.6%
Fulton Brook	205	32.7%
Bronx River Upper Direct Drainage	959	29.8%
Troublesome Brook	511	29.6%
Bronx River Middle Direct Drainage	956	29.4%
Sprain Brook	240	22.0%
Manhattan Park Brook	459	21.7%
Hartsdale Brook	155	20.1%
Fox Meadow Brook	184	19.9%
Clove Brook	133	15.7%
Grassy Sprain Brook	455	14.6%
Davis Brook	184	13.4%
Kensico Reservoir	479	6.0%
White Plains Reservoirs	10	1.7%
Bronx River Watershed	**6,279**	**20.3%**

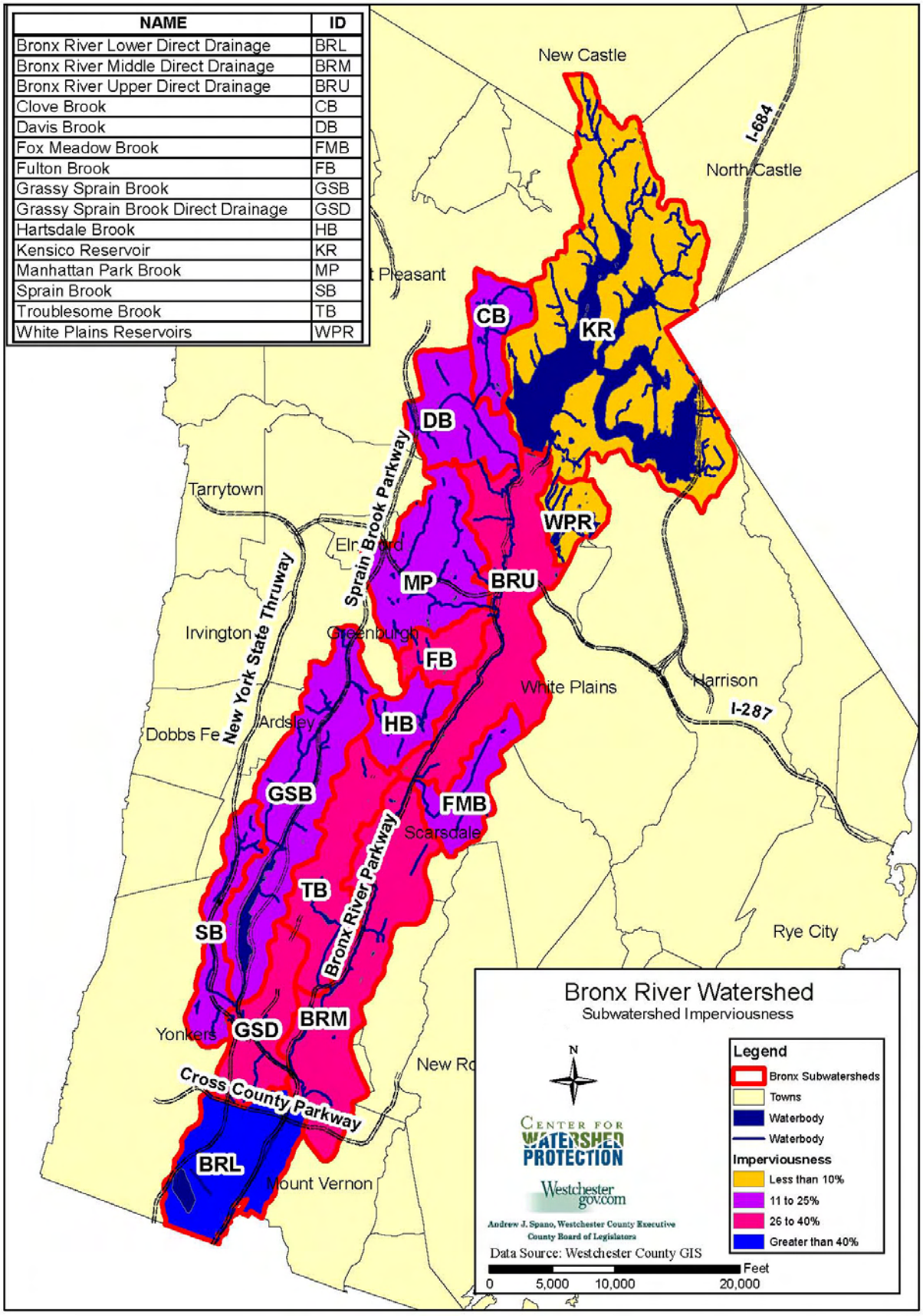


Figure 2-5: Imperviousness of Subwatersheds in the Bronx River Watershed

2.4.3 Future Growth

The potential for future development was not reviewed extensively as part of this project. As noted above, only 3.3% of the watershed is currently classified as "undeveloped," implying that any significant development activities in the future will most likely occur as infill or redevelopment.

With the exception of Sprain Brook, subwatershed undeveloped area generally increases moving south to north in the watershed. The Kensico Reservoir, Clove Brook, and Davis Brook subwatersheds contain more than two-thirds of the undeveloped lands in the watershed. Undeveloped land use by subwatershed is displayed in Table 2-9.

Table 2-9: Undeveloped Land Use by Subwatershed

Subwatershed	Undeveloped Area (acres)	Percent of Subwatershed	Percent of Watershed
Kensico Reservoir	282.1	3.5%	0.9%
Clove Brook	226.5	26.7%	0.7%
Davis Brook	190.7	13.9%	0.6%
Sprain Brook	115.8	10.6%	0.4%
White Plains Reservoirs	69.2	12.0%	0.2%
Bronx River Upper Direct Drainage	44.6	1.4%	0.1%
Grassy Sprain Brook	30.7	1.0%	0.1%
Manhattan Park Brook	22.9	1.1%	0.1%
Grassy Sprain Brook Direct Drainage	16.9	1.3%	0.1%
Bronx River Middle Direct Drainage	12.0	0.4%	0.0%
Troublesome Brook	7.8	0.5%	0.0%
Fox Meadow Brook	0.8	0.1%	0.0%
Hartsdale Brook	0.7	0.1%	0.0%
Bronx River Lower Direct Drainage	0.2	0.0%	0.0%
Fulton Brook	0.1	0.0%	0.0%
Total	**1,020.8**		**3.3%**

2.5 Subwatershed Prioritization

2.5.1 Watershed Treatment Model

The Watershed Treatment Model (WTM) was used to estimate existing and future nutrient and total suspended solid loads within the Westchester County portion of the Bronx River watershed and its 15 subwatersheds. This information was used, in part, to target specific subwatersheds for more detailed and intensive field assessments.

The WTM, version 3.1 (Caraco, 2002), is a simple spreadsheet model used to:

- Estimate pollutant loading under current watershed conditions
- Determine the effects of current management practices

- Estimate load reductions associated with implementation of structural and non-structural management practices
- Evaluate the effects of future development

The model has two basic components: Pollutant Sources and Treatment Options. The *Pollutant Sources* component of the WTM estimates the load from primary land uses (i.e. residential, commercial, forest land) and secondary sources (i.e. active construction, managed turf, channel erosion, illicit connections) in a watershed without treatment measures in place. The *Treatment Options* component of the model estimates the potential reduction in this uncontrolled load if various treatment measures (both structural and nonstructural) are used. A more detailed description of the WTM can be found in Appendix D.

The following caveats should be considered while reviewing this portion of the subwatershed prioritization:

- The WTM is a planning level model primarily for urban/suburban applications. There are many simplifying assumptions made by the WTM, and the model results are not calibrated. Therefore, the results of the model simulations should be compared on a relative basis rather than used as absolute values.
- The application of existing treatment practices in the Bronx River watershed is based on limited GIS data[2], best professional judgment, and default values associated with the WTM.
- A series of modeling assumptions were made on loading rates, existing and current practice application, and stormwater program implementation that may or may not be valid throughout the Bronx River watershed. These assumptions were reviewed by County staff for refinement where possible.

A description of the assessment methods and the results of the WTM modeling for existing and future conditions in the Bronx River watershed, with no change to existing management practices, is provided below.

Pollutant Sources

The WTM land use primary source estimates are based on area calculations from Westchester County's land use layer. Impervious cover factors were assigned to each land use based on guidance derived and reported in "Impervious Cover and Land Use in the Chesapeake Bay Watershed" (Cappiella and Brown, 2001). The WTM impervious cover estimates were also compared to direct impervious cover calculations from Westchester County's impervious cover GIS layers. The WTM estimates were adjusted where reasonable, using best professional judgment, to align more closely with the directly measured values generated from the County impervious cover layers. Limited discrepancies exist between the two impervious cover values for some subwatersheds. This is explained, in part, by 1) factors from Cappiella and Brown are

[2] Although extensive GIS data was provided by the County to the Center, additional GIS data that would have been useful when developing the WTM include locations of existing stormwater treatment practices, septic systems, storm drains, and sanitary sewers.

composites and taken from a different geographic region, and 2) County impervious cover layers don't include all forms of impervious cover such as sidewalks, shorter driveways, and small parking areas.

Additional assumptions for primary sources include:

- An annual average precipitation of 48.9 inches (worldclimate.com for White Plains, Westchester County).
- Half of rural TN load is from storm versus non-storm flow, 70% of TP and 90% of TSS, respectively.
- Planning horizon of 20 years.
- The Kensico Reservoir Basin subwatershed was not included as a primary source contributor to the entire Bronx River watershed because there is no longer a hydrologic connection between the Kensico Reservoir and the Bronx River.
- Pollutant contributions from open water were removed from the following subwatersheds: White Plains Reservoirs, Kensico Reservoir, Grassy Sprain and the Bronx River Lower Direct Drainage. This adjustment was made based on three factors: 1) each of these subwatersheds contain a large area of open water; 2) the pollutant assimilation or uptake capacity of these water bodies is unknown; and 3) removing the open water pollutant component allows all the Bronx River subwatersheds to be compared more evenly.

Secondary source loads are basically calculated as a product of flow and concentration. Refer to Caraco (2002) for detail on how loads are specifically calculated for each type of secondary source. Secondary sources that are present in the watershed and quantifiable based on existing data were considered. In most cases, this involved using GIS data provided to CWP by Westchester County or default values of the WTM. Table 2-10 describes input data and assumptions for secondary sources.

Table 2-10: Secondary Sources and Assumptions	
Secondary Source	**Assumption**
General Sewage Use Data	Based on information received from the County, and as defined in the Westchester County report entitled "Land Use Trends in Westchester County, 1988-1996" (Vasilakos, 2005), the residential land uses are defined as follows: Very low density: <1 du/acre, Low density: <2 du/acre, Medium density: 2-16 du/acre, High density: >16 du/acre. It was also assumed the area treated by septic systems in the watershed is minimal and negligible.
Active Construction	Across the entire watershed 75 total active construction sites exist, each with an area of 2.0 acres. Active construction is assumed to be occurring initially within currently undeveloped or rural land use areas. In subwatersheds where the amount of undeveloped or rural land use area was not great enough to support all the acres presumed to be in active construction, the remaining area was subtracted from the residential land use with the greatest area.
SSOs	Sanitary sewer length was estimated based on land use estimates from a previous study. For the 'Potomac River Source Water Assessments of Maryland Plants', sanitary sewer length was calculated for low (57 ft/acre) and high (118 ft/acre) density residential land uses where sanitary sewer data was available, and applied the resulting ratios to the remaining study area where data was unavailable. These land use estimates were applied to this investigation and interpolated to estimate medium density residential sanitary sewer lengths. For example, low and high density land use areas were assumed to be 57 and 118 ft of sanitary sewer line per acre respectively, and 88 ft of sanitary sewer line per acre for medium residential areas. High density estimates were used for industrial, commercial and institutional land uses.
CSOs	No estimates of existing CSOs were included in the WTM model.
Illicit Connections	0.1% of residential and 10% of business areas assumed to have illicit connections.
Channel Erosion	No estimates of channel erosion were included in the WTM model. This decision was made due to the complexity of the Bronx River watershed and the simplifying assumptions used by the WTM channel erosion estimator, coupled with initial field observations that in-stream sources do not appear to be a large sediment contributor. A more detailed investigation, beyond the capabilities of the WTM, is recommended to more accurately understand the channel erosion patterns in the watershed. This decision means the results of the WTM model focus on upland pollution sources and control programs.
Lawns (Subsurface Flow)	The county GIS soils layer was combined with Hydrologic Soil Group (HSG) information and used to estimate the percentage of HSG A, B, C, or D located within each subwatershed.
Hobby Farms / Livestock / Marinas	No hobby farms, livestock operations, or marinas are present in the Bronx River watershed.
Road Sanding	Two road layers were used to estimate the total road length in each subwatershed, and where information is not available, it was assumed all roads have 2 lanes. Additionally, it was assumed all highway miles are sanded, approximately 75% of the non-highway roads are sanded and approximately 15% of all the roads in the watershed are open section. Based on information from the Maryland State Highway Administration and presented in the 'Potomac River Source Water Assessments for Maryland Plants' report, a road sand application rate of 1.66 tons/lane mile/year was applied.

Management Practices

The WTM models load reductions from primary and secondary sources associated with the application of treatment practices. Existing practices and future reductions associated with potential practice implementation can both be modeled. To date, only existing management practices have been included in the WTM model, based primarily on information provided by Westchester County and field observations made by CWP. Table 2-11 summarizes the assumptions used for applying the existing treatment practices.

Table 2-11: Existing Management Practices and Assumptions

Input	Assumption
Lawn Care / Pet Waste Education	Although both pet waste and lawn care education programs exist in the watershed, it is assumed that these are not effective at reaching a large number of citizens. In addition, the existing Grass Roots Healthy Lawn program focuses on reduction of pesticide use on private property, as opposed to reduced nutrient application.
Erosion and Sediment Control	ESC programs exists throughout the watershed, with an approximate 70% program efficiency. A program efficiency of 70% is based on a sediment control program that emphasizes erosion control measures, including practices that limit clearing and grading or use of phased construction methods, and requires advanced erosion and sediment control measures to reduce the concentration of sediment in runoff leaving the site (Caraco, 2002). It is assumed approximately 50% of all construction sites have ESC permits. Additionally, it is assumed the programs have few inspectors, no pre-construction meetings, and some poor and ineffective practices are included in the guidance manuals.
Street Sweeping	Residential roadways, parking lots and other roadways are swept twice a year with a mechanical sweeper. Additionally, no parking restrictions or operator training are required or in place.
Impervious Cover Disconnection	25% of residential parcels and 10% of commercial parcels employ rooftop disconnection techniques.
Structural Stormwater Management Practices	Based on December 2005 field work, CWP is aware of at least one stormwater pond in the Davis Brook subwatershed, two in the Clove Brook subwatershed, and at least one in Manhattan Park Brook. These have been accounted for in the WTM. However, in general, the vast majority of developed sites do not appear to have structural stormwater management features, and the rest of the subwatersheds were modeled as such.
Riparian Buffers	No design guidance is provided and the buffer is a setback, with no restrictions on activities within the buffer. The riparian buffer length was calculated using the deciduous forest land cover estimate from the University of Connecticut. Riparian buffer width was estimated by averaging the buffer width at 10 random locations, where a riparian buffer had been identified, within each subwatershed.
Catch Basin Cleanouts	The acreage treated by catch basins in each subwatershed can be approximated by the roadway imperviousness in each subwatershed. Additionally, catch basins are cleaned annually and poor disposal practices are employed.

Future Development

Future land use was estimated using a GIS zoning layer for Westchester County in the Bronx River watershed. The descriptions in the zoning layer were matched with the categories used for the land use primary source estimates, and are summarized in Table 2-12. Additionally, areas where the land use was assumed not to change between existing and future conditions were

incorporated into the zoning information. The land use areas assumed not to change included public open space, areas adjacent to water supply water bodies, known roadways, and cemeteries.

Table 2-12: Zoning Description Summary

Zoning Description	WTM Category
1 to 2 DU's	Low Density Residential
17 to 49.9 DU's	High Density Residential
50 and Over DU's	High Density Residential
9 to 16 DU's	Medium Density Residential
Business, Office, Commercial	Commercial
Campus, Office, Research, Ind. Park	Institutional
Less than 1 DU	Very Low Density Residential
Major Water Bodies	Open Water
Manufacturing, Industrial, Warehouse, Storage, Public Utilities	Industrial
Other Non-Res. Classifications	Office
Over 2 to 8.9 DU's	Medium Density Residential

The zoning descriptions used in the future loads analysis did not always align with existing land use categories. As a result, a random quality review of the data revealed that where zoning descriptions did not accurately align with the existing land use category the impervious cover for that parcel could be somewhat under or over estimated. However, inspection of the overall changes in impervious cover for each subwatershed are reasonable and within the expected shift.

The following are additional assumptions made for future development conditions:

- The Kensico Reservoir subwatershed was not included as a contributor of future pollutant loads to the entire Bronx River watershed because there is no hydrologic connection between the two.
- Pollutant contributions from open water were removed from the following subwatersheds: White Plains Reservoirs, Kensico Reservoir, Grassy Sprain, and Bronx River Lower Direct Drainage. This adjustment was made based on three factors, 1) each of these subwatersheds contain a large area of open water, 2) the pollutant assimilation or uptake capacity of these water bodies is unknown, and 3) removing the open water pollutant component allows all the Bronx River subwatersheds to be compared more evenly.

Table 2-13 summarizes the data and assumptions input into the WTM to model future conditions.

Table 2-13: New Development Input Data and Assumptions	
Input	**Assumption**
New Wastewater Treatment Customers	Additional future development in the watershed will not be treated by wastewater treatment plants discharging to the Bronx River or its tributaries.
New Construction	Estimate based on increased land use area between existing and future conditions divided by a planning horizon of 20 years to estimate the annual construction acreage.
Stormwater Controls on New Development	The controls on new development inputs were based on the current stormwater program, with an assumption that Best Management Practices (BMPs) would be required for stormwater quality. As currently modeled, pollutant loads for future conditions assume no change in existing management practices.

Results

Results are presented for Total Nitrogen (TN), Total Phosphorus (TP) and total suspended solid (TSS) loads for existing and future conditions, both based on existing management practices. Nutrient and TSS loads for existing conditions are summarized for the Bronx River watershed and each of the 15 subwatersheds in Table 2-14.

Table 2-14: Existing Load Estimates				
Name	**Existing Imperviousness (%)**	**TN (lb/acre/year)**	**TP (lb/acre/year)**	**TSS (lb/acre/year)**
Bronx River Lower Direct Drainage [1]	41.2	6.5	0.9	316.0
Bronx River Middle Direct Drainage	29.1	6.3	0.7	292.5
Bronx River Upper Direct Drainage	28.5	6.0	0.7	267.5
Clove Brook	19.4	6.0	0.7	180.8
Davis Brook	13.3	3.1	0.3	191.8
Fox Meadow Brook	18.5	5.9	0.6	227.9
Fulton Brook	35.8	7.6	1.0	309.6
Grassy Sprain Brook [1]	17.9	3.2	0.3	215.2
Grassy Sprain Brook Direct Drainage	36.2	5.0	0.6	273.1
Hartsdale Brook	19.2	6.0	0.6	231.2
Kensico Reservoir [1]	9.2	3.6	0.4	129.1
Manhattan Park Brook	25.0	5.3	0.6	217.0
Sprain Brook	27.8	3.4	0.3	192.4
Troublesome Brook	32.4	6.4	0.8	278.3
White Plains Reservoirs [1]	1.8	2.5	0.3	111.8
Bronx River Watershed	**22.3**	**5.0** [2]	**0.6** [2]	**229.2** [2]

Notes:
1. Bronx River Lower Direct Drainage, Grassy Sprain Brook, Kensico River, and White Plains Reservoirs do not include load estimates from atmospheric deposition into open water bodies.
2. Load estimates for Bronx River watershed do not include the Kensico River Basin, which is not hydrologically connected to the Bronx River.

Nutrient and TSS loads for future conditions are summarized for the Bronx River watershed and each of the 15 subwatersheds in Table 2-15. Table 2-16 summarizes the net increase in imperviousness and the percent increase in pollutant loads from existing to future land use conditions.

Table 2-15: Future Load Estimates				
Name	**Future Imperviousness (%)**	**TN (lb/acre/year)**	**TP (lb/acre/year)**	**TSS (lb/acre/year)**
Bronx River Lower Direct Drainage [1]	42.0	6.7	1.0	374.9
Bronx River Middle Direct Drainage	30.9	6.6	0.9	369.5
Bronx River Upper Direct Drainage	31.4	6.6	0.8	342.7
Clove Brook	25.4	6.7	0.9	279.1
Davis Brook	18.3	3.9	0.5	283.0
Fox Meadow Brook	26.1	7.2	0.9	361.8
Fulton Brook	40.0	8.8	1.3	430.0
Grassy Sprain Brook [1]	20.4	3.3	0.4	282.4
Grassy Sprain Brook Direct Drainage	42.0	6.0	0.7	331.2
Hartsdale Brook	26.5	7.3	0.9	338.0
Kensico Reservoir [1]	9.1	3.8	0.4	151.6
Manhattan Park Brook	31.2	6.9	0.9	333.2
Sprain Brook	28.4	3.6	0.4	228.0
Troublesome Brook	36.6	7.2	1.0	351.9
White Plains Reservoirs [1]	5.2	3.1	0.4	157.4
Bronx River Watershed	**24.5**	**5.6** [2]	**0.7** [2]	**295.8** [2]

Notes:
1. Bronx River Lower Direct Drainage, Grassy Sprain Brook, Kensico River, and White Plains Reservoirs do not include load estimates from atmospheric deposition into open water bodies.
2. Load estimates for Bronx River watershed do not include the Kensico River Basin, which is not hydrologically connected to the Bronx River.

Table 2-16: Summary of Increases from Existing to Future Land Use Conditions				
Name	**Net Increase in Imperviousness (%)**	**% Increase in TN (lb/year)**	**% Increase in TP (lb/year)**	**% Increase in TSS (lb/year)**
Bronx River Lower Direct Drainage [1]	0.8	3.6%	9.9%	18.7%
Bronx River Middle Direct Drainage	1.8	4.7%	18.4%	26.3%
Bronx River Upper Direct Drainage	2.9	9.4%	21.3%	28.1%
Clove Brook	6.1	10.8%	18.5%	54.4%
Davis Brook	5.0	26.2%	52.9%	47.5%
Fox Meadow Brook	7.6	22.6%	46.7%	58.8%
Fulton Brook	4.2	15.2%	25.4%	38.9%
Grassy Sprain Brook [1]	2.5	26.7%	56.8%	36.0%
Grassy Sprain Brook Direct Drainage	5.8	20.5%	28.8%	21.3%
Hartsdale Brook	7.2	21.4%	37.4%	46.2%
Kensico Reservoir [1]	-0.1	6.2%	8.9%	17.5%
Manhattan Park Brook	6.3	29.1%	43.2%	53.5%
Sprain Brook	0.6	7.1%	16.6%	18.5%
Troublesome Brook	4.2	12.4%	21.1%	26.4%
White Plains Reservoirs [1]	3.4	22.9%	24.7%	40.7%
Bronx River Watershed	2.2	**12.2%** [2]	**21.9%** [2]	**29.1%** [2]

Notes:
1. Bronx River Lower Direct Drainage, Grassy Sprain Brook, Kensico River, and White Plains Reservoirs do not include load estimates from atmospheric deposition into open water bodies.
2. Load estimates for Bronx River watershed do not include the Kensico River Basin, which is not hydrologically connected to the Bronx River.

2.5.2 Comparative Subwatershed Analysis

The Comparative Subwatershed Analysis (CSA) screens subwatersheds within a watershed to identify the ones with the greatest restoration potential. Subwatershed "metrics" are used to conduct this analysis. Metrics are single numeric values that characterize the relative restoration potential of a subwatershed.

The CSA involves a simple spreadsheet analysis of selected subwatershed metrics that are derived by analyzing available GIS layers and other subwatershed data sources. Subwatersheds with the highest aggregate score become priorities of subsequent field investigations for actual restoration potential. This enables watershed planners to allocate limited resources on subwatersheds where restoration has the greatest chance of success.

Many different subwatershed metrics can be used for screening purposes. The basic method to conduct a CSA consists of four general tasks:

1. Delineate subwatershed boundaries and review available metric data
2. Choose and compute metrics that best describe restoration potential
3. Develop weighting and scoring rules to assign points to each metric
4. Compute aggregate scores and develop initial subwatershed ranking

The Center completed a CSA for the Bronx River watershed. First, the Center completed a review of all existing watershed data provided by Westchester County, including GIS data. Based on this review, the Center proposed 15 metrics that could be used in the CSA:

1. Current Impervious Cover
2. Future Impervious Cover
3. Publicly-Owned Land
4. Subwatershed Forest Cover
5. Subwatershed Wetland Cover
6. Subwatershed Conserved Land
7. Detached Residential Land
8. Industrial Land
9. Stormwater Hotspot Density
10. Subwatershed Stream Density
11. Stream Corridor Forest Cover
12. Public Ownership of Corridor
13. Road Crossings
14. Special Designation / Special Resources
15. Current Annual Total Pollutant Loading

Upon further review of available data, and after conversations with County staff, the Center selected 12 metrics to use in the Bronx River watershed CSA. The Center used GIS data provided by the County and NEMO to compute the value of each metric.

After the metrics were computed for each subwatershed, the Center developed a weighted scoring system. Table 2-17 provides more detailed information on each selected metric, including:

- *Metric* – The metric selected to measure restorability of the subwatershed.
- *How Metric is Measured* – Describes the units used to define the metrics.
- *Indicates Higher Restoration Potential When…* – Describes how this metric is used to determine "restorability" of a subwatershed.

- *Metric Points* – Provides an example of how points may be assigned to different metric values.

The results of the CSA for the Bronx River watershed, including metric scores and total scores, are summarized in Table 2-18. Actual metric values are provided in Appendix E.

Table 2-17: Summary of Subwatershed Metrics Proposed for the Bronx River Watershed

Metric	How Metric is Measured	Indicates Higher Restoration Potential When…	Metric Points
Current Impervious Cover	% impervious cover in subwatershed	Current impervious cover is low	Less than 10% = 10 pts; 11 to 25% = 7 pts; 26 to 40% = 5 pts; 41 to 60% = 3 pts; >60% = 1 pt
Publicly-Owned Land	% of subwatershed that is publicly owned	Public land ownership is high	Award 1 pt for each 2.5% of subwatershed in public ownership
Subwatershed Forest Cover	% forest cover in subwatershed	Forest cover is low	Less than 10% = 10 pts; 11 to 25% = 7 pts; 26 to 40% = 5 pts; 41 to 60% = 3 pts; >60% = 1 pt
Subwatershed Wetland Cover	% of subwatershed that is wetlands	Wetlands cover is high	Award 1 pt for each 2% of subwatershed area
Subwatershed Conserved Land	% of subwatershed that is currently conserved	Conserved land is high	Award 1 pt for each 2% of subwatershed area
Detached Residential Land	% of subwatershed as detached residential	Detached residential land is high	Award 1 pt for each 10% of subwatershed in public ownership
Industrial Land	% of subwatershed as industrial	Industrial land is high	Award 1 pt for each 1% of subwatershed classified as industrial
Subwatershed Stream Density	stream miles / square mile	Stream density is high	Award 1 pt for each 5% increase in stream density from watershed average of 1.1 stream miles / square mile
Stream Corridor Forest Cover	% of stream corridor that is forested	Corridor forest cover is low	Add 1 pt for each 10% reduction in forest cover
Public Ownership of Corridor	% of stream corridor that is publicly owned	Public corridor ownership is high	Add 1 pt for each 10% of stream corridor in public ownership
Stormwater Hotspot Density	potential hotspots / square mile	Hotspot density is high	Less than 3 hotspots/sq mi = 1 pt; 3 to 6 = 3 pts; 6 to 9 = 5 pts; >9 = 7 pts
Municipalities	number of municipalities / subwatershed	Number of municipalities is low	Award 5 pts for 1 municipality; 3 pts for 2 municipalities; 1 pt for 3 or more municipalities

Table 2-18: Results of the Comparative Subwatershed Analysis for the Bronx River Watershed													
Subwatershed	**Score (points)**												
	Current Impervious Cover	**Publicly-Owned Land**	**Forest Cover**	**Wetland Cover**	**Conserved Land**	**Detached Residential Land**	**Industrial Land**	**Stream Density**	**Stream Corridor Forest Cover**	**Public Ownership of Corridor**	**Hotspot Density**	**Municipalities**	**Total**
Hartsdale Brook	7	15	5	3	9	4	0	0	5	2	7	3	**60**
Bronx River Middle Direct Drainage	5	6	7	4	4	6	1	4	6	7	7	1	**58**
Bronx River Lower Direct Drainage	3	3	10	2	6	5	0	0	9	8	7	3	**56**
Sprain Brook	7	8	5	5	0	3	1	15	7	1	3	1	**56**
Grassy Sprain Brook	7	12	5	4	6	4	0	2	7	5	1	3	**56**
White Plains Reservoirs	10	3	1	3	32	0	0	0	2	2	1	1	**55**
Bronx River Upper Direct Drainage	5	6	7	4	5	5	1	1	6	6	5	1	**52**
Fox Meadow Brook	7	2	7	3	0	8	0	7	6	1	1	3	**45**
Manhattan Park Brook	7	6	5	3	0	3	0	4	7	1	5	1	**42**
Grassy Sprain Brook Direct Drainage	5	0	7	1	3	6	2	0	8	0	5	5	**42**
Davis Brook	7	2	5	4	3	1	0	7	6	0	3	3	**41**
Clove Brook	7	0	3	6	2	3	0	5	3	0	3	5	**37**
Fulton Brook	5	0	5	4	0	4	0	1	7	0	7	3	**36**
Troublesome Brook	5	1	7	0	0	7	0	0	9	1	3	3	**36**
Kensico Reservoir	10	2	3	2	11	2	0	0	3	0	1	1	**35**

2.5.3 Priority Subwatersheds for Restoration

As part of the CSA, the Center grouped the 15 subwatersheds into five categories based on similar conditions (e.g., land use, development patterns, drainage patterns, etc.):

- Subwatersheds that drain to water supply reservoirs
- Subwatersheds that drain to northern Bronx River tributaries
- Subwatersheds that drain to the mainstem of the Bronx River
- Subwatersheds that drain to Grassy Sprain, the largest Bronx River tributary
- Subwatersheds that drain to middle Bronx River tributaries

Subwatersheds with similar characteristics will also have comparable restoration strategies and recommendations. Watershed restoration is a costly and lengthy process – developing detailed restoration strategies for all 15 subwatersheds would be an extremely expensive undertaking. Instead, the Center will develop detailed plans for select subwatersheds that are considered "most restorable" per the CSA. Then, general, subwatershed-wide recommendations identified for these specific subwatersheds may be applied to other subwatersheds in the same grouping.

The subwatershed categorization is displayed in Table 2-19 and in Figure 2-6. Based on the subwatershed categorization, the results of the CSA, and the results of the WTM, the Center recommended five subwatersheds for detailed assessment and planning:

- Manhattan Park Brook
- Middle Bronx River Basin
- Grassy Sprain Brook
- Hartsdale Brook
- Fulton Brook

With the exception of Fulton Brook, these subwatersheds received the highest restorability scores on the CSA in their respective categories. Fulton Brook was also selected due to the highly developed nature of the subwatershed, the diversity of land use, and the high density of hotspots. A subwatershed in the "reservoirs" category was not selected due to the existing reservoir and land use management practices already in place in these subwatersheds.

Table 2-19: Bronx River Subwatersheds Categorization and CSA Results

Subwatershed Group	Subwatershed Group Characterization	Subwatershed	Subwatershed Area (sq mi)	CSA Score (points)
1	Subwatersheds drain to water supply reservoirs	White Plains Reservoirs	0.9	**55**
		Kensico Reservoir	12.4	**35**
2	Subwatersheds draining to northern Bronx River tributaries	Manhattan Park Brook	3.3	**42**
		Davis Brook	2.1	**41**
		Clove Brook	1.3	**37**
3	Subwatersheds drain to the mainstem of the Bronx River	Bronx River Middle Direct Drainage	5.1	**58**
		Bronx River Lower Direct Drainage	3.3	**56**
		Bronx River Upper Direct Drainage	5.0	**52**
4	Subwatersheds drain to Grassy Sprain, the largest Bronx River tributary	Sprain Brook	1.7	**56**
		Grassy Sprain Brook	4.9	**56**
		Grassy Sprain Brook Direct Drainage	2.0	**42**
5	Subwatersheds draining to middle Bronx River tributaries	Hartsdale Brook	1.2	**60**
		Fox Meadow Brook	1.4	**45**
		Fulton Brook	1.0	**36**
		Troublesome Brook	2.7	**36**

Note: Subwatersheds selected for detailed assessment and planning are highlighted in gray.

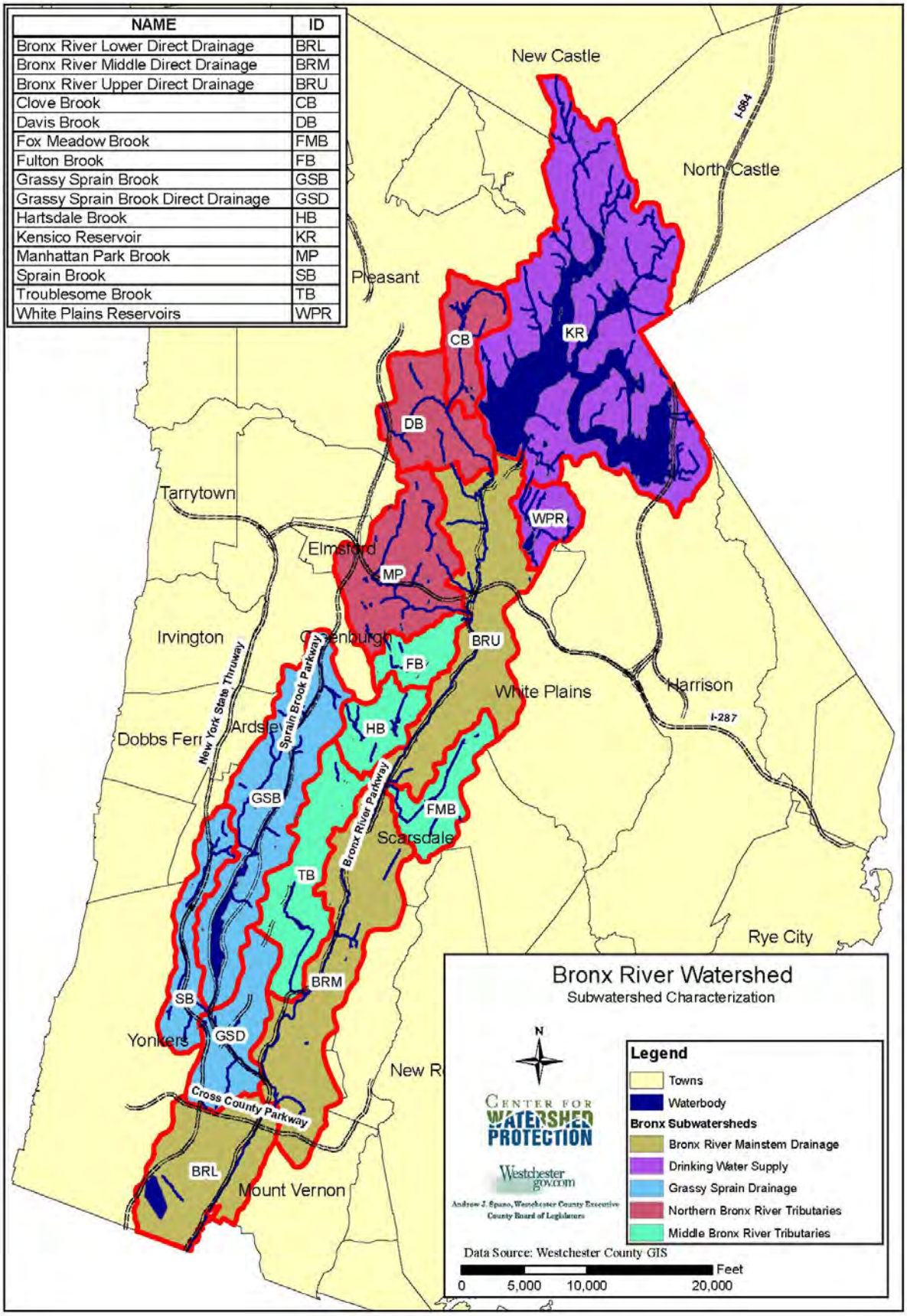


Figure 2-6: Categorization of Subwatersheds in the Bronx River Watershed

Section 3. Stream Corridor and Upland Assessments Protocols and General Findings

3.1 Introduction to the Stream Corridor and Upland Assessments

The Center and Biohabitats conducted stream and upland field assessments in the Westchester County portion of the Bronx River watershed in 2005 and 2006. The findings of this fieldwork are summarized in this section and were presented in detail in three technical memorandums. These documents are available for viewing online at www.westchestergov.com/planning under "Bronx River Coalition."

- *Summary of Findings from the Bronx River Watershed Stream Corridor and Upland Assessments, Fall 2005: Technical Memorandum* (CWP, 2006b)
- *Bronx River Fluvial Geomorphic Assessment: Technical Memorandum Summarizing Findings of the Stream Corridor Assessment* (Rauhofer, et al., 2006)
- *Bronx River Fluvial Geomorphic Assessment: Technical Memorandum Summarizing Findings of the Riparian Corridor Restoration and Retrofit Inventory* (Salladin, 2006)

During this assessment period, field crews assessed approximately 20 miles of stream, 25 residential neighborhoods and 42 potential hotspot locations in the Bronx River watershed. In addition, 16 open space lots or natural area remnants, 15 riparian corridor restoration sites, and 59 potential retrofit sites were evaluated. Table 3-1 summarizes the general findings from each of the assessments.

Due to the large size of the watershed, field efforts were targeted to priority stream reaches and subwatersheds identified through the Comparative Subwatershed Analysis, conducted during the baseline watershed assessment task (see Section 2). Figure 3-1 is a watershed map depicting the subwatersheds where stream and upland assessments were targeted.

A key to the nomenclature used by field teams during the assessment work is provided in Table 3-2. The naming convention was designed to be flexible for multiple field teams and to immediately impart key information about the site. Identifiers consist of three parts: 1) the abbreviation of the subwatershed in which the site or reach is located, 2) the type of assessment conducted, and 3) a unique identifier that is employed sequentially as a team evaluates a subwatershed or reach (e.g. the first three retrofits identified in one subwatershed reach would be numbered R1, R2, R3…). This nomenclature has carried through the project and is used elsewhere in this *Report*.

Table 3-1: Findings from Field Assessments

Task	General Findings
Unified Stream Assessment	• Walked over 20 miles of stream • Evaluated 70 stream reaches • Completed site impact evaluations at 22 stream crossings, three modified channels, seven erosion sites, 19 outfalls, 11 impacted buffers, 10 trash sites, 11 utility sites, and three hill slope erosion areas • Major findings include absence of aquatic fauna, buffer encroachment and prevalence of invasive plants, trash accumulation, potential fish barriers, and legacy sediment

Table 3-1: Findings from Field Assessments	
Task	**General Findings**
Riparian Corridor Restoration Inventory	• Fifteen potential restoration sites evaluated for project feasibility, cost, benefit, visibility, and other community factors • Restoration recommendations include invasive plant species management, revegetation and reforestation, stream repair, and stormwater retrofitting.
Hotspot Site Investigation	• Forty-two potential hotspot sites investigated • Seventeen were confirmed as pollution hotspots, 18 are potential hotspots, and 7 are not hotspots • Representative sampling of common hotspots, not comprehensive • Biggest offenders include municipal yards, gas stations, and shopping centers • Types of projects recommended include pollution prevention at municipal maintenance yards related to vehicle operations and salt storage; storm drain inserts; and education
Neighborhood Source Assessment	• Twenty-five neighborhoods assessed • Three had high pollution severity and 22 had moderate pollution severity • Six had high restoration potential, 13 moderate restoration potential; and six low restoration potential • Assessed high to medium density single-family residential neighborhoods, town home communities, and apartment complexes • Types of recommendations include rooftop disconnections, storm drain stenciling, and areas to target for better lawn care/landscaping practices
Pervious Area Assessment	• 16 sites considered for restoration • Sites predominantly parks, vacant lots, cemeteries, and golf courses • Types of recommended activities include reforestation, invasive plant species removal, and soil amendments
Retrofit Inventory	• 54 opportunities to implement stormwater retrofits • Focus on water quality and recharge • Types of retrofits include bioretention; perimeter sand filters, porous pavers, and storm drain inserts

Table 3-2: Field Assessment Nomenclature Key			
Subwatershed	**Abbreviation**	**Assessment Type**	**Abbreviation**
Bronx River Lower Direct Drainage	BRL	*Upland*	
Bronx River Middle Direct Drainage	BRM	Hotspot	H
Bronx River Upper Direct Drainage	BRU	Neighborhood	N
Clove Brook	CB	Pervious Area	P
Davis Brook	DB	Retrofit	R
Fox Meadow Brook	FMB	*Stream Corridor*	
Fulton Brook	FB	Reach	RCH
Grassy Sprain Brook	GSB	Outfall	OT
Grassy Sprain Brook Direct Drainage	GSD	Stream Crossing	SC
Hartsdale Brook	HB	Eroded Bank	ER
Kensico Reservoir	KR	Impacted Buffer	IB
Manhattan Park Brook	MP	Trash and Debris	TR
Sprain Brook	SB	Utility	UT
Troublesome Brook	TB	Channel Modification	CM
White Plains Reservoirs	WPR	Miscellaneous	MI
		Riparian Corridor Restoration	S

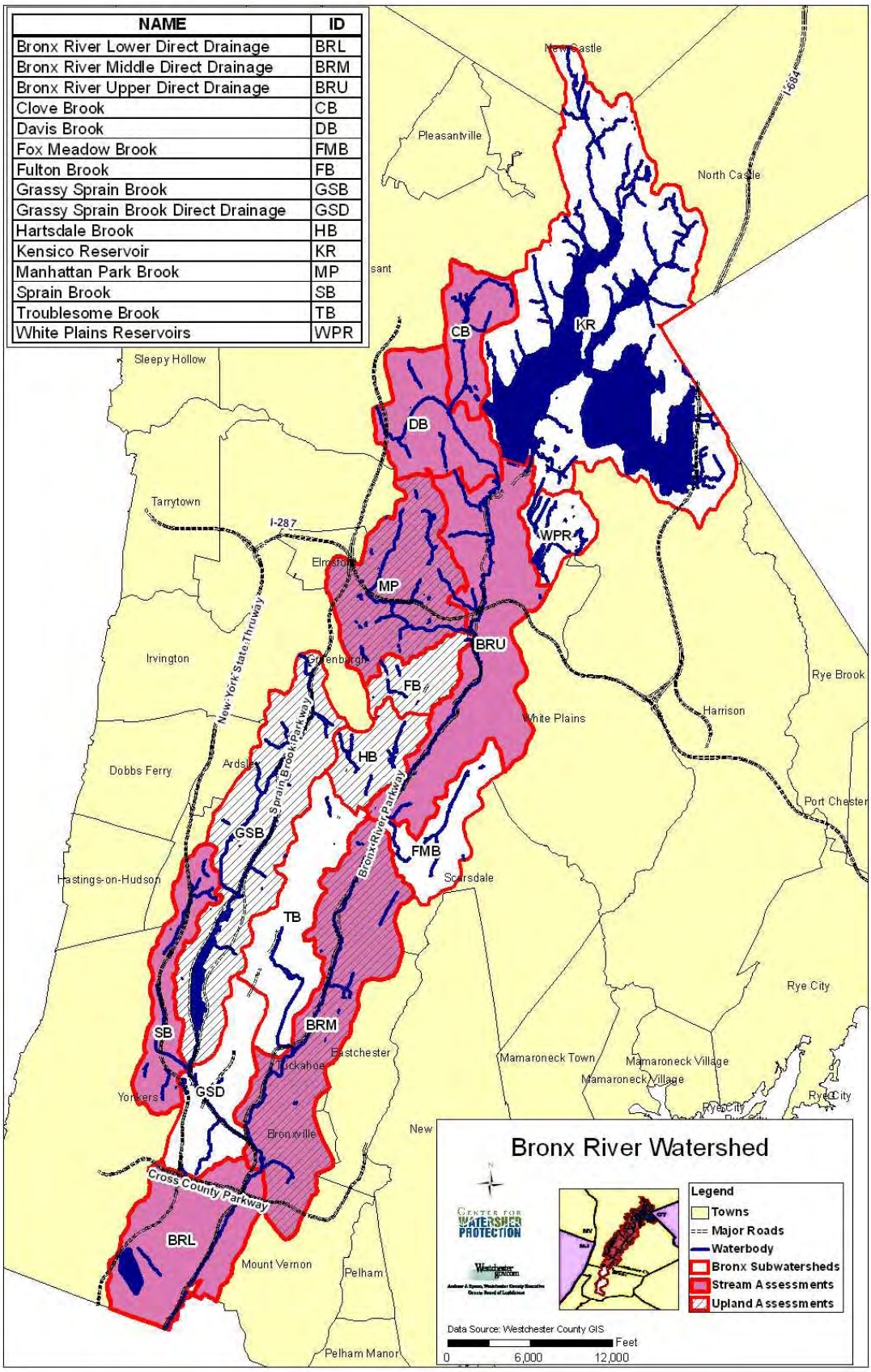


Figure 3-1: Targeted subwatersheds for stream corridor and upland assessments in the Bronx River watershed.

A summary of observations made by field crews during the stream and upland assessments of the Bronx River watershed are listed below (in no specified order). Specific findings related to each assessment are described throughout the rest of this section. Overall watershed observations include:

1. Streams and physical in-stream habitat appear to be relatively stable despite the extent of development and watercourse channelization throughout the watershed. There are a significant number of stream crossings (dams, culverts, etc) that have probably contributed to channel stability over time, acting as grade control structures, as well as containment for much of the sediment being transported through the system. In lower tributary reaches and in some sections of the mainstem, there are large amounts of sand present within the bankfull channel. It is believed that most of this sediment is "legacy" sediment from erosion caused by past disturbances, as no significant active sources of sediment were observed during field assessments.

2. There is a general lack of abundance and diversity of macroinvertebrates or fish in Bronx River streams. WCDP has taken water samples throughout the Bronx River and its tributaries. Although trout were observed in Davis Brook, and have been reportedly present near the reservoir backwash area, detailed study shows aquatic species to only be those tolerant of pollution.

3. Buffer encroachment, trash and dumping, and extensive invasive plant species appear to be significant problems throughout the watershed. Many stream reaches are physically constrained into a narrow corridor by roads or buildings, which limits planting opportunities. Dumping of trash and debris, and the clearing of native riparian vegetation was frequently observed. Dumping of organic materials into the floodplain was also commonly observed. Education and signage may be a recommended approach to improving buffer management. Invasive plant species management, particularly for porcelain berry, Japanese knotweed, purple loosestrife, bittersweet and other common species, should be integrated with all stream corridor restoration activities.

4. The watershed is almost completely developed (i.e., built out), leaving very little room for large new developments. Small scale, single lot infill and redevelopment projects make up the majority of projects. Enforcement of erosion and sediment control at many observed sites appeared to be lacking. In addition, many sites are being constructed on steep slopes, thereby enhancing erosion potential.

5. Only a handful of stormwater practices were observed in the County portion of the Bronx River watershed. As a result, there are few local examples of well-designed, functioning, and integrated practices. Due to the developed nature of the watershed, there were limited opportunities for new storage facilities outside of the stream corridor. A few demonstration retrofits have been implemented or are planned by the County; these sites should be regularly monitored and actively used for education. Opportunities for on-site stormwater retrofits, particularly in parking lots and at publicly owned facilities, are plentiful. Underground practices (i.e., sand filters, proprietary practices, and catch basin inserts) may be appropriate concepts for highly urban parts of watershed where surface practices are less desirable.

6. New development does not appear to be employing sufficient post-construction stormwater controls.

7. Aging infrastructure, illicit connections, and limited staffing appear to contribute to pervasive and chronic sewer overflows throughout the watershed. Each municipality is responsible for cleaning lines and removing blockages within their jurisdiction, and overflows are generally reported by residents through the local police dispatch.

8. All County and municipal facilities visited were confirmed or severe hotspots and had multiple opportunities for improvement. In most cases, drainage from salt storage areas and vehicle fueling and maintenance areas went directly into storm drains. Buffer encroachment and dumping was also observed. Examples of good practices were observed at some locations (i.e., secondary containment, oil grease separators, permit posting, staff training).

9. Each municipality has its own schedule for sweeping and clean outs, and uses different deicing mixes and storage practices. These programs should be designed to minimize pollution (i.e., covered storage, diversion from storm drains) and target watershed hotspots. Cost-sharing opportunities for bulk purchases (e.g., vactor trucks) should be pursued across municipalities.

10. Cemeteries, golf courses, and municipal parks represent the majority of turf cover in the watershed. In some instances, municipal parks serve as dumping areas for organic wastes / asphalt slag.

11. Very few large contiguous forest tracts remain in the upland portion of the watershed. Remaining tracts, such as the one straddling Clove and Manhattan Park Brook subwatersheds, should be investigated as to their vulnerability to development and overall habitat quality.

12. Encroachment and yard waste disposal were frequently observed in stream buffers in residential areas. Residential areas also appear to contribute a large percentage of rooftop runoff to the storm drain system. Opportunities to install rainbarrels / raingardens, as well as the conversion of landscaped areas at apartment complexes and schools into bioretention areas should be considered.

13. Evaluation of residential practices (i.e., extent of fertilization, mowing, watering, car washing, disposal of lawn clippings, etc.) was hard to fully determine due to the time of year of the assessment and snow cover on the ground.

14. The Bronx River Parkway (Parkway) brings attention to the river. Educational signage (i.e., pet waste cleanup, storm drain stencils), while noted in a few locations throughout the watershed, is lacking in most residential areas and urban centers.

15. There appear to be a variety of watershed restoration efforts occurring in the watershed (i.e. wetland restoration, invasive plant species management, stormwater retrofits). The Bronx River Watershed Coalition (previously known as the Watershed Advisory Committee 7) may be a logical forum for developing a long-term intermunicipal group.

3.2 Unified Stream Assessment and Riparian Corridor Restoration Inventory

Biohabitats conducted a physical stream corridor assessment along 20.1 stream miles in the County portion of the Bronx River watershed during the week of October 24 to 28, 2005. The assessment was used to identify outfall locations, severely eroded stream banks, utility crossings, impacted riparian buffers, trash dumping, stream crossings, and channel modifications within the stream corridor. Potential restoration opportunities at impacted locations were also identified.

Seven subwatersheds were considered priority areas for the assessment (see Figure 3-1): Clove Brook; Davis Brook; Manhattan Park Brook; Sprain Brook; and Bronx River Upper, Middle and Lower Direct Drainage subwatersheds. The following criteria assisted in the determination of priority reaches within each subwatershed:

- First order streams (i.e., streams with no tributaries) were a high priority
- Reaches discharging directly to lakes were not considered
- Reaches along the main stem of the Bronx River on private land were not considered

Biohabitats returned to the watershed May 15 to 17, 2006 to conduct additional field evaluations of 15 potential riparian corridor restoration sites. These sites were selected after a review of stream assessment field findings.

Assessment Protocol

The primary assessment protocol used was the Unified Stream Assessment (USA), which is a comprehensive stream walk protocol developed by the Center for evaluating the physical riparian and floodplain conditions in small urban watersheds. The USA integrates qualitative and quantitative components of various stream survey and habitat assessment methods and is used to identify locations of suspected illicit connections, impacted buffer, severe stream bank erosion, excessive trash accumulation and dumping, and impacted stream crossings. Restoration opportunities for discharge prevention, stream restoration, stormwater retrofits, and riparian reforestation are also identified.

The USA provides an overall reach assessment to document average in-stream and riparian conditions for an individual reach. In addition, the USA utilizes eight individual impact assessment forms for evaluating restoration potential for common urban stream impairments, including:

- Stormwater pipe outfalls
- Severe erosion
- Impacted upland buffers adjacent to streams
- Utilities in the stream corridor
- Trash and debris
- Stream crossings (e.g., road bridges)
- Channel modification
- Other miscellaneous impacts (e.g., failed erosion and sediment control, mountain bike crossings, cattle crossings, log jams, etc.)

More detail on conducting the USA protocol can be obtained directly from CWP (2004b).

Biohabitats included two additional site forms as part of the assessment: hillslope evaluation (to document potential upland sediment sources) and channel characteristic evaluation.

Special emphasis was placed on identifying stream processes that may contribute significant sediment loads to the Bronx River. Specifically, Biohabitats-led field crews identified sediment sources (e.g., instream bank and bottom sources, ephemeral or intermittent tributaries, uncontrolled or unstable adjacent developed areas, and unstable outfalls), storage sinks (e.g., impoundments), and downstream transport mechanisms.

For the Riparian Corridor Restoration Inventory, Biohabitats evaluated each of the 15 selected sites for project feasibility, cost, benefit, visibility, and other community factors.

Summary of Sites Assessed

Over 70 stream reaches were evaluated in the Bronx River watershed using the USA Reach Form. An overall quantitative score for each reach was assigned based on average physical condition of various instream and riparian parameters (habitat, floodplain connectivity, buffer width, etc). These scores were used to classify stream reaches into condition categories ranging from excellent to very poor.

Reach categories are defined based on a reference condition, which is considered to be the least impaired, best attainable condition for a stream in a given region. For this assessment the reference condition was limited to the Bronx River watershed only. Therefore, the highest rated reach in the watershed was considered to be equivalent to the reference condition.

The best reach score in the study area was Reach SB-10, which scored 155 points. This can be considered a representative score for the best attainable condition for a reach within the watershed. A score of at least 90% or greater of this number (>140) is considered comparable to the reference condition and represents excellent stream conditions for the watershed. A score less than 35% (<54 pts) of the reference score is considered very poor. Between these two extremes, 75% of the reference score (116 pts) represents the divide between good and fair stream conditions, and 55% (85 pts) represents the threshold between fair and poor conditions. The scoring criteria are shown in Table 3-3.

Table 3-3: Bronx River Stream Reach Scoring Criteria

Category	Percentile	Point Threshold
Excellent	90%	≥140
Good	75%	≥116
Fair	55%	≥85
Poor	35%	≥54
Very poor	<35%	<54

While these criteria serve to place the assessed reaches in context, they are somewhat subjective. A reach scoring a few points higher than another may be placed in a higher category, but the

qualitative aspects of the method makes differences of a few points insignificant. It should also be noted that these classifications are based on highly urban conditions and are not comparable to conditions in non-urban settings.

Table 3-4 summarizes the reaches by classification category. Excellent and good reaches often had better quality riparian buffer and floodplain connectivity than streams scoring in the fair or poor range. The location of these reaches can be found on the subwatersheds maps in Appendix H.

Table 3-4: Stream Reach Classifications

Excellent		Good		Fair		Poor		Very poor	
Site ID	Score	Site ID	Score	Site ID	Score	Site ID	Score	Site ID	Score
SB-10	155	CB-7	136	MP-11	111	CB-3	81	BRU-6	52
SB-20	146	SB-13	136	BRU-4	110	DB-5	80	MP-10	47
DB-1	144	SB-1	135	BRU-5	109	BRM-2	79	SB-7	42
		SB-17	132	BRU-8	108	SB-23	79	MP-1	40
		CB-2	131	CB-4	108	DB-2	78	MP-9	40
		SB-16	131	SB-4	108	CB-1	74	DB-7	37
		SB-18	131	BRU-7	103	MP-15	74	MP-14	33
		DB-4	129	DB-3	101	SB-3	73	MP-13	25
		BRU-1	128	BRU-3	99	BRL-2	66	MP-16	25
		CB-5	128	CB-6	99	MP-8	64	BRM-5	23
		SB-2	128	DB-8	99	MP-4	63	SB-8	18
		BRM-3	122	MP-17	97	BRM-1b	62		
		SB-15	121	MP-3	95	MP-5	61		
		SB-14	120	SB-25	95	SB-24	61		
		SB-6	117	BRM-4	94	DB-6	60		
		SB-12	116	BRM-1a	92	SB-21	60		
				MP-12	90	SB-9	60		
				MP-2	90				
				MP-6	90				
				SB-22	90				
				BRL-1	86				
				BRU-2	86				
				MP-7	85				

Figure 3-2 illustrates various examples from the reach classifications.

Individual site impact evaluations were completed for 22 stream crossings, three modified channels, seven erosion sites, 19 outfalls, 11 impacted buffers, 10 trash sites, 11 utility sites, and three hill slope erosional areas. Figures 3-3 through 3-7 illustrate some of the site conditions noted during these assessments.

These assessments, along with the Riparian Corridor Restoration Inventory, identified many opportunities to restore the riparian corridor and to improve riparian corridor-related municipal practices and programs. Typical riparian corridor restoration projects identified for the watershed include invasive plant species management, enhancement of floodplain wetland area, stream repair, stream re-alignment, stormwater retrofits, stream bank stabilization, and buffer

reforestation. Municipal practice opportunities related the stream corridor include locations for discharge investigations, existing infrastructure assessments, and trash removal. Details on recommended riparian corridor restoration practices and municipal practices and programs are provided in Section 5.

General Findings

The Bronx River watershed has experienced a period of intense change in land use over the past two centuries. Much of the watershed has been developed for residential and commercial uses, with some light industry present. The intensity of new development has slowed in the past decade, allowing the stream to slowly recover from the initial disturbance. While the stream is in recovery, numerous problems were identified during the stream assessment. Some prevalent issues throughout the watershed are as follows:

- There is a general lack of abundance and diversity of macroinvertebrates or fish in Bronx River streams. WCDP has taken water samples throughout the Bronx River and its tributaries. Although trout were observed in Davis Brook, and have been reportedly present near the reservoir backwash area, detailed study shows aquatic species to only be those tolerant of pollution.

- Invasive plant species in the riparian corridor are ubiquitous throughout the subwatersheds surveyed. Invasive management should be undertaken in conjunction with other stream and buffer restoration activities. From the stream assessment, Japanese knotweed and porcelain berry appear to be dominant species of concern.

- Buffer encroachment is a consistent problem in the watershed. Many stream reaches are physically constrained into a narrow corridor by roads or buildings, which limits planting opportunities. Dumping and clearing of native vegetation was also frequently observed. Education and signage may be a recommended approach to improving buffer management.

- There are a lot of channelized stream reaches that may have potential for stream restoration (i.e., natural channel design, increased sinuosity, wetland restoration, and floodplain connection).

- Excessive trash and debris in the stream and in the riparian area was noticed throughout the reaches assessed. Potential locations for volunteer cleanups, opportunities for dump prevention (i.e. blocking access), and stream adoption locations were identified. The County should consider targeting chronic trash accumulation locations, particularly outfalls, for possible retrofits in the Bronx River Parkway Reservation. Dumping of organic materials into the floodplain also was commonly observed.

- There are a significant number of stream crossings (dams, culverts, pipe crossings, weirs, etc) in the watershed. These have probably contributed to channel stability over time, acting as grade control structures, as well as containment for much of the sediment being transported through the system. Some crossings could be potential fish barriers (though water quality and other considerations may be bigger limiting factors).

- In the lower reaches of the tributaries to the Lower Bronx River and the Upper Bronx River there are large amounts of sand present within the channel. It is believed that most of this sediment is legacy sediment; meaning that no obvious sites which could be the source for large amounts of sediment were discovered upstream from these locations. This sediment is most likely from erosion caused by past disturbances in the upstream areas and is now making its way downstream. Easily distinguishable from the native sediment in the stream; the legacy sediment is sand while the native sediment is mostly cobble. The legacy sediment seems to move only during storm events. The legacy sediment is mostly absent in areas where the floodplain is confined and consequently has a higher shear stress during storm flows, which allows for greater sediment transport.

- During October 2005 fieldwork, Biohabitats staff noted that the headwaters of the Sprain Brook subwatershed, as delineated by the USACE, actually drain to Grassy Sprain Brook. The final subwatershed areas and delineations reflect this change.

Figure 3-2: An example of stream reaches in each category. Reaches in Sprain Brook, SB-20 (A) and SB-12 (B), are considered excellent and good based on high quality of riparian area and instream features. A selected reach in Bronx River Upper Direct Drainage, BRU-5 (C), is considered fair, due to extensive invasive plant species and encroachment in riparian buffer and lack of instream habitat. A selected reach in Sprain Brook, SB-8 (D), is considered very poor due to channelization and lack of riparian buffer and instream habitat.

Figure 3-3: Field crews evaluated outfalls (A), looking for maintenance issues like undercutting (B) in Sprain Brook at reach SB-21 and suspected illicit discharges for further investigation like OT-1 discharge in Sprain Brook at reach SB-6 (C) and as evident with suds and murky/greenish discharge in Bronx River Middle Direct Drainage at reach BRM-1a (D).

Figure 3-4: Examples of encroachment into stream buffers include (A) removal of riparian vegetation at a golf course in Manhattan Park Brook at reach MP-1; (B) dumping of waste materials in Sprain Brook at reach SB-17; and (C) encroachment of a parking lot in Bronx River Upper Direct Drainage at reach BRU-2.

Figure 3-5: Extensive invasive plants were observed including (A) Phragmites in Manhattan Park Brook along reach MP-6; (B) Porcelain Berry at the Yonkers Waterworks in Sprain Brook along reach SB-3; and (C) Japanese Knotweed in Bronx River Upper Direct Drainage along reach BRU-5.

Figure 3-6: Problems with (A) stream bank erosion, (B) erosion in the upland corridor, and (C) head cuts were noted by field crews. These examples are from reaches in Bronx River Upper Direct Drainage (BRU-6 and BRU-5) and Manhattan Park Brook (MP-3), respectively.

Figure 3-7: Field teams noted potential problems with utility crossings (A), and culverts that required debris or trash removal, such as (B) a debris jam and trash accumulation and (C) a blocked grated culvert in Davis Brook in reach DB-8. (D) Locations of potential fish barriers were also noted like the one here in Davis Brook in reach DB-2.

3.3 Unified Subwatershed and Site Reconnaissance

The Center conducted an assessment of upland conditions in the Westchester County portion of the Bronx River watershed during the week of December 5-9, 2005. The assessment was used to identify pollution prevention opportunities at urban hotspots and in residential areas, as well as to identify opportunities for restoring pervious areas.

Five subwatersheds were considered priority areas for the assessment (see Figure 3-1): Bronx River Middle Direct Drainage, Fulton Brook, Grassy Sprain Brook, Hartsdale Brook, and Manhattan Park Brook. These subwatersheds were selected through a Comparative Subwatershed Analysis, described in Section 2. Individual hotspot and retrofit candidates were also targeted in Bronx River Lower Direct Drainage, Bronx River Upper Direct Drainage, Clove Brook, Davis Brook, Grassy Sprain Brook Direct Drainage, and Sprain Brook; however these subwatersheds were not comprehensively assessed.

The primary assessment protocol used was the Unified Subwatershed and Site Reconnaissance (USSR) – a field survey to evaluate potential pollution sources and restoration opportunities

within urban subwatersheds. The USSR is a "windshield survey" where crews drive or walk roads to determine specific pollution sources and identify areas outside the stream corridor where pollution prevention possibilities exist. The USSR can be a powerful tool in shaping an initial subwatershed restoration strategy, and in locating upland restoration projects that deserve further investigation. The concept behind the USSR is to provide watershed groups, municipal staff, and consultants a quick but thorough characterization of upland areas to identify major sources of pollutants and restoration opportunities for source controls, pervious area management, and improved municipal maintenance (i.e. education, retrofits, and referral for immediate enforcement). More information on the USSR protocol can be found in CWP (2004c).

The USSR conducted in the Bronx River has three major assessment components: hotspots, neighborhoods, and pervious areas. Descriptions of methods, sites visited, and general findings are discussed separately for each assessment in the following sections.

3.3.1 Hotspot Site Investigation

Assessment Protocol

The Hotspot Site Investigation (HSI) is used to evaluate commercial, industrial, municipal or transport-related sites that have a high potential to contribute contaminated runoff to the storm drain system or directly to receiving waters. At hotspot sites, field crews look specifically at vehicle operations, outdoor materials storage, waste management, building conditions, turf and landscaping, and stormwater infrastructure to evaluate potential pollution sources. Based on observations at the site, the HSI can help rank the potential pollution severity of sites within each subwatershed.

Prior to going out in the field, potential hotspot locations were identified. Table 3-5 includes a list of the types of hotspots considered.

Table 3-5: Hotspot Candidates in Bronx Watershed

Category	Description	
Commercial	• Gas Stations • Shopping malls • Restaurants	• Nurseries • Dry Cleaners • Hotels
Industrial	• Equipment and chemical storage • Cemetery operations	• Manufacturing plants • Distribution centers
Municipal	• DPW Maintenance Facilities • Public Schools • Post Offices • Recycling Depots	• Tire Disposal Locations • Landfills • Police and Fire Stations
Transport-related	• NYS DOT Rest Areas • Toll Plazas	• Train Stations
Other	• Private Schools • Hospitals	• Colleges • Golf Courses

Summary of Sites Assessed

Field crews were unable to assess all of the potential hotspot locations in the watershed. However, more than 40 representative hotspot candidates were assessed including: six auto-related sites (i.e. gas stations, servicing, car wash); 16 municipal sites (i.e. maintenance facilities, schools, fire stations, parks); two train stations; five plant nurseries/landscaping; nine commercial sites (i.e. shopping malls, business districts, or retail stores); four industrial sites; and one golf course.

The overall pollution potential for each hotspot site was assessed based on observed sources of pollution and the potential of the site to generate pollutants that would likely enter the storm drain network. The hotspot designation criteria as set forth in CWP (2004c) was used to determine the status of each site based on field crew observations. Sites were classified into four initial hotspot status categories:

- Not a hotspot – no observed pollutant; few to no potential sources
- Potential hotspot – no observed pollution; some potential sources present
- Confirmed hotspot – pollution observed; many potential sources
- Severe hotspot – multiple polluting activities directly observed

Active pollution was observed at more than a third of the sites visited during the assessment period. Eighteen sites were potential hotspots, eleven sites were confirmed hotspots and six were considered severe hotspots. No observed or apparent pollution sources were identified at seven of the sites visited.

In addition to enforcement referrals, discharge investigations, or further inspections, each hotspot was evaluated for the following restoration opportunities:

- Education and staff training – on proper pollution prevention practices, spill prevention, and basic stormwater management; includes storm drain stenciling and posting of SPDES signage
- On-site retrofits – such as catch basin inserts, infiltration practices, or other stormwater treatment practice; covered fueling islands; secondary containment, etc
- Pervious area restoration – protection of vegetated buffers; reforestation; soil amendments to increase infiltration of compacted soils in open space
- Pollution prevention planning – develop facility specific plan or review existing plan

These assessments identified many opportunities to improve municipal practices and programs at publicly-owned hotspots and to implement pollution prevention and source control education focused on owners of privately-owned hotspots. Details on recommended practices and programs are provided in Section 5. Locations of hotspots where opportunities are available are identified on the subwatershed maps in Appendix H.

General Findings

General findings from the hotspot assessment include:

- There are very few stormwater treatment practices in the watershed, so local demonstration projects are critical to gaining retrofit momentum.

- The biggest offenders observed during the assessment included municipal yards, gas stations, and shopping centers. Types of projects commonly recommended include pollution prevention at municipal maintenance yards related to vehicle operations and salt storage; storm drain inserts and other retrofits; and education.

- Shopping malls offer great opportunities for stormwater retrofitting due to large impervious areas, lack of existing practices, and unused landscape features.

- Field crews at a shopping center observed multiple sewer overflows and reported them immediately to local authorities. Response time to overflows was greater than 24 hours. Municipal staff reported chronic issues with grease from restaurants, illicit connections from residential areas, limited staffing, and aging infrastructure as contributing factors. Opportunities exist to develop a county-wide hotline for reporting overflows as part of an illicit discharge detection and elimination program.

- Each municipality conducts it own public works programs. These programs do not appear to be coordinated based on watershed characteristics. Opportunities exist to develop watershed-wide guidance on deicing, street sweeping, catch basin cleanouts, and sewer and storm infrastructure maintenance.

- All of the fully assessed municipal maintenance facilities were confirmed hotspots and offer many opportunities for improved source control. Facilities in Eastchester, Tuckahoe, Yonkers, and Grasslands may present the best opportunities for improved source control due to high visibility, willingness, partnering opportunities, or remodeling timing. Specific findings include:

    - None of the yards had covered fueling islands and all drained directly to inlets. Greenburgh DPW fueling island potentially drains to oil/grease separator, but this was not confirmed. Restoration options include fueling area covering, redirecting or containing drainage, or use of catch basin inserts.

    - Greenburgh had good examples of: posted permit signage; secondary containment; washbay with oil/grease separator; staff knowledge of drainage issues; sloped floors in salt barn; and maintenance records for an existing underground practice. Greenburgh could potentially invest in Sanitary Sewer overflow (SSO) and street sweeping equipment.

    - Secondary containment only seen at Greenburgh and Eastchester. The County Health Department required Eastchester to provide secondary containment, so similar requirements may be in place elsewhere too (unless standards are size dependent).

    - Salt storage areas in general appeared to be directly connected to the storm drain

system. Yonkers exhibited the poorest salt storage practices, with a large pile of salt rising above the banks of Grassy Sprain Brook. The Cross County Mall salt pile is adjacent to a storm drain. Recommended practices include: (a) covered stockpiles and (b) containment/diversion to keep salt from directly reaching storm drains or creeks. Consider prevention practices observed at the Greenburgh yard as a minimum Countywide standard. Sweeping of yard areas at the end of the day may also be a practice to recommend/require.

- Eastchester and Elmsford both expressed interest in upgrading their yards. Tuckahoe is about to remodel. Elmsford is moving their yard out of the watershed, but the fueling area will remain at the existing site. Eastchester provides a good restoration opportunity because it links with a public park, recycling center (good for education) and downstream golf course.

- Multiple pollution producing activities and stream impacts were observed at Westchester County's Grasslands facility: stream buffer encroachment and dumping, wetland impacts and encroachment, confusion over responsibilities for underground practice maintenance, lack of proper material storage, etc. This site should be a model for municipalities to follow.

- The extent of pollution prevention and spill response training for staff appeared mixed. It's clear that pollution prevention is a low priority for the staff at sites that are really under budget and over worked. Based on informal interviews, it appears that Greenburgh and Eastchester staffs were aware of and expressed a willingness to take the proper actions to clean up spills/dispose of things properly, etc.

- The county and some municipalities voluntarily stencil new storm drains. County executive orders require native plant usage, and limited chemical application on landscaping on county owned properties. In meeting NDPES good housekeeping requirements, the county should develop individual pollution prevention plans specific to each of the county's maintenance facilities.

- The Scarsdale and Bronxville yards were not evaluated during the assessment period due to closed offices or remodeling.

- Eastchester municipal programs include daily street sweeping, but they only have one sweeper. On average, about 1/3 of the catch basins in Eastchester are cleaned per year (they contract out and have about 1000 or so inlets).

- Gas stations throughout the watershed were often lacking covered fueling islands. No stormwater treatment practices were observed. Research into why they are not currently covered (regulations, taxes, aesthetics) and the benefits of covering is recommended.

- It was difficult to determine the pollution potential of landscape companies and plant nurseries during the winter assessment period, as most were not fully operational. Sites utilizing greenhouses were common; however, few nurseries seemed to be promoting

native vegetation.

- Individual businesses were not closely assessed, in part due to access issues. A business outreach program targeted towards these small business owners and/or further site investigations is recommended.

- Commercial businesses generally had poor dumpster/waste management in the rear of buildings. The watershed would benefit from either an education effort or "enforcement" to keep dumpster lids closed or provide covers for waste areas.

Figures 3-8 through 3-12 illustrate some of the findings described above.

Figure 3-8: A sewer overflow was observed in the loading area in back of the Best Buy shopping center on Central Avenue in Fulton Brook Subwatershed (site ID FB-H2). Overflow drained into storm drain, which discharged directly into stream.

Figure 3-9: Other businesses such as restaurants, gas/service stations and car washes can also be potential stormwater hotspots. (A) poor dumpster management and waster storage practices, as the practice of (B) rinsing of garage floors out onto the street can contribute to polluted runoff. (C) Fueling islands at this gas station in Scarsdale were indoors and protected from rain.

Figure 3-10: Municipal maintenance facilities were confirmed hotspots, though good practices were observed. Specific observations include: (A) stream and wetland encroachment; (B) secondary containment; (C and D) evidence of polluted drainage to storm drains; (E) drain stenciling; (F) posting of signage; (G) fueling islands draining directly to storm drains.

Figure 3-11: The racetrack in Yonkers provided stormwater retrofit, pollution prevention, and erosion and sediment control opportunities during construction.

Figure 3-12: Salt storage practices ranged from (A) uncovered stockpiles in Yonkers, to covered storage areas that were (B and D) directly connected to storm drains in Eastchester and County Reservation Yard, or (C) were sloped to help contain salt in Greenburgh.

3.3.2 Neighborhood Source Assessment (NSA)

Assessment Protocol

The Neighborhood Source Assessment (NSA) was conducted to evaluate stormwater pollution source areas, stewardship behaviors, and restoration opportunities within individual residential areas. The assessment looks specifically at yards and lawns, rooftops, driveways and sidewalks, curbs, and common areas.

Prior to going out in the field, potential residential locations to visit were identified in the office through aerial photograph interpretation. Distinct neighborhood units were delineated using land use data and digital orthophotos. Neighborhood units in the watershed included blocks with similar single-family residential housing density, physically defined communities, and apartment or town home complexes.

Neighborhoods were assessed in terms of age, lot size, tree cover, drainage, lawn size, general upkeep, and evidence of resident stewardship (i.e., storm drain stenciling, pet waste management signage, etc.). Each site was assigned a pollution severity of “severe,” “high,” “moderate,” or

"low," using a set of benchmarks set forth in CWP (2004c). Pollution severity is an index of how much non-point source pollution a neighborhood is likely generating based on easily observable features (lawn care practices, drainage patterns, oil stains, etc). A restoration potential was also determined for each neighborhood type of "high," "moderate," or "low." Restoration potential is a measure of how feasible onsite retrofits or behavior changes would be based on space, number of opportunities, presence of a strong home owner's association (HOA), etc.

Summary of Sites Investigated

Field crews evaluated 25 neighborhoods during the assessment period. Only three neighborhoods met the standards of high pollution generation; the rest were classified as moderate generators. Opportunities for the following types of restoration activities were evaluated for each site:

- On-site Retrofits – such as new rain gardens, rain barrels or other rooftop or driveway disconnection practices
- Better Lawn and Landscaping Practices – improved buffer protection, native plants, turf area reduction, proper fertilization and pesticide application, and mowing practices
- Better Open Space Management – more natural management of neighborhood common areas or courtyards (landscaping, pet waste, etc.)
- Multifamily Parking Lot Retrofits – stormwater retrofits (e.g., bioretention, pervious pavers, etc.) for common parking areas

Six neighborhoods were considered to have a high restoration potential; 13 had moderate potential; and the remaining six are considered low restoration candidates. The locations of these neighborhoods are identified on the subwatershed maps in Appendix H.

These assessments identified many opportunities to implement pollution prevention and source control education geared towards watershed residents. Details on recommended practices and programs are provided in Section 5.

General Findings

- Recommendations include rooftop disconnections, storm drain stenciling, and environmentally friendly lawn care and landscaping practices for targeted sites.

- Most assessed residential areas were high density and well established (older). New development appears to be primarily single-lot infill and/or additions. Much of this new development is on steep slopes. On-site erosion control and appropriate landscaping techniques are lacking at most of these infill sites. Better guidance and enforcement may reduce the impacts being generated from these sites.

- Residential areas appear to contribute a large percentage of rooftop runoff to the storm drain system. Opportunities exist to install rain barrels / rain gardens in residential areas, as well as to convert courtyards at apartment complexes and open space at schools into bioretention areas or naturally vegetated depression areas that accept rooftop drainage.

- Very little watershed-related signage was observed in residential areas (with the exception of limited pet waste pickup signage). There is an opportunity for buffer awareness signage and storm drain stenciling throughout the residential watershed, as well as simple signage making residents aware that they are residing within a specific subwatershed.

- Evaluation of residential practices (i.e., extent of fertilization, mowing, watering, car washing, disposal of lawn clippings, etc.) was hard to fully determine due to the time of year of the assessment and snow cover on the ground.

- Buffer encroachment and yard waste dumping was common in residential areas along stream corridors.

- There was evidence of municipal curbside leaf and yard waste pickup in many of the neighborhoods assessed. This can be a beneficial community service to provide; however, when municipal pickup lags there is a window of opportunity for significant slugs of nutrients and sediment to enter into the storm drain system during storm events.

Figures 3-13 through 3-18 illustrate some of the findings presented above.

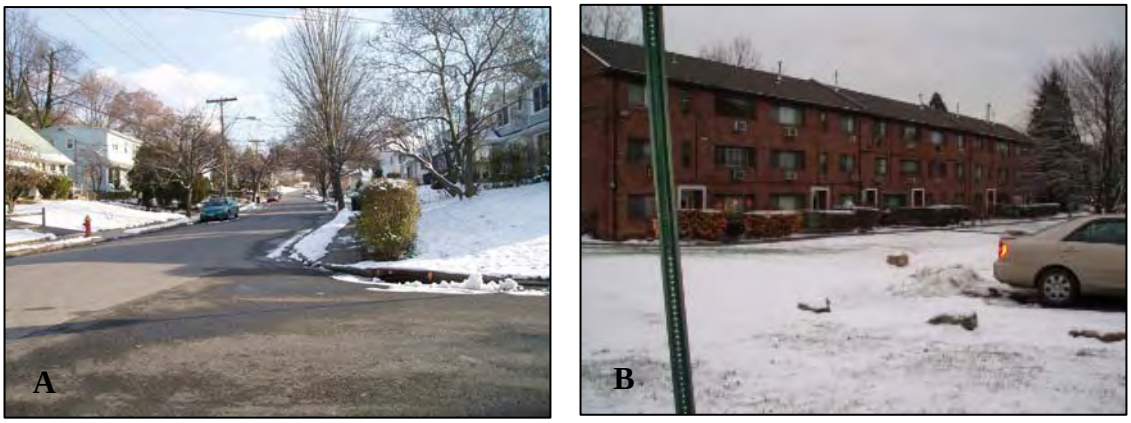


Figure 3-13: Residential areas ranged from (A) single family neighborhoods or city blocks that were generally ½ acre to 1/8 acre lots to (B) multifamily apartment complexes or townhouse units.

Figure 3-14: Opportunities for downspout disconnection in residential areas are plentiful. (A) shows a downspout directly connected to the storm drain system or to outlets on the street curb (B) shows a downspout draining onto driveway, which may subsequently drain to a pervious area or to the storm inlets on the street. (C) Shows a diverted downspout into a lawn area or landscape feature, which is preferable where feasible.

Figure 3-15: Relatively little signage was seen in residential areas touting pollution prevention behaviors.

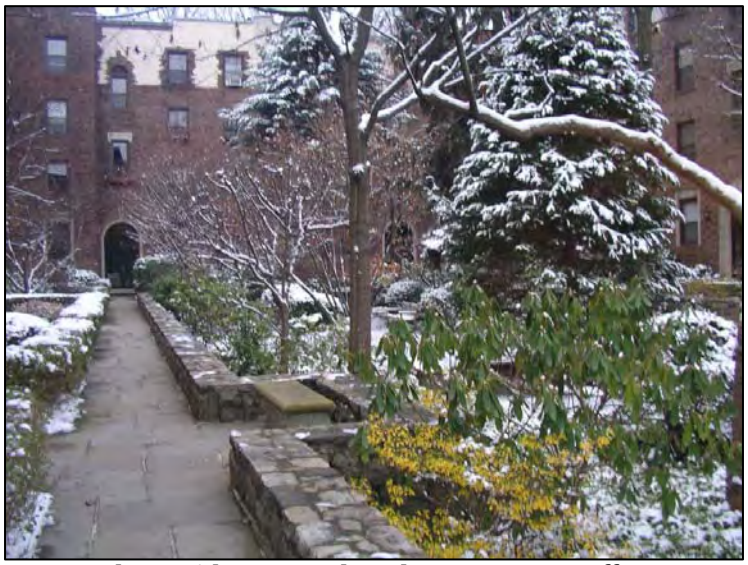


Figure 3-16: Apartment complexes with courtyards and common space offer opportunities for downspout disconnection. This courtyard in Bronx River Middle Direct Drainage (site ID BRM-N4) at Sangamore Rd. apartments offers an interesting landscape, however downspouts are internal to the building.

Figure 3-17: Other notable features in residential areas included (A) two-track driveway designs that help reduce impervious cover, (B) evidence of lawn chemical application in the winter, and (C) evidence of homeowner car maintenance with a potential for oil and grease to enter stormdrain.

Figure 3-18: Construction in residential areas was mostly single lot infill and redevelopment with poor erosion and sediment control implementation.

3.3.3 Pervious Area Assessment (PAA)

Assessment Protocol

The Pervious Area Assessment (PAA) was conducted to evaluate natural area remnants and large pervious areas outside the stream corridor. During the USSR, field crews looked specifically at existing vegetative cover, potential impacts, and site constraints at each location. The potential to reforest turf areas or restore natural area remnants and open parcels via soil amendments, plantings, invasive plant species removal, and trash cleanup were evaluated.

Prior to going out in the field, sites with significant turf cover and publicly-owned sites were identified in the office using aerial photos and land use mapping information.

Summary of Sites Investigated

A total of 16 sites were evaluated by field crews, including: three schools, three vacant lots, five parks, one cemetery, one golf course, one residential area, and two old commercial sites. While restoration opportunities were identified at each of these sites, eight sites were considered to be good candidates due to minimal site preparation requirements, public ownership considerations, or potential linkage with other upland restoration opportunities.

Specific recommendations on managing and restoring these pervious areas are provided in Section 5. Locations of each site can be found on the respective subwatershed map in Appendix H.

General Findings

- Cemeteries, golf courses, and recreational parks represent the majority of turf cover in the watershed. While these areas provide unique services for the community, efforts to understand nutrient management, groundwater interactions, landscape practices, and reforestation potential at these sites should be made.

- Bedrock outcrops are common in the watershed, so more extensive site investigation may be necessary where reforestation is recommended.

- The dumping of organic wastes, asphalt slag, fill material, and other wastes in municipal parks was observed (e.g., Town of Ardsley).

- Invasive plant species control in upland and wetland open space and natural area remnants needs to be addressed in restoration and management activities.

- There are few remaining large contiguous forest areas in the watershed: tracts in Clove Brook, Manhattan Park Brook, and one split between Hartsdale Brook and Grassy Sprain Brook subwatersheds, and the adjacent watershed that should be investigated (protection status, habitat quality, etc).

Figures 3-19 through 3-22 illustrate some of the findings discussed above.

Figure 3-19: Golf course, such as the Leewood course pictured here, may provide a good opportunity for restoration via perimeter tree planting and stormwater retrofits in partnership with upstream municipal maintenance yard.

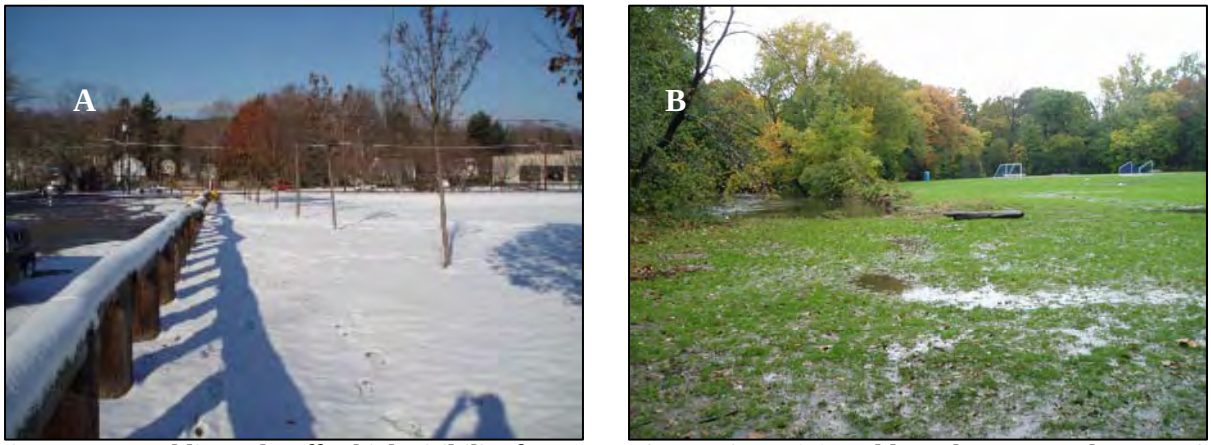


Figure 3-20: Public parks offer high visibility for restoration projects. (A) Webb Park on Central Avenue in Fulton Brook (site ID FB-P1) has a potential for reforestation along the north and east boundaries of the park and a native plant demonstration site along the parking lot. (B) At this site near the confluence of Laurel Brook and the Bronx River, wetland restoration may be a potential project.

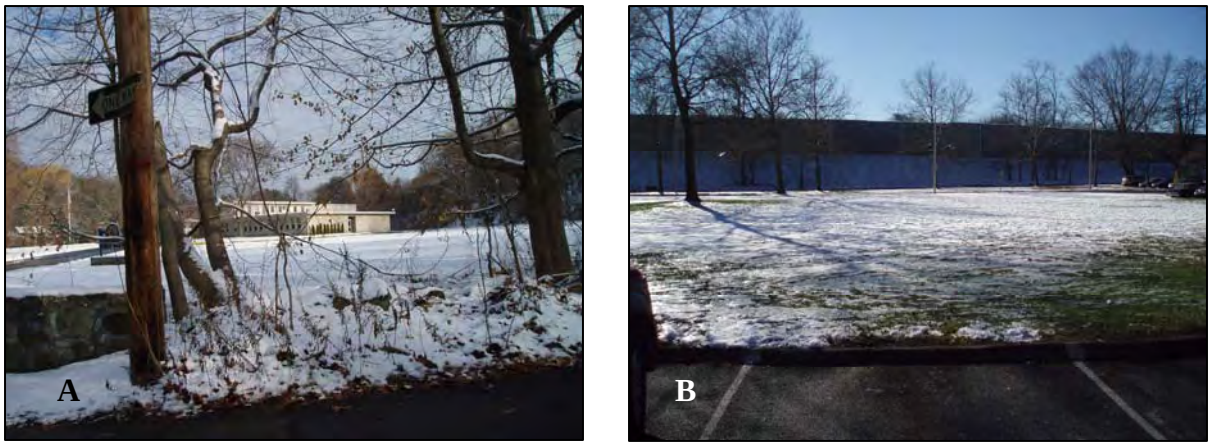


Figure 3-21: Designated open space or large turf areas can be good locations for tree planting or other restoration projects. Property owners must be on board with these activities. (A) is in Grassy Sprain Brook (site ID GSB-P3) and (B) is Greenburgh housing authority apartments in Manhattan Park Brook (site ID MP-P3).

Figure 3-22: Vacant lots like those pictured here may provide opportunities for enhancing infiltration through soil amendments (extensive site prep) or for buffer reforestation, respectively. (A) is in Bronx River Middle Direct Drainage (site ID BRM-P4) and (B) is in Manhattan Park Brook (site ID MP-P1).

3.4 Stormwater Retrofit Inventory

In addition to USSR assessments, the Center also conducted a stormwater retrofit inventory in targeted subwatersheds. Stormwater retrofits are structural practices that are inserted into the urban landscape where little or no stormwater management currently exists. They are an essential element to successfully restore the overall aquatic health of a stream. Without establishing a stable, predictable hydrologic regime, which regulates the volume, duration, frequency, and rate of flow, many of the other restoration strategies such as bank stabilization, riparian reforestation, and aquatic habitat enhancement may fail. In addition, stormwater retrofits provide important water quality benefits that can result in improved instream conditions.

Stormwater retrofits generally fall into two categories: storage retrofits and on-site retrofits. Storage retrofits treat drainage areas ranging from five to 500 acres. In comparison, on-site retrofits normally treat less than five acres of contributing drainage area, and frequently less than one. Application of practices in the different categories vary according to the impervious cover

and land use makeup of each subwatershed as well as the restoration goals being pursued. Storage retrofits, such as ponds and wetlands, often provide the widest range of watershed restoration benefits; however, on-site retrofit practices, such as bioretention and filtering practices, can provide a substantial benefit when applied over large areas. For the Bronx River watershed assessment, the goal was to identify all categories of retrofits, with the primary objectives of increasing water quality treatment and recharge, and to mitigate known localized channel erosion areas.

Assessment Protocol

The Center used the Retrofit Inventory field form to evaluate retrofit opportunities at candidate sites. Field crews look specifically at drainage patterns, the amount of impervious cover, available space, and other site constraints when developing concepts for a site. Candidate sites were initially identified using orthophotos, local input, and information gathered during the stream assessments. Priority candidate retrofit sites in the watershed generally had one or more of the following characteristics:

- Located upstream of potential stream restoration projects
- Located at uncontrolled hotspots
- Have a large amount of impervious cover in the drainage area
- Have existing drainage infrastructure or existing stormwater practices
- On publicly-owned or operated lands
- Could serve as a demonstration project

Summary of Sites Inventoried

Field crews visited a total of 59 sites; multiple concepts were developed for some locations and others were eliminated from further consideration. This resulted in the identification of 54 opportunities to implement stormwater retrofits in the Bronx River watershed, as described in detail in Section 5.

The majority of stormwater retrofit opportunities identified in the watershed are on publicly-owned land in highly visible locations. Some retrofit opportunities are on privately-owned land, primarily school grounds and commercial parking lots. Specific types of stormwater treatment options prescribed for the different retrofit locations vary, but include bioretention practices, sand filters, porous pavement, swales, wet ponds, and forested wetlands.

General Findings

- Only a handful of stormwater practices were observed in the Westchester County portion of the Bronx River watershed, which is almost completely built out. As a result, there are few local examples of well-designed, functioning, and integrated practices. Due to the built out nature of the watershed, there were limited opportunities for new storage facilities outside of the stream corridor. There were, however, abundant opportunities for onsite practices that could be well integrated with the existing land use and incorporated in a manner that provides aesthetic improvement and educational opportunities to the sites.

- A few demonstration retrofits have been implemented or are planned by the County. Signs have been installed to educate parkway users and train passengers about the pocket wetlands, swales, and rain gardens located at the Crestwood Maintenance Facility in the Bronx River Parkway Reservation.

- There are some underground stormwater practices that field crews were not aware of (i.e., sand filters, proprietary practices, and catch basin inserts). Underground practices may be appropriate concepts for highly urban parts of the watershed where surface practices are less desirable because they take up space.

- Opportunities for on-site stormwater retrofits, particularly in parking lots and at publicly owned facilities are plentiful. These areas also represent good opportunities for evaluating different technologies such as porous pavement and cisterns.

- New development does not appear to be employing sufficient post-construction stormwater management practices, such as those noted in the New York State Stormwater Management Design Manual.

- Random snow storage sites were observed in several locations throughout the watershed. Melt water from large snow piles can have a significant impact on receiving water due to salts and other pollutant build up that occurs.

- Several good opportunities for stormwater retrofits were located on private property. The County and local municipalities will need to explore incentives such as cost sharing, recognition programs, discounts on public services or utility fees, etc. to encourage participation by the private sector.

Figures 3-23 through 3-26 illustrate some of the sites visited and illustrate some of the findings outlined above:

Figure 3-23: A few demonstration retrofits like the pocket wetland at the Crestwood Maintenance Facility in the Bronx River Parkway Reservation shown here exist in the watershed.

Figure 3-24: Parking lots at commercial shopping centers and businesses offer many opportunities to collect and treat stormwater runoff. (A) This shared parking lot at the Bed Bath & Beyond in Manhattan Park Brook (site ID MP-R2) is a potential candidate for underground sand filters. (B) The Lord and Taylor in Bronx River Middle Direct Drainage (site ID BRM R2) and (C) Frank's Nursery in Grassy Sprain Brook (site ID GSB-R1) offer bioretention, porous pavement and vegetative swales options.

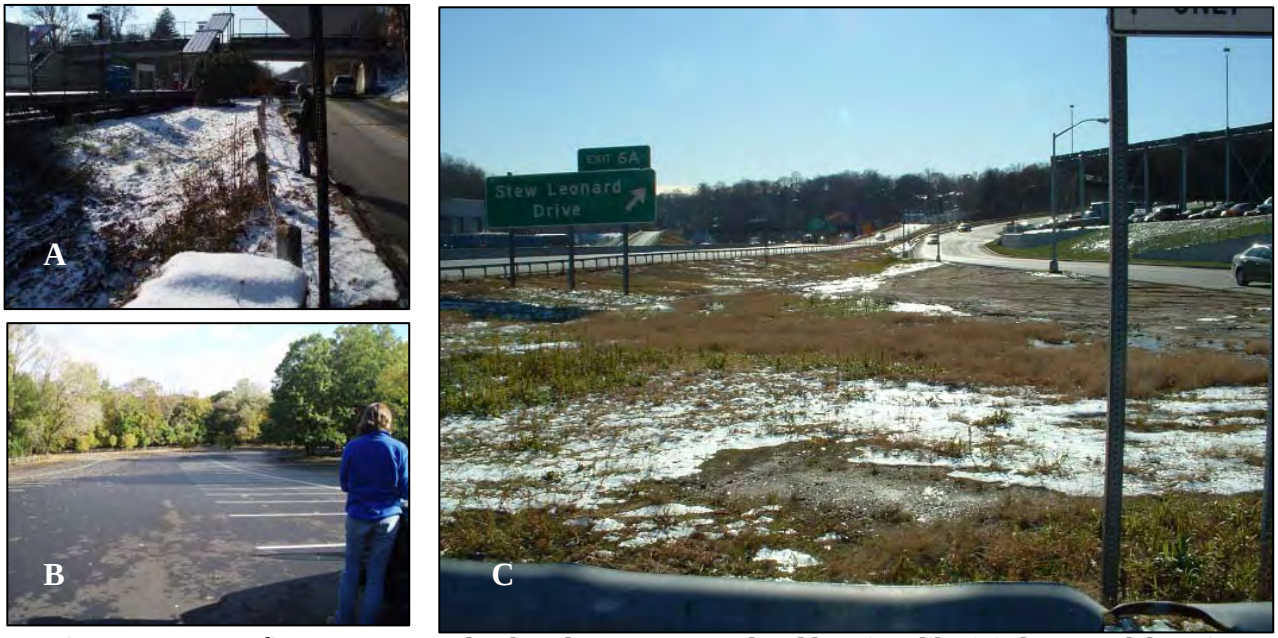


Figure 3-25: Retrofit concepts were developed at transport-related locations like (A) the Hartsdale train station in Hartsdale Brook (site ID HB-R1); (B) the Park and Ride in Sprain Brook (site ID SB-R4); and (C) the right of way between the toll plaza and Home Depot on Sprain Brook Parkway (site ID SB-R3).

Figure 3-26: Retrofit teams also developed concepts for schools (site ID BRM-5), apartment complexes (site ID BRM-R1), and municipal buildings (site ID BRM-R10) throughout the targeted subwatersheds (A, B, and C, respectively). During this assessment, evidence of watershed stewardship signage was noted in a few locations (D and E).

Section 4. Watershed Goals and Recommendations

Recommendations for managing the County portion of the Bronx River watershed are guided by the overarching goal set by the Westchester County Department of Planning (WCDP) and the supporting objectives identified by the Bronx River Watershed Coalition. The goal and objectives are geared towards improving impaired conditions of the Bronx River and ultimately helping restore the larger resource, Long Island Sound.

This section presents the goal and objectives for managing the Bronx River watershed along with 15 implementation recommendations based on extensive desktop analysis and watershed assessments conducted by the Center and Biohabitats.

4.1 Bronx River Watershed Goal and Objectives

The WCDP initiated this watershed planning effort with the overarching goal of *improving water quality in the Bronx River and its tributaries by controlling the volume of polluted stormwater runoff (aka, non-point source pollution) entering these watercourses*. This goal can best be met by improving and installing infrastructure capable of treating polluted stormwater, natural resources restoration and re-establishment, and public education and outreach.

In addition to this overarching goal established by the WCDP, the Center developed specific management objectives based on language from the Bronx River Watershed Coalition Memorandum of Agreement and input provided by municipal representatives during the Coalition meeting on May 3, 2006. These objectives further define Coalition members' overall vision for managing the Bronx River as outlined in the MOA:

> *To maintain and enhance water quality and ecological health in and along the Bronx River and its tributaries, which is essential to the economic well-being, environmental and public health, recreation opportunities, and quality of life for the local governments, residents, and visitors of the Bronx River and Long Island Sound watersheds.*

Ten specific objectives to support the WCDP's goal and to meet the Coalition's vision are as follows:

1. Improve water quality by eliminating illicit discharges, increasing litter prevention and trash cleanup efforts, and reducing sources of sediment loading as a way to maintain "fishable/swimmable" conditions from headwaters to the most downstream reaches in the County. Enhance clarity so that the bottom can be seen during baseflow conditions and trash is not visibly prevalent.
2. Enhance in-stream and riparian habitat along the river and its tributaries in order to sustain a diversity of aquatic insect and fish communities.
3. Incorporate the historical aspects of the river and the Bronx River Parkway into overall watershed education and restoration planning.
4. Advance residential, local government, and community business awareness of the Bronx River through pollution prevention education and watershed restoration outreach activities.

5. Promote recreational activities such as fishing, trail walking, birdwatching, and canoeing/kayaking by improving water quality, riparian habitat, and passage along the mainstem from the Kensico Reservoir to the Bronx Borough. The Bronx River should serve as an environmental corridor and recreational resource for the region.
6. Mitigate the negative impacts of stormwater runoff on hydrology and water quality through stormwater retrofits (i.e., directing runoff into new stormwater practices prior to discharge), flood prevention, and pervious area restoration (infiltration into amended soils, tree planting, etc).
7. Provide information needed to evaluate flood attenuation, habitat, and recreational benefits of existing impoundments when determining pond dredging and wetland creation potential.
8. Encourage intermunicipal coordination in managing water quality and habitat issues in the Bronx River watershed through the Bronx River Watershed Coalition. This forum should be used to maintain communication, identify cost-sharing opportunities, adopt watershed-wide regulations, and develop a monitoring program to measure the success of water quality, habitat, and ecological health improvement actions affecting the Bronx River and its tributaries.
9. Identify specific actions to help County and municipalities meet federal, state, and regional regulatory and policy criteria (i.e., NPDES, 303(d) listing, Long Island Sound Conservation and Management Plan, etc).
10. Integrate water resource activities with public health, regional transportation and greenway planning, and infill and redevelopment projects.

4.2 Implementation Recommendations

To meet the WCDP's goal and the Coalition's objectives, 15 key actions are recommended for the watershed. These recommendations provide a framework for implementing the numerous management and restoration practices identified through field assessments as well as program and education-related recommendations identified through both desktop analyses and field assessments.

These recommendations are presented in order of implementation priority. Recommendations should be loosely viewed as short-term, mid-term, and long-term implementation priorities.

Short-term recommendations are initial actions to be carried out within the next year that set the framework for executing further watershed recommendations. Such actions include adoption of local laws, discharge investigations, and education program planning. Small demonstration restoration projects could be completed during this phase, however construction of large retrofit practices and stream restoration projects requiring extensive design, engineering, and permitting should be planned for later implementation.

Mid-term recommendations involve continued programmatic and operational measures, distribution of educational materials, and construction of one or two large retrofit and/or stream restoration projects over the next two to four years. Progress on land conservation and continued enforcement and inspection as the watershed develops should be made during this period, as well as project monitoring and tracking.

Long-term recommendations mark continued implementation of any additional projects necessary to meet watershed objectives, as well as an evaluation of progress, accounting of successes and lessons learned, and an update of the watershed implementation plan.

Implementation recommendations for the Bronx River watershed are as follows:

1. Transition the Bronx River Watershed Coalition into a long-term management structure.

During the planning process, the Coalition served as a means of educating, informing and involving each of the jurisdictions in assessing watershed conditions and determining watershed priorities. As the focus moves towards implementation, the Coalition should shift towards the more active roles as identified in the MOA:

- Advance water quality and ecosystem improvement actions in the watershed
- Identify funding opportunities for grants or other financial assistance
- Periodically review and update priority actions in the plan; approve annual work plans for the Coalition
- Convene annual forums for the purpose of reviewing accomplishments and discussing next steps

As a group, the Coalition should encourage formal adoption of the watershed plan by member jurisdictions and develop formal guidelines and procedures for long-term Coalition membership. In addition, the County should consider hiring a full-time staff person who would oversee implementation of the plan, coordinate Coalition activities, etc.

2. Follow-up with recommended discharge investigations and identified infrastructure maintenance issues.

During field work several restoration opportunities were identified by the Center and Biohabitats, including locations where localities should consider pursuing discharge investigations and assessing the need for infrastructure repair. Discharge investigations target dry weather flows that have the potential to contain pollutant loads, such as illicit discharges, sewage overflows, and industrial or transport-related spills.

The need to assess existing infrastructure was noted at locations where utilities in the stream corridor have the potential to cause water quality, stream habitat, or channel stability problems. Storm drainage, sanitary sewer, and road related infrastructure damage was also noted. Examples include exposed sewer pipes and manhole stacks, blocked culverts, and damaged outfalls.

Tables 5-8 and 5-9 provide lists of locations recommended for discharge investigation or infrastructure repair assessment. Follow-up should occur at each location by the responsible municipality.

3. Adopt appropriate regulatory protections.

The County review of local programs and regulations applicable to watershed management identifies areas for improvement in local protection laws (i.e., buffer, steep slope, open space, stormwater).

All municipalities in the watershed subject to NPDES Phase II requirements should consider adopting a local stormwater and erosion and sediment control law that cites the New York State Stormwater Management Design Manual for technical guidance.

Regulations protecting steep slopes; promoting tree planting and open space protection; and establishing wetland and stream buffer criteria should be adopted where appropriate. In addition, opportunities for improving erosion and sediment control at small development sites (e.g., less than one acre) should be evaluated and implemented. These may include both educational and regulatory approaches.

4. Establish a watershed-wide illicit discharge detection and elimination (IDDE) program.

Aging infrastructure, illicit connections, and limited municipal staffing appear to contribute to pervasive and chronic sewer overflows throughout the watershed. Each municipality is responsible for maintaining storm and sanitary sewer lines and responding to overflows within their jurisdiction. Overflows are generally reported by residents through the local police dispatch, rather than a water quality or spill response hotline.

Consider establishing a County-wide IDDE program, where municipalities can cost-share equipment, overflow response staff, educational materials, discharge investigations, and possibly repairs. A centralized watershed hotline for reporting suspicious discharges and overflows could be maintained as part of this effort, along with a GIS database to map infrastructure, track maintenance activities and costs, and estimate discharge impacts.

The Coalition should investigate the legality of establishing a shared program, particularly as it relates to water/sewer service fees and taxes collected by each jurisdiction. In addition, consider establishing point-of-sale plumbing inspection requirements.

5. Provide construction and post-construction stormwater management guidance for infill and redevelopment projects.

Small-scale, single-lot infill and redevelopment projects make up the majority of development projects in the watershed but are not necessarily captured under current regulations as these sites typically have less than one acre of disturbance. In addition, during field assessments, numerous small development sites across the watershed were observed to have insufficient, or no, erosion and sediment control practices.

Jurisdictions in the watershed should examine voluntary or regulatory means for improving application of erosion and sediment control practices and post-construction stormwater management practices at small sites. This may include providing additional education and

training for designers and contractors, increased construction site inspections, establishment of a hotline that citizens can call if they observe sediment flowing from a construction site, etc.

In addition, the *New York State Stormwater Management Design Manual Chapter 9: Redevelopment Practices* was recently released by NYS DEC. The Coalition should consider providing training on the design guidance in this chapter to designers in the watershed.

6. Encourage "good housekeeping" at State, County and municipal facilities.

All publicly-owned maintenance facilities visited were confirmed hotspots and multiple opportunities for improvement were observed. NPDES requirements include measures for "good housekeeping" at municipal facilities, and these public sites should serve as demonstration sites for comparable private operations.

Training should be provided for municipal staff on appropriate pollution prevention techniques, and a model pollution prevention plan (PPP) should be developed that could be adapted for each maintenance facility.

Examples of good practices observed at some locations (i.e., secondary containment, spill response plan, permit posting, staff training) should be recognized and modeled. The Greenburgh maintenance facility had many examples of pollution prevention practices that should be applied at facilities watershed-wide. High priority sites include the County's Grasslands facility, and the Eastchester, Tuckahoe, and Yonkers public works yards.

7. Install priority stormwater retrofits, i.e., management practices, for water quality improvement.

Stormwater retrofits targeting nutrient and pathogen removal are priorities. Retrofits designed to control volume and protect channels from erosive flows are also critical in the watershed.

The County has installed some demonstration practices (i.e., Crestwood Maintenance Facility) already, and should plan on the installation of at least three highly visible demonstration projects in the near-term. The County should also begin design and permitting for three larger, more expensive projects with the goal of installing at least one priority practice as funding becomes available. Priority retrofits are identified in Section 5. Concept designs for priority projects can be found in Appendix I.

The installation of demonstration projects or experimental innovative practice designs should be standard during construction or renovation of publicly-owned facilities, and encouraged for private infill and redevelopment projects. These sites should be regularly monitored and actively used for education.

8. Implement priority riparian, i.e., stream, corridor restoration projects.

A number of stream repair, buffer reforestation, and stream cleanup projects were identified throughout the watershed to help stabilize eroding stream channels, restore floodplain wetlands, and enhance vegetated riparian buffers. Collectively, 10,500 linear feet of stream restoration and over 90 acres for invasive plant species management and tree planting were identified in 15 potential stream corridor restoration projects.

Buffer planting and invasive plant species management projects require modest planning prior to implementation and stream repair projects will require additional design work and potentially coordination with upstream retrofits. Because invasive plants are prevalent throughout the watershed, integrating their management with priority buffer reforestation projects will be critical to success. Priority projects are identified in Section 5. Concept designs for priority riparian corridor restoration projects are provided in Appendix J.

9. Conduct pollution prevention and source control education for property owners and residents of priority private hotspots and neighborhoods, including governmental staff and elected and appointed officials.

Education efforts should be specific to the types of pollution producing behaviors observed at priority businesses and residential neighborhoods throughout the watershed.

Encroachment and yard waste disposal was frequently observed in stream buffers in residential areas. Residential areas also appear to contribute a large percentage of rooftop runoff to the storm drain system. Opportunities exist in neighborhoods and at apartment complexes throughout the watershed to disconnect downspouts, to install rain barrels or rain gardens, and to convert turf to landscaping. Section 5 identifies priority residential areas for targeting educational programs.

During the hotspot investigation, many private businesses were found to have poor pollution prevention practices. The types of businesses included from private golf courses, gas stations, restaurants, greenhouses, and car washes. Improved pollution prevention needed at these sites ranged from dumpster management to improved storage of outdoor materials.

After demonstrating pollution prevention planning at municipal sites (i.e., covered fueling islands, inlet inserts, grease traps, covered storage, wash water management), the Coalition should provide guidance and develop incentives to encourage local businesses to adopt these model practices (see Section 5).

10. Restore priority pervious areas, e.g., manage and remove invasive plant species management and removal, amend soils, plant trees and native species, etc.

Approximately 30 acres of vacant land or large turf areas were identified for pervious area restoration (tree planting, soil amendments, etc) to improve infiltration and groundwater recharge and increase urban canopy cover. To serve as demonstration sites, consideration should be given to restoring up to three priority pervious areas within the first two years of

completion of this *Report*. Priority areas for pervious area restoration are identified in Section 5.

11. Increase watershed stewardship signs for public educational purposes.

The Bronx River Parkway and Bronx River Parkway Restoration bring attention to the river, its history, and ecology. Improved signage on the parkway and in the reservation connecting motorists and trail users to the river and its watershed is recommended. In addition, signage should be considered for other major transportation corridors in the watershed, including Sprain Brook Parkway, Cross County Parkway, Cross Westchester Expressway (I-287), New York State Thruway (I-87), and the Harlem Line of the Metro North Railroad System.

While some evidence of educational signage (e.g., pet waste cleanup, storm drain marking) was noted throughout the watershed, stormwater and pollution prevention signage is lacking in most residential areas and urban centers. Additional storm drain marking in heavily used pedestrian areas or at all municipal facilities (e.g., town centers, train stations, local parks, libraries, etc.) should be considered. Currently, Westchester County has adopted a policy to use storm drain marking on all new catch basin grates. The Coalition should encourage member jurisdictions to adopt a similar policy.

12. Develop a coordinated monitoring and project tracking plan to track the delivery, implementation, and effectiveness of management and restoration practices.

Coalition partners should develop a three-pronged approach to monitoring implementation activities: project monitoring, sentinel station monitoring, and project tracking.

Project monitoring should be geared towards quantitative measures of success for both structural and non-structural management and restoration practices (i.e., stormwater retrofits, stream repair projects, public education, etc.). Monitoring methods will depend upon the project, but can involve pre and post biological sampling and cross sections at stream repair projects, pre and post behavior surveys for educational activities, and simple accounting of the number of hotline calls or disconnections performed as part of a discharge prevention program.

Continued monitoring at existing stations throughout the watershed is recommended for baseflow and storm flow sampling to investigate water quality conditions, the impact of potential barriers on in-stream biology, and long term trends. Trend monitoring is the best way to determine if stream conditions are improving, watershed goals are being met, and progress towards meeting regulatory requirements is being made. Additional stations are recommended for tributaries where no information is available (i.e., confluence with Davis and Clove Brook).

Managing the delivery of a large group of restoration projects within the watershed can be a complex enterprise. Therefore, it is a good idea to create a master project spreadsheet linked to a GIS system that tracks the status of individual projects through final design, permitting, construction, inspection, maintenance and performance monitoring. By tracking the delivery

of restoration projects, lessons learned can be identified and implementation progress over time can be assessed, which in turn, helps explain future changes in water resource quality. Project tracking can also improve the delivery of future projects, and creates reports that can document implementation progress for key funders and stakeholders. The tracking system should account for all restoration practices undertaken in the watershed regardless of their type or size.

13. Conduct additional assessment in non-priority subwatersheds, large turf areas, and remaining upland forests.

Since only a handful of subwatersheds were assessed as part of this planning effort, the Coalition should establish a schedule for assessing the remaining subwatersheds over the next five years.

In addition, further investigation of major turf areas such as cemeteries, golf courses, and municipal parks should be conducted as part of community greening projects. Further investigation of nutrient management and landscape practices is needed at these sites to determine their feasibility for reforestation.

Few contiguous forest tracts remain in the upland portion of the watershed. These areas should be investigated as to their vulnerability to development and overall habitat quality.

14. Develop a comprehensive management plan for the Bronx River watershed in both Westchester County and New York City.

Since water resource management is irrespective of jurisdictional boundaries, Westchester County, New York City, and the state of Connecticut should integrate their watershed planning efforts into an overall strategy for the Bronx River. Progress towards meeting the river's designated uses and measuring improvements overtime will ultimately require coordination.

15. Host an annual meeting to report on implementation progress and plan updates.

Every year, the Coalition should host a public meeting to celebrate accomplishments, recognize participants, review lessons learned, and solicit feedback on plan updates and next steps. The watershed plan should be reviewed, and if necessary, updated at least every five years.

Section 5. Management and Restoration Practices Applicable to the Bronx River Watershed

This section presents recommendations on the application of specific watershed management or restoration practices throughout the Bronx River watershed. These practices focus on treatment of polluted runoff, natural resources restoration and re-establishment, and public education and outreach. They are broadly classified into five major groups as described in Figure 5-1.

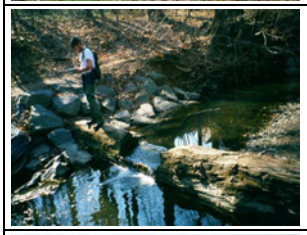
	**Upland Stormwater Retrofits** Structural practices installed in upland areas to capture and treat stormwater runoff before it is delivered to the storm drainage system, and ultimately, the Bronx River.
	**Riparian Corridor Restoration** Stream repair, stream restoration, stormwater retrofitting, reforestation, and other techniques used to enhance the appearance, structure, or function of riparian corridors.
	**Pervious Area Management and Restoration** Application of land reclamation and upland revegetation techniques to improve soil quality, increase stormwater infiltration, and increase urban tree canopy.
	**Pollution Prevention and Source Control Education** Provision of educational, enforcement, and technical resources to watershed residents that promote changing resident behaviors or business operations that are causing pollution.
	**Municipal Practices and Programs** Improved operation and maintenance of publicly-owned facilities and infrastructure that will reduce pollution generation.

Figure 5-1: Five Groups of Restoration and Management Practices Recommended for the Bronx River Watershed

Specific locations for the application of these restoration and management practices were identified and evaluated during the six field assessments conducted by the Center and Biohabitats (see Section 4). During these field assessments, the Center and Biohabitats visited over 150 locations in the watershed and used one of six field assessment methodologies to evaluate the feasibility of implementing a management or restoration practice. The type of

practices that resulted from each of these six field assessment methodologies are presented in Table 5-1.

Table 5-1: Correlation of Field Assessments to Practice Groupings

Field Assessment	Types of Practices Identified and Evaluated
Unified Stream Assessment	Municipal Practices and Programs Riparian Corridor Restoration
Riparian Corridor Restoration Inventory	Riparian Corridor Restoration
Hotspot Site Investigation	Municipal Practices and Programs Pollution Prevention and Source Control Education
Neighborhood Source Assessment	Pollution Prevention and Source Control Education
Pervious Area Assessment	Pervious Area Management and Restoration
Retrofit Inventory	Upland Stormwater Retrofits

After the field assessments were completed, the Center and Biohabitats developed a ranking system to prioritize identified management and restoration practices within each practice group. Using best professional judgment, each practice location was assigned points and ranked according to the factors listed below. The ranking system is based on 100 points. The ranking factors and criteria are described in more detail in Appendix F.

- Cost – Cost associated with project.
- Synergy – Project with high potential to support other benefits and functional values in the subwatershed. This includes project support, location benefits, ecological benefits, economic synergy, support other functional values.
- Visibility – Project with high visibility and potential to raise the public's awareness of the watershed (visible from street or located in public park).
- Improve water quality – Potential for treatment or prevention of pollutants. Treats water quality volume or eliminates exposure of pollutants to stormwater runoff.
- Feasibility – Project with high potential that it will be implemented. The site has access for equipment, low maintenance burden, serves as a demonstration site and is publicly owned.
- Community Involvement – Project with potential to educate and involve the community.

The recommended management and restoration practices are described in more detail below. A list of management and restoration practice opportunities organized by jurisdiction is provided in Appendix G.

5.1 Upland Stormwater Retrofits

Upland stormwater retrofits are structural practices installed in upland areas to capture and treat stormwater runoff before it is delivered to the storm drainage system, and ultimately, the Bronx River. Fifty-four opportunities to implement stormwater retrofits in the Bronx River watershed are presented in Table 5-2.

These opportunities are located primarily in the priority subwatersheds for restoration, although opportunities were also identified in Bronx River Lower and Bronx River Upper Direct Drainages, Clove Brook, and Sprain Brook. The majority of stormwater retrofit opportunities

identified in the watershed are on publicly-owned land in highly visible locations. Some retrofit opportunities are on privately-owned land, primarily school grounds and commercial parking lots. Further detail on site selection and assessment methodology is provided in Section 3.4.

Specific types of stormwater treatment options prescribed for the different retrofit locations vary, but include bioretention practices, sand filters, porous pavement, swales, wet ponds, and forested wetlands. If implemented, these stormwater retrofits will increase stormwater runoff quality and recharge; mitigate localized channel erosion areas; protect riparian corridor restoration sites; and serve as demonstration and education sites. Conceptual designs have been developed for 15 high and medium priority stormwater retrofit projects (Appendix I). These projects were selected to represent a diversity of stormwater management practices and locations.

Table 5-2: Upland Stormwater Retrofit Opportunities in the Bronx River Watershed

Location	Opportunity	Rank	Site ID	Map
Ardsley (Ardsley Park)	Modified grass channel with infiltration trench; bioretention	High	GSB-R6	H-8
Ardsley (McDowell Park)	Modified sand filter swale with turf cover, gravel trench, perforated underdrain; remove large waste pile of asphalt	Medium	GSB-R8	H-8
Bronxville (Concordia College)	Rain garden; bioretention; porous pavers	Low	BRM-R6	H-2
Bronxville (Bronxville School)	Rain garden; underground practice	Low	BRM-R8	H-2
Bronxville (Bronxville train station)	Planter boxes	Medium	BRM-R4	H-2
Bronxville (Bronxville Library)	Disconnect roof drains; rain garden; educational signage	Medium	BRM-R9	H-2
Eastchester (Immaculate Conception Church and School)	Permeable pavers; bioretention; rain garden; storm drain stenciling	Low	BRM-R5	H-2
Eastchester (Along the east side of the Bronx River, south of Harney Road)	Forested wetland	Low	BRM-R17	H-2
Eastchester (Lord & Taylor shopping center)	Bioretention cells; vegetated swale	Medium	BRM-R2/3	H-2
Elmsford (Bed, Bath & Beyond shopping center on Tarrytown Road)	Perimeter or underground sand filters	Medium	MP-R2	H-12
Greenburgh (Large school complex in Greenburgh)	Bioretention; swales; rooftop disconnection; reforestation; demonstration and educational projects	High	FB-R3	H-5
Greenburgh (Best Buy shopping center on Central Avenue)	Swale; bioretention	High	FB-R4	H-5
Greenburgh (Turco's shopping center on Central Avenue)	Swale	High	FB-R5	H-5
Greenburgh (Veterans Park North)	Rain garden	High	GSB-R2	H-8

Table 5-2: Upland Stormwater Retrofit Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Greenburgh (Hartsdale Train Station)	Perimeter sand filter; bioswale; demonstration project	High	HB-R1	H-10
Greenburgh (Greenburgh Nature Center)	Porous pavers; bioretention; educational signage	High	HB-R3	H-10
Greenburgh (Crossroads Plaza on Tarrytown Road)	Bioretention; grass swale; perimeter sand filter; expanded tree pits; underground sand filter; remove a concrete slab over stream; planter boxes at downspouts; covered storage for sand/salt; tree planting	High	MP-R1	H-12
Greenburgh (Greenburgh Elementary School on Hillside Avenue)	Remove impervious cover; incorporate more efficient parking and bus lanes; increase landscaping; stormwater treatment practices; demonstration site	High	MP-R4	H-12
Greenburgh (Greenburgh Town Hall)	Pervious paving; bioretention / rain gardens	High	MP-R5	H-12
Greenburgh (Greenburgh Library)	Perimeter sand filters; bioretention; revegetation of slopes with native plant demonstration area; permeable paving	High	MP-R6	H-12
Greenburgh (Westchester Community College)	Pervious pavers; curb cuts; enhance pervious areas on campus	High	MP-R20	H-12
Greenburgh (Edgemont High School)	Bioretention	Low	BRM-R13	H-2
Greenburgh (Ridge Park)	Bioretention/rain garden; divert water to vegetated areas	Low	GSB-R5	H-8
Greenburgh (Right-of-way along Central Avenue at Marion)	Bioretention	Low	HB-R4	H-10
Greenburgh (Danon Corporate Offices on Hillside Avenue)	Bioretention	Low	MP-R3	H-12
Greenburgh (Bed, Bath & Beyond shopping center on Central Avenue)	Bioretention; catch basin inserts; perimeter sand filters	Medium	FB-R2	H-5
Greenburgh (Old Franks Nursery on Central Avenue)	Porous pavement; grass channels; bioretention	Medium	GSB-R1	H-8
Greenburgh (Veterans Park South, east side)	Perimeter sand filters	Medium	GSB-R3	H-8
Greenburgh (Veterans Park South, west side)	Proprietary subsurface practices	Medium	GSB-R4	H-8
Greenburgh (Scarsdale Country Club)	Bioretention	Medium	HB-R2	H-10
Greenburgh (Large vacant lot at the intersection of Central Avenue and Healy)	Wet extended detention pond	Medium	HB-R5	H-10

Table 5-2: Upland Stormwater Retrofit Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Greenburgh (Greenburgh Housing Authority apartment building on Manhattan and Elm)	Bioretention; catch basin inserts; improved dumpster management	Medium	MP-R7	H-12
Greenburgh (Sprain Ridge Park and Ride)	Bioretention	Medium	SB-R4	H-13
Greenburgh / White Plains (TJ Maxx shopping center on Central Avenue)	Underground or perimeter sand filter	Medium	FB-R1	H-5
Mount Pleasant (Old Kensico Treatment Facilities)	Bioretention; pervious pavement	Medium	CB-R1	H-4
Mount Pleasant (Legionnaires of Christ Conference Center)	Pervious pavers; infiltration trenches; swales; tree planting	Medium	CB-R2	H-4
Mount Vernon (Pennington Grimes Elementary School)	Rain gardens; extended tree pit; trash management; storm drain stenciling; bioswale	High	BRM-R7	H-2
Mount Vernon (Cross County Mall)	Incorporate stormwater demonstration projects into new development plans	Low	BRL-R1	H-1
Mount Vernon (Cross County Parkway cloverleaf)	Stormwater wetland; no-mow area	Low	BRM-R12	H-2
Mount Vernon (Brewster Carter Apartments)	Perimeter sand filter	Medium	BRM-R1	H-2
Scarsdale (Scarsdale Village Hall)	Reduce imperviousness; bioretention	Medium	BRM-R10	H-2
Tuckahoe (Marbledale Vacant Lot)	Stormwater wetland	Low	BRM-R11	H-2
White Plains (Verizon Building near the County Center)	Forested wetland	Low	BRU-R1	H-3
Yonkers (Public park along Paxton Avenue immediately south of its intersection with Stone Place)	Biofilter	High	BRM-R16	H-2
Yonkers (City of Yonkers Water Works Building / Sign Shop)	Move traffic operations maintenance to different location; pollution prevention; perimeter sand filter	High	SB-R1	H-13
Yonkers (Yonkers Ice Rink)	Underground practice (e.g., sand filter)	Low	SB-R2	H-13
Yonkers (New York State Thruway right-of-way, adjacent to Home Depot)	Swale; stormwater wetland	Low	SB-R5	H-13
Yonkers (Home Depot, adjacent to New York State Thruway)	Perimeter sand filter	Low	SB-R7	H-13
Yonkers (AB Davis School)	Tree plantings in front of school and next to track	Medium	BRL-R2	H-1
Yonkers (Franko School)	Convert asphalt to pervious area; pervious pavement	Medium	BRL-R3	H-1

Table 5-2: Upland Stormwater Retrofit Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Yonkers (Old Macy's Distribution Center)	Green roofs; cisterns; porous pavement; swales; bioretention	Medium	GSB-R7	H-8
Yonkers (Sprain Brook Golf Course)	No mow areas; outfall stabilization; geese management	Medium	GSB-R9	H-8
Yonkers (Toll plaza on New York State Thruway)	Stormwater wetland	Medium	SB-R3	H-13
Yonkers (Westchester County Resource Recovery Center)	Bioretention; sand filters; inlet treatment	Medium	SB-R6	H-13

5.2 Riparian Corridor Restoration

Riparian corridor restoration involves the application of a variety of techniques to enhance the appearance, structure, or function of the stream corridor. The combination of techniques recommended for any given site is location-specific, but may include stream repair, stream restoration, stormwater retrofitting, wetland restoration, enhanced riparian management, invasive plant species management, and reforestation.

Fifteen opportunities to restore the riparian corridor in the Bronx River watershed are presented in Table 5-3. The majority of riparian corridor restoration projects identified in the watershed are on publicly-owned land within the Bronx River Reservation, but some are along Davis Brook and Manhattan Park Brook.

Specific techniques prescribed to these fifteen locations include invasive plant species management, enhancement of floodplain wetland area, stream repair, stream re-alignment, stormwater retrofits, stream bank stabilization, and buffer reforestation. If implemented, these riparian corridor restoration projects will result in enhanced riparian habitat and improved stormwater runoff quality. Conceptual plans have been developed for seven high and medium priority locations (Appendix J).

Table 5-3: Riparian Corridor Restoration Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Eastchester / Yonkers (Near Garth Woods, along the Bronx River north of Strathmore Road / Harney Road)	Bank stabilization; widen riparian buffer; remove and manage invasive plant species; expand floodplain area; stormwater retrofit; stabilize stormwater outfall; realign Bronx River	High	BRM-S1	H-2
Eastchester / Yonkers (Along the Bronx River from Harney Road south for approximately 3,000 feet)	Stabilize eroding banks; widen riparian buffer; stabilize stormwater outfalls; remove and manage invasive plant species; expand floodplain wetland area; realign Bronx River	Medium	BRM-S3	H-2
Greenburgh (Along Manhattan Park Brook at the Old Tarrytown Park, south of Old Tarrytown Road)	Redesign channel; replace culvert and/or daylight stream; remove and manage invasive plant species	High	MP-S1	H-12

Table 5-3: Riparian Corridor Restoration Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Greenburgh (Knollwood Golf Course)	Stabilize eroding banks; stormwater retrofit; improve buffer	Low	MP-S2	H-12
Greenburgh / North Castle (Along a tributary to the Bronx River, extending from Edge Park Road east to the confluence with the Bronx River)	Remove and manage invasive plant species; expand floodplain wetland; stormwater retrofit	Medium	BRU-S4	H-3
Greenburgh / White Plains (Between Old Kensico Road and the Bronx River Parkway under the Interstate 287 crossing)	Stormwater retrofit; reforestation; remove and manage invasive plant species; widen buffer	High	BRU-S1	H-3
Mount Pleasant (Westchester County DPW Grasslands facility)	Remove and manage invasive plant species; expand/enhance floodplain; realign stream; stormwater retrofit	High	DB-S1	H-5
Mount Pleasant (Along the Davis Brook from the Commerce Street crossing south between the Taconic State Parkway and the parking lot of a rock gym)	Remove and manage invasive plant species; expand floodplain; stormwater retrofit	Low	DB-S4	H-5
Mount Pleasant (Along Davis Brook, 300 feet south of Lakeview Avenue along a landscaping business)	Natural grade control structure; remove and manage invasive plant species; enhance wetland seep	Low	DB-S5	H-5
Mount Pleasant (Along the Davis Brook, at a monument business near the intersection of Lakeview Avenue and Taconic State Parkway)	Remove and manage invasive plant species; expand floodplain; realign stream; stormwater retrofit	Medium	DB-S2	H-5
Mount Pleasant (Train station parking lot in Valhalla)	Remove blockage at water main crossing; remove and manage invasive plant species; expand floodplain; stormwater retrofit	Medium	DB-S3	H-5
Mount Vernon / Yonkers (Along the Bronx River south of Midland Avenue, north of Scout/Parkway Field)	Replant riparian buffer; remove and manage invasive plant species; stormwater retrofit	High	BRM-S2	H-2
Mount Vernon / Yonkers (Along the Bronx River from the Broad Street crossing to the Oak Street crossing)	Widen riparian buffer; stabilize stormwater outfall; remove and manage invasive plant species; reconnect and expand floodplain; stormwater retrofit	Medium	BRL-S1	H-1
White Plains (In north White Plains, along the Bronx River from the Fisher Lane Bridge crossing south to the Cemetery Road crossing)	Widen riparian buffer; remove and manage invasive plant species; expand floodplain; stormwater retrofit	Medium	BRU-S2	H-3
White Plains (Along the Bronx River from the County Center parking lot access bridge north to the Cemetery Road crossing)	Widen riparian buffer; remove and manage invasive plant species; expand floodplain wetland area; stormwater retrofit	Medium	BRU-S3	H-3

5.3 Pervious Area Management and Restoration

Pervious area management and restoration involves the application of land reclamation and upland revegetation techniques to vacant lands and natural area remnants, resulting in improved soil quality, increased stormwater infiltration, and increased urban tree canopy.

Sixteen opportunities to manage and restore pervious area in the Bronx River watershed are presented in Table 5-4. Many of these sites are publicly owned; have little evidence of soil compaction, invasive plants, and trash or dumping; and can be reforested with minimal site preparation.

Specific pervious area management and restoration techniques recommended for these different locations include impervious cover removal, soil amendments, invasive plant species management, and reforestation or revegetation with native species. Application of these recommendations will result in improved soil quality, increased canopy cover, increased canopy interception of stormwater, and increased infiltration of stormwater runoff. In addition, these projects will provide community benefits, such as improved aesthetics and creation or enhancement of community amenities.

Table 5-4: Pervious Area Management and Restoration Opportunities in the Bronx River Watershed

Location	Opportunity	Rank	Site ID	Map
Ardsley (Veterans Park)	Reforestation; invasive plant species management	High	GSB-P2	H-8
Ardsley (Our Lady of Perpetual Help)	Reforestation; stream buffer enhancement	High	GSB-P3	H-8
Ardsley (McDowell Park)	Perimeter reforestation	Medium	GSB-P7	H-8
Eastchester (Leewood Golf Course)	Perimeter reforestation	High	BRM-P2	H-2
Eastchester (Eastchester Park)	Invasive plant removal; trash cleanup; native plantings	High	BRM-P3	H-2
Eastchester (Closed Eastchester Ball Field)	Bioremediation	Medium	BRM-P1	H-2
Eastchester (Immaculate Conception Church / School)	Reforestation; slope stabilization	Medium	BRM-P5	H-2
Greenburgh (Greenburgh Housing Authority complex on Manhattan Avenue)	Native species plantings with signage; benches; pathways	High	MP-P3	H-12
Greenburgh (Old Franks Nursery)	Extensive site preparation; partial site reforestation	Low	GSB-P1	H-8
Greenburgh (Vacant lot on Jackson Avenue)	Extensive site preparation; reforestation	Low	GSB-P4	H-8
Greenburgh (Fern Cliff Cemetery)	Reforestation	Low	GSB-P5	H-8
Greenburgh (Mohawk Camp and School on Old Tarrytown Road)	Native tree plantings; educational signage	Low	MP-P2	H-12
Greenburgh (Webb Park on Central Avenue)	Native plant demonstration; perimeter reforestation	Medium	FB-P1	H-5

Table 5-4: Pervious Area Management and Restoration Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Greenburgh (Vacant lot at the intersection of Tarrytown Road and Dobbs Ferry Road)	Reforestation; stream buffer enhancement	Medium	MP-P1	H-12
Tuckahoe (Marbledale Vacant Lot)	Extensive site preparation; reforestation	Low	BRM-P4	H-2
Yonkers (Old Macy's Distribution Center)	Reforestation	High	GSB-P6	H-8

5.4 Pollution Prevention and Source Control Education

Pollution prevention and source control education is a broad restoration practice that seeks to prevent pollution from residential neighborhoods or stormwater hotspots. This practice focuses education, enforcement, and technical resources on changing residential behaviors or business operations that cause pollution. Specific resources applied to different target audiences are selected based on major pollutant source areas identified in a watershed.

In the Bronx River watershed, several opportunities exist to implement pollution prevention and source control education targeted at both residents and hotspot property owners. These are described below.

Residential Neighborhoods

Pollution prevention and source control education focused on citizens is about more than just raising awareness, although this is an important component. In the Bronx River watershed, opportunities exist for the County and municipalities to act as the direct service provider to help residents and businesses practice better stewardship. Examples include local programs to conveniently dispose of yard wastes, used oil or household hazardous wastes.

Opportunities to implement pollution prevention and source control education in 25 neighborhoods are presented in Table 5-5. These include a variety of residential areas that represent different housing densities, ranging from quarter-acre lot single family homes to multifamily apartment buildings. Specific residential behaviors and activities that can be targeted at different neighborhoods across the watershed include:

- Disconnecting rooftops – Opportunities exist to install rain barrels, rain gardens as well as convert courtyards at apartment complexes and open space at schools into bioretention areas or naturally vegetated depression areas that accept rooftop drainage.
- Improving lawn care and landscaping practices – Educate land owners on practices to reduce fertilizer and pesticide use on their lawns. In addition, encourage an increase in native plant landscaping and reduction in the size of lawn areas.
- Improving control of erosion at infill development lots – Provide better guidance and enforcement of on-site erosion on single lot infill and/or additions. Also, provide education on appropriate landscaping techniques.

- Increasing watershed awareness – Implement stream buffer awareness signs and storm drain stenciling throughout the residential watershed along with simple signs making residents aware that they reside within a specific subwatershed.

Table 5-5: Neighborhood Source Control Opportunities in the Bronx River Watershed

Location	Opportunity	Rank	Site ID	Map
Bronxville (Gramatan Court Condos at Sagamore Road and Preston Road)	Planter boxes at downspouts	Low	BRM-N3	H-2
Bronxville (Sagamore Road Apartments)	Disconnect and direct downspouts to interior courtyard; pollution prevention for physical plant maintenance	Low	BRM-N4	H-2
Bronxville (Single family residential neighborhood along Masterson Road)	Lawn care education; rain gardens; erosion control and ground cover for steep slopes	Medium	BRM-N2	H-2
Bronxville (Stoneleigh Plaza apartment complex)	Rain gardens; landscaping education	Medium	BRM-N6	H-2
Elmsford / Greenburgh (Single family residential neighborhood bounded by Knollwood Rd., Sprain Brook Parkway, and Sky Meadow Place)	Storm drain stenciling; downspout disconnection / rain barrels / rain gardens; homeowner lawn care education; turf conversion	Medium	MP-N1	H-12
Greenburgh (Single family residential neighborhood along Secor Road)	Lawn care education; storm drain cleanout; downspout disconnection	High	GSB-N1	H-8
Greenburgh (Single family residential neighborhood east of North Central Avenue, north of East Hartsdale Avenue, and south of Jane Street)	Buffer replanting along stream in open lots; rain gardens and rain barrels; storm drain stenciling; homeowner education on lawn care practices	High	HB-N3	H-10
Greenburgh (Single family residential neighborhood bounded by Thomas Street, South Healy Avenue, Marion Avenue, and North Healy Avenue)	Homeowner education on lawn care practices; downspout disconnection / rain barrels / rain gardens; check for potential swimming pool discharges	High	HB-N5	H-10
Greenburgh (Single family residential neighborhood bounded by Hillside Avenue, North Road, Winnetou Road, and the Manhattan Park Brook subwatershed boundary)	Rain barrels / downspout disconnection; lawn conversion, storm drain stenciling; household hazardous waste education; stream buffer management education and replanting	High	MP-N3	H-12
Greenburgh (Single family residential neighborhood bounded by Mclean Avenue, Hillside Avenue, I-287, and Manhattan Avenue)	Downspout disconnection / rain barrels; turf conversion; storm drain stenciling; household hazardous waste education	High	MP-N4	H-12
Greenburgh (Greenburgh Housing Authority Apartments off of Old Tarrytown Road)	Storm drain stenciling; dumpster management; downspout disconnection; lawn conversion - increased landscaping; catch basin cleanouts	High	MP-N5	H-12
Greenburgh (Single family residential neighborhood along Juniper Hills Road)	Downspout disconnection; rain barrels; turf conversion; planting to stabilize steep slopes on lots	Low	FB-N3	H-5

Table 5-5: Neighborhood Source Control Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Greenburgh (Rex Ridge town house complex off of Pinewood Road)	Increase landscaping in open areas; rain gardens to treat rooftop runoff; stabilize eroded areas adjacent to parking lots	Low	FB-N4	H-5
Greenburgh (Single family residential neighborhood along Hawthorne Way)	Rain gardens; downspout disconnection; homeowner education on lawn care practices	Low	GSB-N2	H-8
Greenburgh (Single family residential neighborhood along South Washington Avenue)	Rain barrels; homeowner education on lawn care practices; storm drain stenciling; steep slope plantings; clean up trash / dumping	Low	HB-N4	H-10
Greenburgh (Single family residential neighborhood along Winding Ridge Road)	Rain barrels / downspout disconnection; homeowner lawn care education	Low	MP-N2	H-12
Greenburgh (Fox Glen Colony apartment complex off of North Washington Avenue)	Storm drain stenciling; potential on-site parking lot / catch basin retrofits.	Medium	FB-N5	H-5
Greenburgh (Windsor Park residential subdivision off of West Hartsdale Avenue)	Downspout disconnection; rain barrels; rain gardens; buffer plantings; storm drain stenciling; homeowner education on lawn care practices	Medium	HB-N1	H-10
Greenburgh (Country Club Ridge Apartments on Rockledge Road)	Storm drain stenciling; rain gardens; nutrient / lawn care education; improved dumpster management	Medium	HB-N2	H-10
Greenburgh (Scarsdale Fairway Luxury Apartments)	Replant open spaces; downspout disconnection; parking lot retrofit (catch basin inserts, underground sand filter)	Medium	HB-N6	H-10
Greenburgh / White Plains (Single family residential neighborhood east of Central Avenue and south of Wayne Avenue)	Downspout disconnection; rain barrels; turf conversion	Medium	FB-N1	H-5
Mount Vernon (Single family residential neighborhood at Mount Vernon and Fulton Avenue)	Downspout disconnection; rain barrels; storm drain stenciling; better planter boxes for street trees	Low	BRM-N1	H-2
Tuckahoe (Single family residential neighborhood along Warren Avenue)	Rain gardens; rain barrels	Low	BRM-N5	H-2
White Plains (Single family residential neighborhood east of Central Avenue and north of Trenton Avenue)	Downspout disconnection; rain barrels; turf conversion	Medium	FB-N2	H-5
Yonkers (Single family residential neighborhood along Mountaindale Road)	Storm drain stenciling; household hazardous waste management (mobile oil recycling); pet waste management; no dumping signs	High	GSB-N3	H-8

Privately Owned Hotspots

Hotspots are the commercial, industrial, institutional, municipal, and transport-related land uses that tend to produce higher levels of stormwater pollution, or present a higher risk for spills, leaks and illicit discharges. Targeted pollution control and source control education for owners of privately owned hotspots should focus on discouraging pollution-producing behaviors and implementing practices or programs that will help to reduce pollution from these locations.

Opportunities to implement pollution prevention and source control education at 22 privately-owned hotspots are presented in Table 5-6. These hotspots included auto-related sites (e.g., gas stations, and car wash); plant nurseries/landscaping; commercial sites (e.g., shopping malls, business districts, or retail stores); and industrial sites.

Table 5-6: Privately Owned Hotspot Management Opportunities in the Bronx River Watershed

Location	Opportunity	Rank	Site ID	Map
Bronxville (BAMs Gas Station)	Covered fueling island; spill containment; stormwater retrofit	Low	BRM-H1	H-2
Greenburgh (Bed Bath & Beyond shopping center on Central Avenue)	Improved dumpster management	Medium	FB-H1	H-5
Greenburgh (Best Buy shopping center on Central Avenue)	Illicit discharge investigation; stormwater retrofit; secondary containment for grease storage	Medium	FB-H2	H-5
Greenburgh (Crossroads Plaza on Tarrytown Road)	Stormwater retrofit; improved dumpster management and material storage	Medium	MP-H1	H-12
Greenburgh (Gas station at the intersection of Tarrytown Road and Knollwood Road)	Follow-up site investigation; stormwater retrofit	Medium	MP-H5	H-12
Greenburgh (Getty Gas station on South Central Avenue)	Covered fueling island	Low	HB-H2	H-10
Greenburgh (Sprain Brook Nursery)	Flow diversion	Low	GSB-H1	H-8
Greenburgh (Westchester Greenhouses)	Follow-up site investigation; pollution prevention education; posting / distribution of educational materials for public (native plants and proper landscaping procedures)	Low	GSB-H4	H-8
Greenburgh / White Plains (Light industrial strip along Fulton Street)	Containment at fueling operation; pollution prevention education; pollution prevention plan review; stormwater retrofits	High	FB-H4	H-5
Mount Pleasant (Businesses along Railroad Avenue near Lakeview Avenue, includes monuments, car repair, tree service, and land excavation businesses)	Stormwater retrofit; lot paving; covered materials storage	Low	DB-H1	H-5
Mount Pleasant (Grayrock Florist and Memorials)	Covered material storage; materials storage education	Low	DB-H2	H-5
Mount Vernon (Lincoln BBQ Restaurant)	Secondary containment for grease storage; waste storage and wash water disposal education	High	BRL-H4	H-1

Table 5-6: Privately Owned Hotspot Management Opportunities in the Bronx River Watershed				
Location	**Opportunity**	**Rank**	**Site ID**	**Map**
Mount Vernon (Bubble Bath Auto Spa)	Illicit discharge investigation	Medium	BRL-H2	H-1
Mount Vernon (Commercial strip (car wash, auto repair, barbecue, two gas stations) near West Lincoln Avenue and North 8th Avenue)	Catch basin cleanouts; dumpster management, wash water disposal, and waste storage education; investigate car wash drainage	Low	BRL-H3	H-1
Mount Vernon (Gerardi Nursery)	Posting / distribution of educational materials for public (native plants and proper landscaping procedures)	Low	BRM-H6	H-2
North Castle (Metro North Welfare Facility on Fisher Lane)	Follow-up site investigation; pollution prevention plan review	High	BRU-H2	H-3
North Castle (Aggregate loading operation on Lafayette Avenue)	Covered material storage; stabilized entranceway	Medium	BRU-H1	H-3
North Castle (A&C Furia Electric Motor Company on Lafayette Avenue)	Follow-up site investigation	Low	BRU-H3	H-3
North Castle (Michael Bellatoni Landscaping on Lafayette Avenue)	Follow-up site investigation	Low	BRU-H4	H-3
Tuckahoe (Freeman Industries on Marbledale Road)	Covered material storage; spill prevention plan review	Medium	BRM-H4	H-2
White Plains (Gulf Gas station on Central Avenue and Aqueduct Place)	Stormwater retrofit; covered fueling island; improved dumpster management	Low	FB-H3	H-5
Yonkers (Cross County Mall)	Secondary containment for salt storage; catch basin inserts or other retrofit; pollution prevention education	Medium	BRL-H1	H-1

5.5 Municipal Practices and Programs

Local governments can play several pivotal roles in subwatershed restoration. For instance, communities maintain much of the physical infrastructure in a watershed, including roads, sewers, and storm drain systems. In many cases, communities can reduce or prevent pollutants from entering the watershed by changing their infrastructure maintenance policies.

In addition, municipalities operate certain facilities that are well-known stormwater hotspots. Common examples include solid waste facilities, public works yards, fleet storage lots and maintenance depots. Many of these operations have opportunities to implement source control or pollution prevention practices.

In the Bronx River watershed, many opportunities exist for improved operation and maintenance of publicly-owned facilities and infrastructure that will reduce pollution generation. These are described below.

Public Hotspots

Multiple opportunities for improvement were observed at all publicly-owned hotspots visited during field assessments, as summarized in Table 5-7.

NPDES requirements include measures for "good housekeeping" at municipal facilities, and these public sites should serve as demonstration sites for comparable private operations. In addition, training should be provided for municipal staff on appropriate pollution prevention techniques, and a model pollution prevention plan (PPP) should be developed that could be adapted for each maintenance facility. Finally, examples of good practices observed at some locations (i.e., secondary containment, spill response plan, permit posting, staff training) should be recognized and modeled.

Table 5-7: Publicly Owned Hotspot Management Opportunities in the Bronx River Watershed

Location	Opportunity	Rank	Site ID	Map
Eastchester (Eastchester Municipal Maintenance Yard)	Stormwater retrofit; catch basin inserts; pollution prevention education; pollution prevention plan review	High	BRM-H2	H-2
Eastchester / Scarsdale (Garth Road Village Center)	Storm drain stenciling	High	BRM-H3	H-2
Elmsford (Elmsford Maintenance Facility)	Retrofit fueling island with underground practice, cover, or catch basin insert	High	MP-H6	H-12
Greenburgh (Greenburgh Maintenance Yard)	Good examples of compliance, use for demonstration site; upgraded trap in washing area; covered fueling islands	High	GSB-H6	H-8
Greenburgh (Town of Greenburgh storage yard on Stadium Road)	Covered storage; stormwater retrofit	Medium	MP-H2	H-12
Greenburgh (Town of Greenburgh fire station on South Central Avenue)	Proper vehicle washing education; dumpster replacement	Low	HB-H3	H-10
Mount Pleasant (Westchester County DPW Grasslands facility)	Underground practice maintenance; pollution prevention plan review; wetland / buffer encroachment and dumping education	High	DB-H4	H-5
Scarsdale (Bronx River Reservation Maintenance Facility)	Follow-up site investigation; invasive plant species management; stormwater retrofit at fueling area	High	BRM-H8	H-2
Tuckahoe (Tuckahoe Maintenance Yard on Marbledale Road)	Pollution prevention plan review; stormwater retrofit; covered material storage	High	BRM-H5	H-2
Tuckahoe (Westchester County Crestwood Maintenance Facility)	Review stormwater retrofits maintenance plans; perform retrofit maintenance	High	BRM-H7	H-2
Yonkers (Sprain Brook Golf Course)	Materials storage and disposal education; covered fueling island; buffer enhancement	High	GSB-H5	H-8
Yonkers (City of Yonkers Water Works Building / Sign Shop)	Covered storage; stormwater retrofit; materials storage and proper disposal of paint and asphalt education; increased stewardship of Sprain Brook	High	SB-H1	H-13
Yonkers (City of Yonkers Salt Pile)	Covered salt storage area; stormwater retrofit	Medium	GSD-H1	H-9

Discharge Investigation, Infrastructure Assessment, and Trash Removal Sites

There are several locations in riparian corridors throughout the watershed where municipalities should consider pursuing discharge investigations, assessing the need for infrastructure repair, and removing trash. Discharge investigations target dry weather flows that have the potential to contain pollutant loads, such as illicit discharges, sewage overflows, and industrial or transport-related spills.

The need to assess existing infrastructure is noted at locations where utilities in the stream corridor have the potential to cause water quality, stream habitat, or channel stability problems. Storm drainage, sanitary sewer, and road related infrastructure damage was also noted. Examples include exposed sewer pipes and manhole stacks, blocked culverts, and damaged outfalls.

Stream clean-ups and trash removal are often cosmetic and temporary. However, they are an extremely effective tool for involving and educating the public about stream degradation. In addition, some trash and debris accumulation may present risks to infrastructure and increased flooding, such as when outfalls and culverts become clogged with trash.

Tables 5-8, 5-9, and 5-10 provides a list of locations recommended for discharge investigation, infrastructure assessment, and trash removal. Follow-up action is recommended at each location by the responsible municipality.

Table 5-8: Discharge Investigation Opportunities in the Bronx River Watershed

Location	Opportunity	Map
Eastchester / Yonkers (Reach BRM-1)	• Investigate discharge at outfall OT-1 in reach BRM-1	H-2
Greenburgh (Reach SB-12)	• Investigate discharge at outfall OT-2 in reach SB-12	H-13
Greenburgh / North Castle (Reach BRU-1)	• Investigate discharge at outfall OT-1 in reach BRU-1	H-3
Greenburgh / White Plains (Reach BRU-3)	• Investigate discharge at outfall OT-1 in reach BRU-3	H-3
Mount Pleasant (Reach CB-7)	• Investigate potential sewer leak in reach CB-7	H-4
Mount Pleasant (Reach DB-7)	• Investigate discharge at outfall OT-2 in reach DB-7	H-5
Mount Vernon (Reach BRM-3b)	• Investigate discharge at outfall OT-2 in reach BRM-3b	H-2
Mount Vernon / Yonkers (Reach BRM-1b)	• Investigate discharge at outfall OT-1 in reach BRM-1b	H-2
Tuckahoe / Yonkers (Reach BRM-4)	• Investigate discharge at outfall OT-1 in reach BRM-4	H-2
Yonkers (Reach SB-6)	• Investigate discharge at outfall OT-1 in reach SB-6	H-13

Table 5-9: Infrastructure Assessment Opportunities in the Bronx River Watershed		
Location	**Opportunity**	**Map**
Greenburgh (Reach MP-5)	• Stabilize or retrofit broken outfalls in reach MP-5	H-12
Greenburgh (Reach MP-10)	• Repair exposed pipes in reach MP-10	H-12
Greenburgh (Reach MP-11)	• Repair exposed pipes in reach MP-11	H-12
Greenburgh (Reach MP-12)	• Repair exposed pipes in reach MP-12	H-12
Greenburgh (Reach MP-14)	• Stabilize or retrofit broken outfalls in reach MP-14	H-12
Greenburgh (Reach MP-14)	• Repair concrete weir in reach MP-14	H-12
Greenburgh (Reach MP-17)	• Repair exposed pipes in reach MP-17	H-12
Greenburgh (Reach SB-12)	• Stabilize the outfalls in reach SB-12	H-13
Greenburgh / Scarsdale (Reach BRU-8)	• Repair culvert in reach BRU-8	H-3
Mount Pleasant (Reach CB-6)	• Repair V-notch weir in reach CB-6	H-4
Mount Pleasant (Reach DB-8)	• Stabilize broken outfalls in reach DB-8	H-5
White Plains (Reach BRU-5)	• Repair culvert reach BRU-5	H-3
White Plains (Reach BRU-5)	• Stabilize outfall OT-4 in reach BRU-5	H-3
Yonkers (Reach SB-2)	• Remove sediment and debris blocking the culvert under the old railroad grade in reach SB-2	H-13
Yonkers (Reach SB-6)	• Stabilize the outfalls in reach SB-6	H-13

Table 5-10: Trash Removal Opportunities in the Bronx River Watershed		
Location	**Opportunity**	**Map**
Elmsford (Reach MP-3)	• Remove trash in reach MP-3	H-12
Elmsford / Greenburgh (Reach MP-4)	• Remove trash in reach MP-4	H-12
Greenburgh (Reach MP-7)	• Remove trash in reach MP-7	H-12
Greenburgh (Reach MP-14)	• Remove trash in reach MP-14	H-12
Greenburgh (Reach SB-10)	• Remove trash in reach SB-10	H-13
Greenburgh (Reach SB-12)	• Remove trash in reach SB-12	H-13
Greenburgh (Reach SB-13)	• Remove trash in reach SB-13	H-13
Greenburgh (Reach SB-15)	• Remove trash in reach SB-15	H-13
Greenburgh (Reach SB-17)	• Remove trash in reach SB-17	H-13
Mount Pleasant (Reach CB-6)	• Remove trash in reach CB-6 from the riparian area and from behind the grate on the outlet from the reservoir	H-4
Mount Pleasant (Reach DB-4)	• Remove trash in reach DB-4	H-5
Mount Pleasant (Reach DB-7)	• Remove trash in reach DB-7; monitor for illegal dumping	H-5
Mount Pleasant (Reach DB-8)	• Remove trash in reach DB-8	H-5
Yonkers (Reach SB-2)	• Remove trash in reach SB-2	H-13
Yonkers (Reach SB-4)	• Remove trash in reach SB-4	H-13
Yonkers (Reach SB-18)	• Remove trash in reach SB-18	H-13
Yonkers (Reach SB-19)	• Remove trash in reach SB-19	H-13
Yonkers (Reach SB-20)	• Remove trash in reach SB-20	H-13
Yonkers (Reach SB-22)	• Remove trash in reach SB-22	H-13
Yonkers (Reach SB-24)	• Remove trash in reach SB-24	H-13

Section 6. Subwatershed Management Strategies

This section describes management strategies for five subwatersheds. These subwatershed management strategies serve as frameworks for implementing the management and restoration practices identified through field assessments as well as program and education-related recommendations identified through both desktop analyses and field assessments. Strategies were developed for the five priority subwatersheds for restoration in the Bronx River watershed.

Priority Subwatersheds for Restoration

A Comparative Subwatershed Analysis (CSA) was completed for Bronx River watershed to identify priority subwatersheds for restoration. The CSA uses subwatershed "metrics" to screen subwatersheds within a watershed to identify the ones with greatest restoration potential. Metrics are single numeric values that characterize the relative restoration potential of a subwatershed.

The method for conducting the CSA for the Bronx River watershed consisted of five tasks:

- Subwatershed boundaries were delineated and available metric data was reviewed.
- Metrics that best describe restoration potential were selected and computed.
- Weighting and scoring rules to assign points to each metric were developed
- Aggregate scores were computed and the subwatershed ranking was developed.
- The subwatersheds were grouped into five categories based on similar conditions (e.g., land use, development patterns, drainage patterns, etc.).

The CSA conducted for the Bronx River watershed is described in detail in Section 2.

Watershed restoration is an expensive and lengthy process – developing detailed management strategies for all 15 subwatersheds would be a costly undertaking. Typically, subwatersheds with similar characteristics will also have comparable restoration strategies and recommendations. As a way to maximize the planning effort, the Center developed management strategies for selected subwatersheds from four of the five categories (Table 6.1). Strategies developed for these subwatersheds may be generally applied in the other subwatersheds in that particular category.

With the exception of Fulton Brook, these subwatersheds received the highest restorability scores on the CSA in their respective categories. Fulton Brook was also selected due to the highly developed nature of the subwatershed, the diversity of land use, and the high density of hotspots. A subwatershed in the "reservoirs" category (Group 1) was not selected due to the existing reservoir and protective land use management practices already in place in these subwatersheds.

Table 6.1: Bronx River Subwatershed Categorization			
Subwatershed Group Categorization	**Representative Subwatershed**	**Jurisdictions within Representative Subwatershed**	**Other Subwatersheds in Group**
1. Subwatersheds drain to water supply reservoirs*	--	--	White Plains Reservoirs Kensico Reservoir
2. Subwatersheds draining to northern Bronx River tributaries	Manhattan Park Brook	Elmsford, Greenburgh	Davis Brook Clove Brook
3. Subwatersheds drain to the mainstem of the Bronx River	Bronx River Middle Direct Drainage	Greenburgh, Scarsdale, Yonkers, Tuckahoe, Eastchester, Bronxville, Mount Vernon	Bronx River Lower Direct Drainage Bronx River Upper Direct Drainage
4. Subwatersheds drain to Grassy Sprain, the largest Bronx River tributary	Grassy Sprain Brook	Yonkers, Greenburgh, Ardsley	Sprain Brook Grassy Sprain Brook Direct Drainage
5. Subwatersheds draining to middle Bronx River tributaries	Hartsdale Brook	Greenburgh	Fox Meadow Brook Troublesome Brook
	Fulton Brook	Greenburgh, White Plains	
* Reservoir subwatersheds were not included in effort			

This section includes the following for each priority subwatershed:

- Subwatershed Description – A basic description (i.e., land use, impervious cover, jurisdictions) of the subwatershed is provided. This is drawn primarily from the *Baseline Assessment* (CWP, 2006a), but in some cases, includes basic field observations about the subwatershed.
- Subwatershed Management Strategy – The recommended subwatershed management strategy is outlined.
- Management and Restoration Practice Opportunities in the Subwatershed – Management and restoration practice opportunities identified in the subwatershed are summarized by project type. The overall watershed ranking is provided, along with relative planning level cost information. For residential pollution prevention and source control education opportunities, the level of potential community involvement is also included.
- Subwatershed Treatment Analysis Results – The results of the subwatershed treatment analysis conducted for the subwatershed are presented. Assumptions used to model practice application in the subwatershed are also listed.

Subwatershed maps showing general features and the locations of management and restoration practice opportunities are provided in Appendix H.

Introduction to the Subwatershed Treatment Analysis

A Subwatershed Treatment Analysis (STA) was conducted for each priority subwatershed for restoration to examine the extent of subwatershed treatment achieved by the proposed management strategy. The Watershed Treatment Model (WTM) was used to conduct this analysis. The WTM (Caraco, 2002), is a simple spreadsheet model used to estimate pollutant loading; determine the effects of current management practices; and estimate load reductions associated with implementation of structural and non-structural management practices.

As part of the *Baseline Assessment*, the WTM was used to estimate relative current and future nutrient, sediment, and bacteria loads for each subwatershed based on current and future land use (See Section 2).

The STA expanded on this effort by incorporating the management strategy for each priority subwatershed into the WTM to estimate potential pollutant load reductions resulting from their implementation. The percentage of reduced sediment loading (total suspended solids, or TSS), nutrient loading (total nitrogen, or TN; and total phosphorus, or TP), and bacteria loading (fecal coliform) that may be expected from the implementation of the management strategy for each priority subwatershed is presented in this section and summarized in Table 6-2.

Table 6-2: Summary of Potential Pollutant Load Reduction that May Result from Priority Subwatershed Management Strategy Implementation

Subwatershed	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform (billions of colonies/yr)
Bronx River Middle Direct Drainage	-33.6%	-28.6%	-16.0%	-36.0%
Manhattan Park Brook	-19.2%	-16.1%	-5.8%	-23.7%
Hartsdale Brook	-31.8%	-35.3%	-16.8%	-48.3%
Grassy Sprain Brook	-19.8%	-14.6%	-8.9%	-24.0%
Fulton Brook	-19.3%	-18.3%	-7.2%	-27.6%

Pollutant reduction estimates are conservative. General assumptions and caveats of the WTM are presented in Section 2. Specific assumptions on treatment practice application are described for each subwatershed later in this section.

It should be noted that future land use changes (new development and infill development) are not accounted for in treatment reductions, which is not unreasonable given the built-out nature of the watershed. Therefore, the potential pollution reduction associated with the application of better site design techniques in future development projects is not evaluated in this analysis. In addition, no estimates of channel erosion were included in the WTM. Therefore, the WTM does not account for pollutant reduction benefits associated with stream repair or restoration projects.

6.1 Bronx River Middle Direct Drainage (BRM)

Table 6-3: Basic Profile of the Bronx River Middle Direct Drainage Subwatershed	
Management Group	• Subwatersheds drain to the mainstem of the Bronx River. Also includes Bronx River Lower Direct Drainage (BRL) and Bronx River Upper Direct Drainage (BRU) subwatersheds.
Drainage Area	• 3,252 acres (5.1 square miles)
Stream Length	• 6.8 miles
2004 Land Use & Water Coverage	• Residential (66.4%) • Open Space (16.0%) • Non-Residential (15.2%) • Mixed (1.3%) • Undeveloped (0.4%) • Water (0.9%)
Current Imperviousness	• 29.4% of subwatershed
Jurisdictions as Percent of Subwatershed	• Bronxville (16.8%) • Eastchester (23.4%) • Greenburgh (7.0%) • Mount Vernon (11.4%) • Scarsdale (12.3%) • Tuckahoe (11.5%) • Yonkers (17.7%)
Subwatershed Map	• See Map H-2 in Appendix H

Subwatershed Description

The Bronx River Middle Direct Drainage (BRM) subwatershed contains the main stem of the Bronx River, with only a few minor surface tributaries (e.g., Laurel Brook and minor drainages from small ponds). The Bronx River Parkway runs alongside the channel for most of its length. Most of the mainstem contains high amounts of legacy sediment, and at least one section of river has developed into a split channel at higher flows.

A third of the riparian buffer in the subwatershed is forested, and over 75% of the riparian corridor is publicly owned. The presence of the Parkway has helped preserve Garth Butler Woods; one of the last remaining, relatively untouched oak and tulip complexes in the entire watershed. Invasive plant species in the riparian corridor are prevalent throughout the subwatershed; however attempts to control them are evident. The subwatershed has approximately 300 acres of wetland.

Approximately 13% of the subwatershed is forested. On the west side of the river, at the northern end of the subwatershed, there is a wooded area that may be a potential conservation area.

This subwatershed is densely populated; 66% of the land use is detached residential. Most of the residential areas have lots that are one-quarter acre or less, are well established, and are relatively steep. The Leewood Golf Course is located in this subwatershed, and commercial development is clustered in small town centers. Current impervious cover for the subwatershed is 29.4%. Estimated hotspot density is nine hotspots per square mile.

During upland assessments in the subwatershed, field crews saw no storm drain stenciling, and very little evidence of watershed stewardship signage. Most large buildings and apartment complexes evaluated have internal roof drains, which makes downspout disconnection difficult.

The most industrialized portion of subwatershed was observed in Tuckahoe. Active redevelopment and infill development was also observed in Tuckahoe.

A map of this subwatershed (Map H-2) can be found in Appendix H.

Subwatershed Management Strategy

Implementation recommendations for the Bronx River Middle Direct Drainage subwatershed watershed are as follows:

1. *Conduct illicit discharge investigations throughout the subwatershed*. Modeled illicit discharge removal and sanitary sewer overflow repair had a significant impact on bacteria and nutrient (total nitrogen) removal. At a minimum, follow-up with the four discharge investigation opportunities identified in Table 6-10.

2. *Construct demonstration upland stormwater retrofits as opportunities arise. In addition, examine the feasibility of retrofit opportunities identified at the vacant lot on Marbledale in Tuckahoe; in the Cross County Parkway cloverleaf in Mount Vernon; and along the east side of the Bronx River, south of Harney Road, in Eastchester*. Although these three opportunities are considered low priority from a watershed perspective, they are the only opportunities identified to provide treatment of a large volume of stormwater runoff. The retrofit opportunities identified in this subwatershed have the potential to capture a significant amount of impervious area.

3. *Construct the high priority riparian corridor restoration projects along the Bronx River, north of Strathmore Road and south of Midland Avenue*. Invasive plant species removal, in-stream habitat improvement, and native riparian plantings will enhance recreation and riparian habitat. In addition, both projects incorporate stormwater treatment, resulting in improved water quality.

4. *Increase watershed awareness through additional educational signage*. Place a large "Entering the Bronx River Watershed" sign on the Cross County Parkway in Mount Vernon. Replace small Bronx River educational signs along the Parkway with larger, more visible signs. Install signs at highly visible demonstration sites, using the Crestwood Maintenance Facility stormwater retrofit signs as models. Place storm drain markers on stormwater catch basin inlets in dense commercial areas.

5. *Disconnect rooftops and other impervious cover from the storm drain system wherever possible*. Residential areas provide a great opportunity for disconnection; just in the neighborhoods assessed, more than 20 acres of rooftop are estimated to be available for disconnection in this subwatershed. Pursue multifamily and single-family neighborhoods where disconnection is feasible.

6. *Target lawn care education to neighborhoods with large areas of high maintenance turf*. With over 1,500 acres of residential lawn, residential lawn care education was modeled to be the highest nutrient reducing activity in the subwatershed.

7. *Improve pollution prevention at the publicly-owned maintenance facilities*. This may include updating pollution prevention plans, educating staff on pollution prevention and spill response activities, and implementing stormwater retrofits or storm drain inlet treatment.

These findings may be applicable to the other Bronx River mainstem subwatersheds – Bronx River Upper Direct Drainage and Bronx River Lower Direct Drainage.

Management and Restoration Practice Opportunities in the Subwatershed

Several upland stormwater retrofit opportunities are available in the subwatershed (Table 6-4). Two of these are considered watershed priorities, primarily due to their high visibility and demonstration site potential. A public park long Paxton Avenue (BRM-R16), immediately south of its intersection with Stone Place, offers an excellent opportunity to construct a biofilter to treat runoff from the adjacent commercial area and road.

At Pennington Grimes Elementary School in Mount Vernon, external roof drains may be directed to rain gardens or bioretention practices, and parking lot runoff may be treated with an extended tree pit and a bioswale. Educational signage should accompany these efforts, and school teachers and children should be involved with planting plan designs and plant selection.

Additional stormwater retrofit opportunities on publicly-owned properties that may serve as demonstration projects include installing planter boxes to treat rooftop runoff at the Bronxville train station; creating rain gardens at the Bronxville library; and reducing parking lot imperviousness and constructing bioretention treatment cells at the Scarsdale Village Hall.

Two opportunities were identified where larger, stormwater wetland facilities may be implemented: at a vacant lot on Marbledale Road in Tuckahoe, and along the Bronx River, south of Harney Road. However, due to feasibility and site constraints, both sites are considered low priority.

Table 6-4: Upland Stormwater Retrofit Opportunities in the Bronx River Middle Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Cost Range
High	BRM-R7	Mount Vernon (Pennington Grimes Elementary School)	Rain gardens; extended tree pit; trash management; storm drain stenciling; bioswale	$$
	BRM-R16	Yonkers (Public park along Paxton Avenue immediately south of its intersection with Stone Place)	Biofilter	$$
Medium	BRM-R1	Mount Vernon (Brewster Carter Apartments)	Perimeter sand filter	$$
	BRM-R2/3	Eastchester (Lord & Taylor shopping center)	Bioretention cells; vegetated swale	$$
	BRM-R4	Bronxville (Bronxville train station)	Planter boxes	$

Table 6-4: Upland Stormwater Retrofit Opportunities in the Bronx River Middle Direct Drainage Subwatershed				
Rank	**Site ID**	**Location**	**Opportunity**	**Cost Range**
	BRM-R9	Bronxville (Bronxville Library)	Disconnect roof drains; rain garden; educational signage	$$
	BRM-R10	Scarsdale (Scarsdale Village Hall)	Reduce imperviousness; bioretention	$$
Low	BRM-R5	Eastchester (Immaculate Conception Church and School)	Permeable pavers; bioretention; rain garden; storm drain stenciling	$$
	BRM-R6	Bronxville (Concordia College)	Rain garden; bioretention; porous pavers	$$
	BRM-R8	Bronxville (Bronxville School)	Rain garden; underground practice	$$
	BRM-R11	Tuckahoe (Marbledale vacant lot)	Stormwater wetland	$$$
	BRM-R12	Mount Vernon (Cross County Parkway cloverleaf)	Stormwater wetland; no-mow area	$$
	BRM-R13	Greenburgh (Edgemont High School)	Bioretention	$$
	BRM-R17	Eastchester (Along the east side of the Bronx River, south of Harney Road)	Forested wetland	$$$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Three riparian corridor restoration opportunities in the subwatershed are summarized in Table 6-5; these include two high priority sites from a watershed perspective. Detailed concepts were developed for both high priority locations (Appendix J).

Site BRM-S1 is near Garth Woods, along the Bronx River north of Strathmore Road / Harney Road. The Bronx River Parkway southbound runs along the west side of the channel and Bronx River Parkway northbound to the east for its whole length. Portions of the floodplain exist east of the Bronx River Parkway and most of this area lacks good vegetative cover and is regularly mowed. Garth Woods in the Bronx River Parkway Reservation is a partially open/wooded area in the floodplain between the Parkway north and southbound lanes. Invasive plant species are prevalent throughout the site. Restoration and retrofit techniques that may be applied at this site include:

- Widening the riparian buffer by planting native trees and shrubs in open areas along the Bronx River Parkway and in Garth Woods.
- Stabilizing stormwater outfall in the downstream left floodplain coming from the Parkway northbound lanes near Harney Road.
- Removing and managing invasive plant species.
- Expanding and enhancing floodplain wetland areas.

- Realigning Bronx River at the upper end of the site into an alternate channel that has formed to the east. This would protect the southbound lanes from bank erosion and flooding.
- Diverting stormwater drains from the roadway and parking lot at the Church of Our Lady of Fatima to the open area west of the Bronx River Parkway.

Site BRM-S2 runs along the Bronx River south of Midland Avenue. The Bronx River flows between two areas of the Bronx River Parkway Reservation: Scout Field to the west and Parkway Field to the east. Portions of the floodplain exist as playing fields and therefore have minimal vegetation and are mowed regularly. There is a 24 inch outfall approximately 300 feet east of the Bronx River that discharges stormwater via an open channel. There are some existing wetlands in this floodplain area and invasive plant species are prevalent throughout the site. This would be a project site with high feasibility, high public exposure and beneficial. Restoration and retrofit techniques that may be applied at this site include:

- Widening the riparian buffer by planting native trees and shrubs in open areas along the western edge of Parkway Field and the eastern edge of Scout Field.
- Removing and managing invasive plant species.
- Creating a stormwater impoundment in the floodplain to capture drainage from the outfall on the south side of Midland Avenue.

The third riparian corridor restoration opportunity identified (BRM-S3) is along the Bronx River from Harney Road south for approximately 3,000 feet. The Harlem line of Metro-North Commuter Railroad runs along the west side of the channel and Bronx River Parkway northbound to the east for its whole length. Portions of the floodplain between the Bronx River Parkway and the river lack good vegetative cover and are mowed regularly. To the east the floodplain is generally wooded. There is a short tributary east of the Bronx River formed from an 8-foot diameter culvert under Harney Road that is highly eroded. Approximately 700 feet south, there is an area of bank erosion threatening the path. Invasive plant species are prevalent throughout the site. There is a pedestrian path through the area and this would be a project site with high public exposure. Restoration and retrofit techniques that may be applied at this site include:

- Widening the riparian buffer by planting native trees and shrubs in open areas along the Bronx River Parkway.
- Stabilizing the stormwater outfall in the downstream left floodplain coming from under Harney Road.
- Removing and managing invasive plant species.
- Expanding and enhancing floodplain wetland areas and connecting the stream to floodplain depressions through access channels.
- Realign the Bronx River near the lower end of the site into an existing floodplain to protect the pedestrian path and Bronx River Parkway lanes from erosion and flooding.

Table 6-5: Riparian Corridor Restoration Opportunities in the Bronx River Middle Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	ISM (acres)	Stream (linear feet)	Reforest (acres)	Cost Range
High	BRM-S1	Yonkers / Eastchester (Near Garth Woods, along the Bronx River north of Strathmore Road / Harney Road)	Bank stabilization; widen riparian buffer; remove and manage invasive plant species; expand floodplain area; stormwater retrofit; stabilize stormwater outfall; realign Bronx River	5	1,200	2	$$
	BRM-S2	Mount Vernon / Yonkers (Along the Bronx River south of Midland Avenue, north of Scout/Parkway Field)	Replant riparian buffer; remove and manage invasive plant species; stormwater retrofit	4	0	1	$
Medium	BRM-S3	Yonkers / Eastchester (Along the Bronx River from Harney Road south for approximately 3,000 feet)	Stabilize eroding banks; widen riparian buffer; stabilize stormwater outfalls; remove and manage invasive plant species; expand floodplain wetland area; realign Bronx River	5	3,000	7	$$$

ISM: Invasive Species Management
Stream: Stream Restoration
Reforest: Reforestation

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Of the five pervious area management and restoration opportunities identified in the subwatershed, two are considered high priority from a watershed perspective (Table 6-6). The Leewood Golf Course and the Eastchester Park sites are adjacent to each other, and are downstream of the Eastchester Municipal Maintenance Yard. The projects proposed are small in scale (perimeter planting, wetland invasive plant removal, etc.), but they may serve as good demonstration sites and partnering opportunities between the municipality and the golf course.

The closed ball field site is perhaps the least feasible of the pervious area opportunities identified. The site contains contaminated fill, so it is currently unusable. However, there is potential for bioremediation that may be explored.

Table 6-6: Pervious Area Management and Restoration Opportunities in the Bronx River Middle Direct Drainage Subwatershed					
Rank	**Site ID**	**Location**	**Opportunity**	**Area (acres)**	**Cost Range**
High	BRM-P2	Eastchester (Leewood Golf Course)	Perimeter reforestation	5.0	$
	BRM-P3	Eastchester (Eastchester Park)	Invasive plant species removal; trash cleanup; native plantings	1.0	$$
Medium	BRM-P1	Eastchester (Closed Eastchester Ball Field)	Bioremediation	2.2	$$$
	BRM-P5	Eastchester (Immaculate Conception Church / School)	Reforestation; slope stabilization	0.4	$
Low	BRM-P4	Tuckahoe (Marbledale Vacant Lot)	Extensive site preparation; reforestation	3.3	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Neighborhood source control opportunities are identified for six subwatershed neighborhoods in Table 6-7. Residential lawn care and downspout disconnection opportunities were observed in the field and are considered the most critical areas for improvement. The Masterson Road (Bronxville) and Warren Avenue (Tuckahoe) neighborhoods had about 35% to 45% of lots in turf grass; the former is considered a high priority for turf management activities.

Three of the six residential areas assessed in this subwatershed are multi-family complexes. These complexes provide opportunities to efficiently manage turf areas since lawn care is controlled by one entity. In addition, opportunities exist to disconnect roof drains from the storm drains at the Gramatan Court Condos in Bronxville and the Sagamore Road Apartments in Bronxville.

Table 6-7: Neighborhood Source Control Opportunities in the Bronx River Middle Direct Drainage Subwatershed							
Rank	**Site ID**	**Location**	**Opportunity**	**Area (acres)**	**Homes**	**Cost Range**	**Public**
Medium	BRM-N2	Bronxville (Single family residential neighborhood along Masterson Road)	Lawn care education; rain gardens; erosion control and ground cover for steep slopes	26.1	52	$	Low
Medium	BRM-N6	Bronxville (Stoneleigh Plaza apartment complex)	Rain gardens; landscaping education	5.5	--	$$	High
Low	BRM-N1	Mount Vernon (Single family residential neighborhood at Mount Vernon and Fulton Avenue)	Downspout disconnection; rain barrels; storm drain stenciling; better planter boxes for street trees	17.2	103	$	Low

Table 6-7: Neighborhood Source Control Opportunities in the Bronx River Middle Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Area (acres)	Homes	Cost Range	Public
Low	BRM-N3	Bronxville (Gramatan Court Condos at Sagamore Road and Preston Road)	Planter boxes at downspouts	4.9	--	$$$	High
Low	BRM-N4	Bronxville (Sagamore Road Apartments)	Disconnect and direct downspouts to interior courtyard; pollution prevention for physical plant maintenance	1.5	--	$$	High
Low	BRM-N5	Tuckahoe (Single family residential neighborhood along Warren Avenue)	Rain gardens; rain barrels	12.7	51	$$	Low

Area: Neighborhood Area
Homes: Approx. Number of Homes in Neighborhood
Public: Public Involvement Potential

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Three privately-owned hotspots present opportunities for improved pollution prevention and source control education – a light-industrial site in Tuckahoe, a gas station in Bronxville, and a nursery in Mount Vernon (Table 6-8).

Uncovered materials stored outdoors were observed at Freeman Industries. There should be follow-up to review the site's spill prevention plan. Runoff from the BAMs Gas Station currently drains directly to storm drain inlets with no apparent stormwater treatment. Opportunities include covering the fueling islands and retrofitting the site with a perimeter sand filter to capture runoff.

Pollution-producing activities were not observed at the Gerardi Nursery. However, the County or Mount Vernon should consider pursuing a partnership with this and other nurseries to post and distribute educational materials on native plants and low-maintenance landscaping.

Table 6-8: Privately Owned Hotspot Management Opportunities in the Bronx River Middle Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
Medium	BRM-H4	Tuckahoe (Freeman Industries on Marbledale Road)	Covered material storage; spill prevention plan review	Potential	$$
Low	BRM-H1	Bronxville (BAMs Gas Station)	Covered fueling island; spill containment; stormwater retrofit	Confirmed	$$$
Low	BRM-H6	Mount Vernon (Gerardi Nursery)	Posting / distribution of educational materials for public (native plants and proper landscaping procedures)	Potential	$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Four of the five publicly-owned hotspot opportunities in this subwatershed are municipal maintenance facilities – Tuckahoe's maintenance yard; Eastchester's maintenance yard; and the County's Crestwood and Bronx River Parkway Reservation facilities (Table 6-9). These facilities all require pollution prevention planning and minor retrofitting (i.e., fueling islands, salt storage, catch basin inserts).

The Eastchester facility, especially, provides a great opportunity to implement pollution prevention activities because it is highly visible, the staff expressed willingness during the field assessment, and it is linked to other potential restoration projects. The Crestwood facility currently has a demonstration stormwater retrofit, one of the few stormwater practices in the entire subwatershed.

Table 6-9: Publicly Owned Hotspot Management Opportunities in the Bronx River Middle Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
High	BRM-H2	Eastchester (Eastchester Municipal Maintenance Yard)	Stormwater retrofit; catch basin inserts; pollution prevention education; pollution prevention plan review	Severe	$$$
High	BRM-H3	Eastchester / Scarsdale (Garth Road Village Center)	Storm drain stenciling	Potential	$
High	BRM-H5	Tuckahoe (Tuckahoe Maintenance Yard on Marbledale Road)	Pollution prevention plan review; stormwater retrofit; covered material storage	Severe	$$$
High	BRM-H7	Tuckahoe (Westchester County Crestwood Maintenance Facility)	Review stormwater retrofits maintenance plans; perform retrofit maintenance	Confirmed	$
High	BRM-H8	Scarsdale (Bronx River Reservation Maintenance Facility)	Follow-up site investigation; invasive plant species management; stormwater retrofit at fueling area	Severe	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Discharge investigation opportunities are listed in Table 6-10. The appropriate municipalities should follow up with these.

Table 6-10: Discharge Investigation Opportunities in the Bronx River Middle Direct Drainage Subwatershed

Management Practice	Reach	Location	Opportunity
Discharge Investigation	Reach BRM-1	Eastchester / Yonkers (Reach BRM-1)	Investigate discharge at outfall OT-1 in reach BRM-1
	Reach BRM-1b	Mount Vernon / Yonkers (Reach BRM-1b)	Investigate discharge at outfall OT-1 in reach BRM-1b
	Reach BRM-3b	Mount Vernon (Reach BRM-3b)	Investigate discharge at outfall OT-2 in reach BRM-3b
	Reach BRM-4	Tuckahoe / Yonkers (Reach BRM-4)	Investigate discharge at outfall OT-1 in reach BRM-4

Subwatershed Treatment Analysis Results

The following assumptions were incorporated into the WTM to assess potential subwatershed treatment resulting from the subwatershed management strategy:

- Implement lawn care and pet waste education programs: *assumes 25% of homeowners in targeted areas are reached using methods such as newspaper articles*
- Improve erosion and sediment control program inspection and maintenance: *assumes more frequent inspection and willingness to levy fines for poor performance*
- Implement programs to encourage downspout disconnection in residential areas: *assumes this is applicable to 50% of residential areas; that 30% of these residents are reached; and that 25% of those reached are willing to disconnect downspouts*
- Implement programs to encourage disconnect disconnection in commercial areas: *assumes this is applicable to 20% of commercial areas; that 100% of these property owners are reached; and that 20% of those reached are willing to disconnect downspouts*
- Construct upland stormwater retrofits: *assumes 220 impervious acres treated*
- Replant stream buffers: *assumes 0.5 stream miles replanted*
- Stabilize stream channels: *assumes 0.5 stream miles stabilized*
- Remove illicit connections: *assumes 90% of the sewer system will be surveyed for illicit connections and 80% of the illicit connections found will be corrected (WTM default)*
- Reduce sanitary sewer overflows: *assumes a target reduction of 80% of existing load and 80% of necessary repairs made (WTM default)*
- Enhance street sweeping efforts: *assumes same treatment area, but upgraded technology to vacuum assisted sweepers*

Significant load reductions may be obtained by implementing these practices, particularly for nitrogen (34%) and bacteria removal (36%). Table 6-11 and Figure 6-1 summarize the WTM results.

For nutrient (total nitrogen) removal, lawn care education, pet waste education, and stormwater retrofits account for almost 75% of the load reduction. For sediment removal, stormwater retrofits account for over 30% of the load reduction. Removing illicit connection and repairing sanitary sewer overflows are the best opportunities for reducing bacteria loads.

Table 6-11: Potential Pollutant Load Reduction that May Result from Bronx River Middle Direct Drainage Subwatershed Management Strategy Implementation

	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform (billions of colonies/yr)
Estimated Current Annual Load	20,510	2,341	951,237	1,280,094
Estimated Annual Load with Management Strategy	13,621	1,671	799,232	819,458
Potential Annual Pollutant Load Reduction	-33.6%	-28.6%	-16.0%	-36.0%

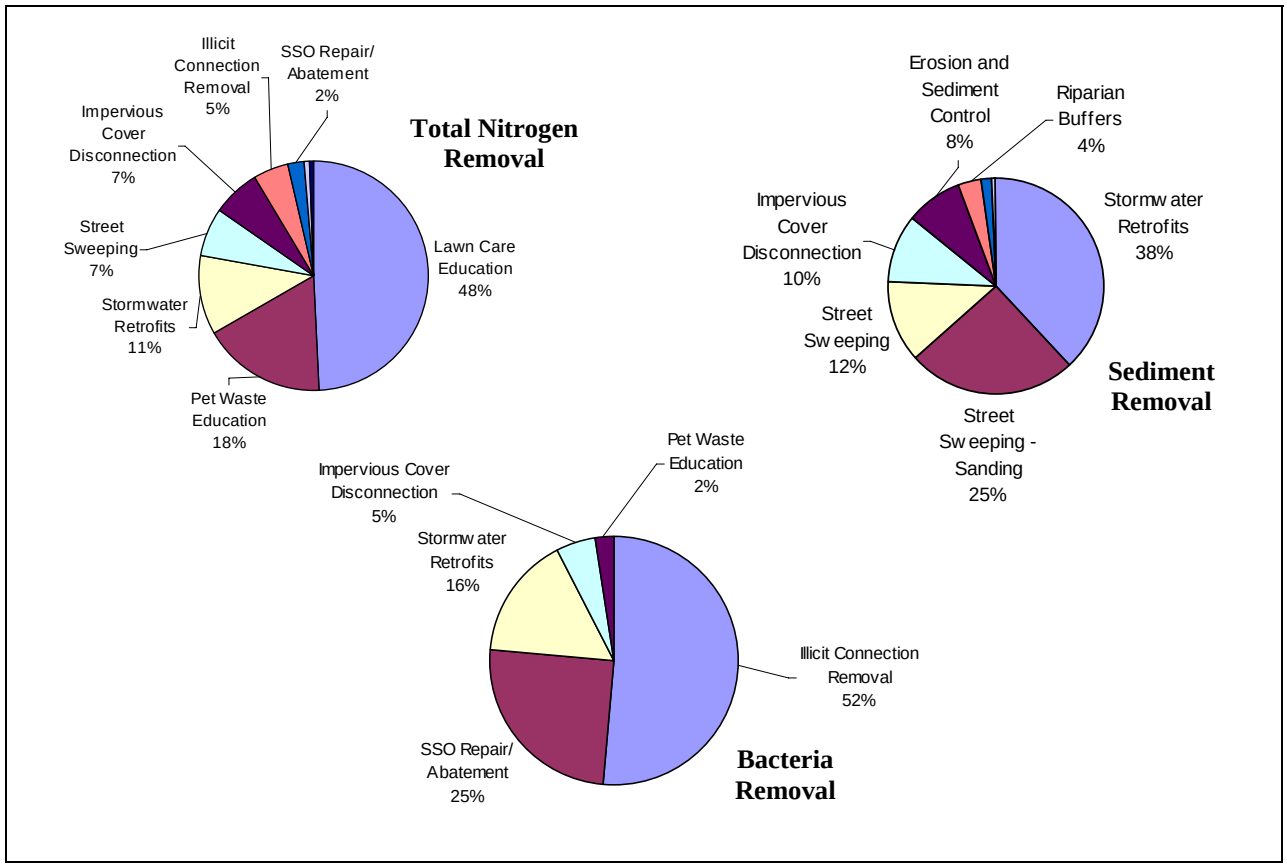


Figure 6-1: Potential Effect of Different Treatment Practices on Pollutant Load Reduction in the Bronx River Middle Direct Drainage Subwatershed

6.2 Fulton Brook (FB)

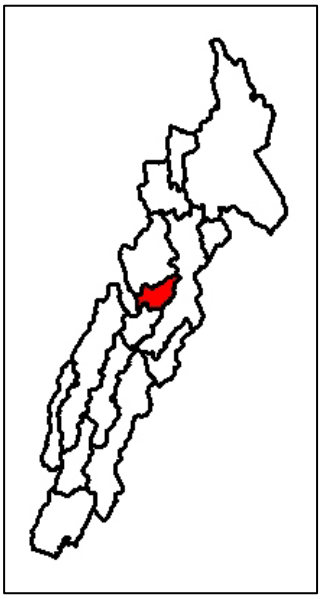


Table 6-12: Basic Profile of the Fulton Brook Subwatershed	
Management Group	• Subwatersheds draining to middle Bronx River tributaries. Also includes Hartsdale Brook (HB), Fox Meadow Brook (FMB), and Troublesome Brook (TB) subwatersheds.
Drainage Area	• 628 acres (1.0 square miles)
Stream Length	• 1.2 miles
2004 Land Use & Water Coverage	• Residential (49.4%) • Non-Residential (40.4%) • Mixed (6.0%) • Open Space (4.2%) • Undeveloped (0.0%) • Water (0.0%)
Current Imperviousness	• 32.7% of subwatershed
Jurisdictions as Percent of Subwatershed	• Greenburgh (76.8%) • White Plains (23.2%)
Subwatershed Map	• See Map H-7 in Appendix H

Subwatershed Description

At one square mile, the Fulton Brook subwatershed is the second smallest in the watershed. It lies mostly in Greenburgh though almost a quarter of its area is within White Plains. There are 1.15 miles of stream in the subwatershed. Less than 30% of the riparian buffer is forested, and less than 1% of the riparian corridor is publicly-owned. Approximately 26% of the subwatershed has forest cover.

The subwatershed is bisected by Central Avenue (Route 100), which is lined with shopping centers with large parking lots and no stormwater management practices. The east side of the subwatershed is mostly small lot, single family residential. The west side of subwatershed contains extensive forested areas associated with a school complex.

Field crews observed active sanitary sewer overflows at multiple locations along Central Avenue in both Greenburgh and White Plains on multiple trips to the watershed. One sanitary sewer overflow in particular, behind the Best Buy, was observed multiple times over a year. Field crews spoke to responders from Greenburgh, who commented that overflows at this location were a chronic problem.

A map of this subwatershed (Map H-7) can be found in Appendix H.

Subwatershed Management Strategy

Implementation recommendations for the Fulton Brook subwatershed watershed are as follows:

1. *Conduct illicit discharge investigations throughout the subwatershed*. Sanitary sewer overflow repair and illicit discharge elimination are critical for reducing bacteria loads.

2. *Assess the stream corridor to identify stream restoration, buffer reforestation, infrastructure maintenance, and discharge investigation opportunities*. The stream corridor was not assessed as part of this effort.

3. *Investigate the conservation potential of the contiguous forest tract in the northwestern portion of the subwatershed*. This represents a significant portion of the subwatershed, and it should be conserved if possible. In addition, invest in invasive plant species management planning for the other riparian and upland forest areas.

4. *Implement the five upland stormwater retrofits identified for the subwatershed*. These may all serve as demonstration sites for additional stormwater retrofits and new stormwater treatment practices in the subwatershed.

5. *Implement the pervious area management recommendations identified for Webb Park.* This may serve as a demonstration site for additional pervious area enhancements on privately owned properties.

6. *Pursue pollution prevention opportunities at privately-owned hotspots*. In particular, focus on sites that link to upland stormwater retrofits or sanitary sewer overflow repair opportunities.

7. *Disconnect rooftops and other impervious cover from the storm drain system wherever possible*. Residential areas provide a great opportunity for disconnection; just in the neighborhoods assessed, over 60 acres of rooftop are estimated to be available for disconnection in this subwatershed.

These findings may be applicable to the other middle Bronx River tributary subwatersheds – Fox Meadow Brook and Troublesome Brook

Management and Restoration Practice Opportunities in the Subwatershed

Five upland stormwater retrofit opportunities in the watershed are presented in Table 6-13. Three of these sites are considered high priorities from the overall watershed perspective.

The large school complex in Greenburgh presents numerous opportunities for retrofits, including, bioretention practices to treat parking lot runoff; swales to treat road runoff; and downspout disconnection and redirection to pervious areas. In addition, this would serve as an excellent demonstration site; education signage should be incorporated into the retrofit, and school teachers and students should be involved in planning and design.

The other four retrofit opportunities in the subwatershed are on commercial properties along Central Avenue. These projects may be more difficult to implement as they are on private property, but they could serve as good model for improved stormwater treatment on other commercial properties along Central Avenue as well as elsewhere in the watershed.

Table 6-13: Upland Stormwater Retrofit Opportunities in the Fulton Brook Subwatershed				
Rank	**Site ID**	**Location**	**Opportunity**	**Cost Range**
High	FB-R3	Greenburgh (Large school complex in Greenburgh)	Bioretention; swales; rooftop disconnection; reforestation; demonstration and educational projects	$$
	FB-R4	Greenburgh (Best Buy shopping center on Central Avenue)	Swale; bioretention	$$
	FB-R5	Greenburgh (Turco's shopping center on Central Avenue)	Swale	$$
Medium	FB-R1	Greenburgh / White Plains (TJ Maxx shopping center on Central Avenue)	Underground or perimeter sand filter	$$
	FB-R2	Greenburgh (Bed, Bath & Beyond shopping center on Central Avenue)	Bioretention; catch basin inserts; perimeter sand filters	$$$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

A pervious area management and restoration opportunity is available at Webb Park on Central Avenue (Table 6-14). This public park is mostly turf and is used as a ball field. However, there is an opportunity to implement a native plant demonstration garden, with signage, along the parking lot. Also, the northern and eastern edges of the park can be reforested with minimal site preparation.

Table 6-14: Pervious Area Management and Restoration Opportunities in the Fulton Brook Subwatershed					
Rank	**Site ID**	**Location**	**Opportunity**	**Area (acres)**	**Cost Range**
Medium	FB-P1	Greenburgh (Webb Park on Central Avenue)	Native plant demonstration; perimeter reforestation	0.9	$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Opportunities for source control in five subwatershed neighborhoods, including an apartment complex, a town house community, and three single family residential areas, are summarized in Table 6-15. None of these neighborhoods are considered high priorities for the watershed; however, they do provide opportunities for nutrient loads reduction from lawns, downspout disconnection, and street sweeping. In addition, community involvement at these sites could be relatively high.

If downspout disconnection programs were instituted in the Wayne Avenue, Trenton Avenue, and Juniper Hills Road neighborhoods in Greenburgh, it is estimated that almost 60 acres of rooftop could be disconnected assuming. In addition, the Juniper Hills Road neighborhood is a good candidate for exploring residential landscaping approaches for steep slopes.

Table 6-15: Neighborhood Source Control Opportunities in the Fulton Brook Subwatershed							
Rank	**Site ID**	**Location**	**Opportunity**	**Area (acres)**	**Homes**	**Cost Range**	**Public**
Medium	FB-N1	Greenburgh / White Plains (Single family residential neighborhood east of Central Avenue and south of Wayne Avenue)	Downspout disconnection; rain barrels; turf conversion	41.5	166	$	Medium
Medium	FB-N2	White Plains (Single family residential neighborhood east of Central Avenue and north of Trenton Avenue)	Downspout disconnection; rain barrels; turf conversion	64.5	389	$$	High
Medium	FB-N5	Greenburgh (Fox Glen Colony apartment complex off of North Washington Avenue)	Storm drain stenciling; potential on-site parking lot / catch basin retrofits.	16	--	$$$	High
Low	FB-N3	Greenburgh (Single family residential neighborhood along Juniper Hills Road)	Downspout disconnection; rain barrels; turf conversion; planting to stabilize steep slopes on lots	16	64	$$	Low
Low	FB-N4	Greenburgh (Rex Ridge town house complex off of Pinewood Road)	Increase landscaping in open areas; rain gardens to treat rooftop runoff; stabilize eroded areas adjacent to parking lots	25.4	--	$$$	High

Area: Neighborhood Area
Homes: Approx. Number of Homes in Neighborhood
Public: Public Involvement Potential

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Four privately-owned hotspots present opportunities for improved pollution prevention and source control education, including two shopping centers on Central Avenue in Greenburgh, a gas station on Aqueduct Place in White Plains, and a light-industrial area on Fulton Street (Table 6-16).

Dumpster management and outdoor material storage appeared to be the main issues at the commercial locations. Both sites are also linked with parking lot stormwater retrofits. The sanitary sewer overflow observed behind the Best Buy shopping center on Central Avenue is adjacent to a Chinese restaurant with outdoor, uncovered, leaking grease storage.

The light industrial strip along Fulton Street in Greenburgh and White Plains can be considered a "hot*strip*," not just a hotspot. Numerous pollution-producing activities were observed, including vehicle refueling in the road over a storm drain inlet. At this location, staff from Greenburgh and White Plains should coordinate to do a sweep of the street to investigate the privately owned sites.

Table 6-16: Privately Owned Hotspot Management Opportunities in the Fulton Brook Subwatershed					
Rank	**Site ID**	**Location**	**Opportunity**	**Hotspot Status**	**Cost Range**
Medium	FB-H1	Greenburgh (Bed Bath & Beyond shopping center on Central Avenue)	Improved dumpster management; stormwater retrofit	Confirmed	$$$
Medium	FB-H2	Greenburgh (Best Buy shopping center on Central Avenue)	Illicit discharge investigation; stormwater retrofit; secondary containment for grease storage	Confirmed	$$$
Low	FB-H3	White Plains (Gulf Gas station on Central Avenue and Aqueduct Place)	Stormwater retrofit; covered fueling island; improved dumpster management	Potential	$$$
High	FB-H4	Greenburgh / White Plains (Light industrial strip along Fulton Street)	Containment at fueling operation; pollution prevention education; pollution prevention plan review; stormwater retrofits	Severe	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Subwatershed Treatment Analysis Results

The following assumptions were incorporated into the WTM to assess potential subwatershed treatment resulting from the subwatershed management strategy:

- Implement lawn care and pet waste education programs: *assumes 25% of homeowners in targeted areas are reached using methods such as newspaper articles*
- Improve erosion and sediment control program inspection and maintenance: *assumes more frequent inspection and willingness to levy fines for poor performance*
- Implement programs to encourage disconnect disconnection in residential areas: *assumes this is applicable to 50% of residential areas; that 30% of these residents are reached; and that 25% of those reached are willing to disconnect downspouts*
- Implement programs to encourage disconnect disconnection in commercial areas: *assumes this is applicable to 25% of commercial areas; that 100% of these property owners are reached; and that 20% of those reached are willing to disconnect downspouts*
- Construct upland stormwater retrofits: *assumes 15 impervious acres treated*
- Replant stream buffers: *assumes 0.0 stream miles replanted*
- Stabilize stream channels: *assumes 0.0 stream miles stabilized*
- Remove illicit connections: *assumes 90% of the sewer system will be surveyed for illicit connections and 80% of the illicit connections found will be corrected (WTM default)*
- Reduce sanitary sewer overflows: *assumes a target reduction of 80% of existing load and 80% of necessary repairs made (WTM default)*
- Enhance street sweeping efforts: *assumes same treatment area, but upgraded technology to vacuum assisted sweepers*

Potential load reductions that may be obtained by implementing these practices are estimated at 19% for nutrients, 7% for sediment and close to 30% for bacteria. Table 6-17 and Figure 6-2 summarize the WTM results.

Lawn care education, pet waste education, and downspout disconnections account for almost 75% of the nutrient (total nitrogen) load reduction while illicit connection removal accounts for 11%. For sediment, stormwater retrofits and downspout disconnection combined account for almost 60% of the load reduction. Removing illicit connections and repairing sanitary sewer overflows account for almost 90% of total bacteria load reductions.

Table 6-17: Potential Pollutant Load Reduction that May Result from Fulton Brook Subwatershed Management Strategy Implementation

	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform (billions of colonies/yr)
Estimated Current Annual Load	4,783	632	194,306	290,863
Estimated Annual Load with Management Strategy	3,860	516	180,369	210,660
Potential Annual Pollutant Load Reduction	-19.3%	-18.3%	-7.2%	-27.6%

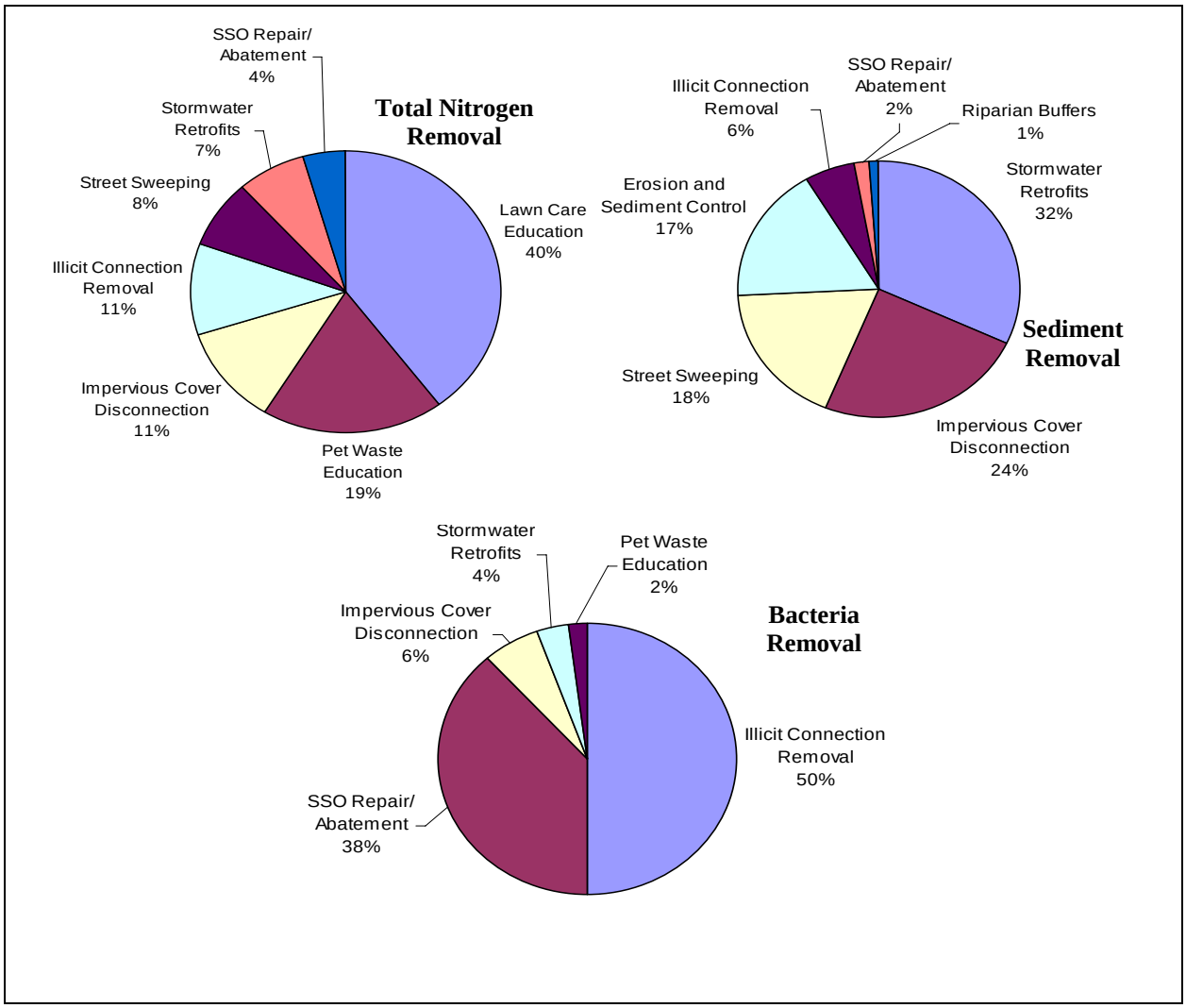


Figure 6-2: Potential Effect of Different Treatment Practices on Pollutant Load Reduction in the Fulton Brook Subwatershed

6.3 Grassy Sprain Brook (GSB)

Table 6-18: Basic Profile of the Grassy Sprain Brook Subwatershed	
Management Group	• Subwatersheds drain to Grassy Sprain Brook, the largest tributary to the Bronx River. Also includes Sprain Brook (SB) and Grassy Sprain Brook Direct Drainage (GSD) subwatersheds.
Drainage Area	• 3,120 acres (4.9 square miles)
Stream Length	• 6.0 miles
2004 Land Use & Water Coverage	• Open Space (39.7%) • Residential (35.9%) • Non-Residential (13.7%) • Water (8.9%) • Undeveloped (1.8%) • Mixed (0.0%)
Current Imperviousness	• 14.6% of subwatershed
Jurisdictions as Percent of Subwatershed	• Ardsley (11.8%) • Greenburgh (57.4%) • Yonkers (30.8%)
Subwatershed Map	• See Map H-8 in Appendix H

Subwatershed Description

Most of the Grassy Sprain Brook (GSB) subwatershed is within Greenburgh; however Yonkers and Ardsley also have some jurisdiction. There are 5.99 estimated stream miles in this subwatershed that flow into the reservoir. Some headwater streams showed signs of encroachment by structures and homeowner activities; although banks had reasonably good stability where mature trees were present. Parking lots and parks encroach on almost a couple thousand feet of stream in the middle of the subwatershed. The stream does not appear to be actively enlarging, but there is evidence of riprap being used for bank stabilization and to prevent channel plan form migration. About a third of the riparian buffer is forested, and almost 60% of the riparian corridor is publicly owned.

The subwatershed is characterized by rolling terrain with steep areas, older development, and mature tree cover that provides both canopy interception and organic debris. Thirty-four percent of land cover is forest and about 10% is wetlands. Most of the developed areas in the subwatershed are medium to low density residential (about 50%), schools, nurseries, or cemetery. There is very little commercial development, and no evidence of any stormwater management except for a dry pond at the old Macy's distribution center; this is a quantity-control facility and does not provide water quality treatment.

The stream corridor was not systematically assessed in this subwatershed, however, field crews confirmed that the upper portion of the subwatershed does drain to the reservoir and the revised delineation is correct. During upland assessments, several areas within the subwatershed were identified for pervious area improvements through tree planting or turf conversion. Community dumping of rubble, debris, and organic matter was frequently observed in public parks. The schools visited were found to be quite limited in terms of on-site opportunities. A chronic flooding issue (four times a year) was reported at the Sprain Brook Nursery near the Greenburgh DPW yard.

A map of this subwatershed (Map H-8) can be found in Appendix H.

Subwatershed Management Strategy

Implementation recommendations for the Grassy Sprain Brook subwatershed watershed are as follows:

1. Because the highway runs directly adjacent to the reservoir, the County should develop an emergency spill response plan to prevent accidental, contaminated runoff from the highway from entering the reservoir.

2. *Increase watershed awareness through additional educational signage.* Place a large "Entering the Bronx River Watershed" sign on the southbound Sprain Brook Parkway in Greenburgh. Install signage at highly visible demonstration sites, using the Crestwood facility (in Bronx River Middle Direct Drainage subwatershed) stormwater retrofit signage as a model. Place storm drain markers on inlets in dense commercial areas.

3. *Assess the stream corridor to identify stream restoration, buffer reforestation, infrastructure maintenance, and discharge investigation opportunities*. The stream corridor was not assessed as part of this effort.

4. *Construct demonstration upland stormwater retrofits as opportunities arise.* These may serve as examples for additional stormwater retrofits and new stormwater treatment practices in the subwatershed.

5. *Explore possible upgrades to street sweeping practices.* This may include switching to a more effective technology.

6. *Implement source control education in targeted neighborhoods.* Depending on the neighborhood, this education may focus on downspout disconnection, better lawn care, household hazardous waste management, or pet waste education.

7. *Implement improved pollution control at targeted hotspots.*

8. *In Ardsley and Greenburgh, discontinue the practice of allowing community dumping of rubble, debris, and organic matter in public parks.*

These findings may be applicable to the other Grassy Sprain Brook tributary subwatersheds – Sprain Brook and Grassy Sprain Brook Direct Drainage.

Management and Restoration Practice Opportunities in the Subwatershed

Nine upland stormwater retrofit opportunities that may treat runoff from up to 14 acres of impervious cover are presented in Table 6-19. The Old Macy's Distribution Center in Yonkers provides the largest treatment potential in the subwatershed; there are several opportunities to use smaller more innovative practices, such as green roofs, cisterns, porous pavement, swales and bioretention.

Two high priority projects are located in Veterans Park North in Greenburgh and Ardsley Park in Ardsley. These both have the potential to be highly visible demonstration projects.

Table 6-19: Upland Stormwater Retrofit Opportunities in the Grassy Sprain Brook Subwatershed

Rank	Site ID	Location	Opportunity	Cost Range
High	GSB-R2	Greenburgh (Veterans Park North)	Rain garden	$$
	GSB-R6	Ardsley (Ardsley Park)	Modified grass channel with infiltration trench; bioretention	$$
Medium	GSB-R1	Greenburgh (Old Franks Nursery on Central Avenue)	Porous pavement; grass channels; bioretention	$$
	GSB-R3	Greenburgh (Veterans Park South, east side)	Perimeter sand filters	$$
	GSB-R4	Greenburgh (Veterans Park South, west side)	Proprietary subsurface practices	$$
	GSB-R7	Yonkers (Old Macy's Distribution Center)	Green roofs; cisterns; porous pavement; swales; bioretention	$$$
	GSB-R8	Ardsley (McDowell Park)	Modified sand filter swale with turf cover, gravel trench, underdrain; remove large waste pile of asphalt	$$
	GSB-R9	Yonkers (Sprain Brook Golf Course)	No mow areas; outfall stabilization; geese management	$$
Low	GSB-R5	Greenburgh (Ridge Park)	Bioretention/rain garden; divert water to vegetated areas	$$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Seven pervious area management and restoration opportunities in the subwatershed are summarized in Table 6-20. Combined, these have the potential to result in 11 acres for reforestation.

Table 6-20: Pervious Area Management and Restoration Opportunities in the Grassy Sprain Brook Subwatershed

Rank	Site ID	Location	Opportunity	Area (acres)	Cost Range
High	GSB-P2	Ardsley (Veterans Park)	Reforestation; invasive plant species management	0.6	$
	GSB-P3	Ardsley (Our Lady of Perpetual Help)	Reforestation; stream buffer enhancement	1.0	$$
	GSB-P6	Yonkers (Old Macy's Distribution Center)	Reforestation	4.5	$$
Medium	GSB-P7	Ardsley (McDowell Park)	Perimeter reforestation	0.4	$$
Low	GSB-P1	Greenburgh (Old Franks Nursery)	Extensive site preparation; partial site reforestation	1.6	$$$
	GSB-P4	Greenburgh (Vacant lot on Jackson Avenue)	Extensive site preparation; reforestation	0.3	$$$
	GSB-P5	Greenburgh (Fern Cliff Cemetery)	Reforestation	2.3	$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Pollution prevention opportunities at three neighborhoods are summarized in Table 6-21. Two of these single family residential neighborhoods, Secor Road in Greenburgh and Mountaindale Road in Yonkers, are consider high priority from the overall watershed perspective. The Secor Road neighborhood should be targeted for downspout disconnection and better lawn care. The Mountaindale neighborhood should be targeted for household hazardous waste management and pet waste education.

The Hawthorne neighborhood in Greenburgh is considered a low watershed priority, however, opportunities exist for rain garden implementation and lawn conversion.

Table 6-21: Neighborhood Source Control Opportunities in the Grassy Sprain Brook Subwatershed

Rank	Site ID	Location	Opportunity	Area (acres)	Homes	Cost Range	Public
High	GSB-N1	Greenburgh (Single family residential neighborhood along Secor Road)	Lawn care education; storm drain cleanout; downspout disconnection	79	316	$$	High
High	GSB-N3	Yonkers (Single family residential neighborhood along Mountaindale Road)	Storm drain stenciling; household hazardous waste management (mobile oil recycling); pet waste management; no dumping signs	63	507	$$	High
Low	GSB-N2	Greenburgh (Single family residential neighborhood along Hawthorne Way)	Rain gardens; downspout disconnection; homeowner education on lawn care practices	66	66	$$	Low

Area: Neighborhood Area
Homes: Approx. Number of Homes in Neighborhood
Public: Public Involvement Potential

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Of the four hotspot opportunities identified in the subwatershed, two are publicly owned (Tables 6-22 and 6-23). The Sprain Brook Golf Course in Yonkers provides an opportunity to develop a model pollution prevention plan on public property that can be used as guidance for other golf courses throughout the Bronx River watershed. The golf course and the Greenburgh Maintenance Yard are directly on the Grassy Sprain Brook; buffer management should be improved at the golf course.

Many pollution prevention practices were observed at the Greenburgh maintenance facility (i.e., secondary containment, SPDES permit posting, spill prevention, trained staff, wash water collection). This facility should be used as a model for demonstrating practices to other facilities in the watershed.

Table 6-22: Privately Owned Hotspot Management Opportunities in the Grassy Sprain Brook Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
Low	GSB-H1	Greenburgh (Sprain Brook Nursery)	Flow diversion to stormwater retrofit	Potential	$$$
Low	GSB-H4	Greenburgh (Westchester Greenhouses)	Follow-up site investigation; pollution prevention education; posting / distribution of educational materials for public (native plants and proper landscaping procedures)	Potential	$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Table 6-23: Publicly Owned Hotspot Management Opportunities in the Grassy Sprain Brook Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
High	GSB-H5	Yonkers (Sprain Brook Golf Course)	Materials storage and disposal education; covered fueling island; buffer enhancement	Potential	$$
High	GSB-H6	Greenburgh (Greenburgh Maintenance Yard)	Good examples of compliance, use for demonstration site; upgraded trap in washing area; covered fueling islands	Confirmed	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Subwatershed Treatment Analysis Results

The following assumptions were incorporated into the WTM to assess potential subwatershed treatment resulting from the subwatershed management strategy:

- Implement lawn care and pet waste education programs: *assumes 25% of homeowners in targeted areas are reached using methods such as newspaper articles*
- Improve erosion and sediment control program inspection and maintenance: *assumes more frequent inspection and willingness to levy fines for poor performance*

- Implement programs to encourage disconnect disconnection in residential areas: *assumes this is applicable to 33% of residential areas; that 30% of these residents are reached; and that 25% of those reached are willing to disconnect downspouts*
- Implement programs to encourage disconnect disconnection in commercial areas: *assumes this is applicable to 25% of commercial areas; that 100% of these property owners are reached; and that 20% of those reached are willing to disconnect downspouts*
- Construct upland stormwater retrofits: *assumes 10 impervious acres treated*
- Replant stream buffers: *assumes 0.0 stream miles replanted*
- Stabilize stream channels: *assumes 0.0 stream miles stabilized*
- Remove illicit connections: *assumes 90% of the sewer system will be surveyed for illicit connections and 80% of the illicit connections found will be corrected (WTM default)*
- Reduce sanitary sewer overflows: *assumes a target reduction of 80% of existing load and 80% of necessary repairs made (WTM default)*
- Enhance street sweeping efforts: *assumes same treatment area, but upgraded technology to vacuum assisted sweepers*

Potential load reductions that may be obtained by implementing these practices were estimated at 20% and 15% for total nitrogen and total phosphorus, respectively, 9% for sediment and 24% for bacteria. Table 6-24 and Figure 6-3 summarize the WTM results.

Lawn care education and street sweeping account for almost 75% of the total nitrogen load reduction. For sediment, reductions in sanding and improvements in street sweeping account for the majority of the load reduction. Similarly to the other subwatersheds modeled, removing illicit connections and repairing SSO's account for 90% of total bacteria load reductions.

Table 6-24: Potential Pollutant Load Reduction that May Result from Grassy Sprain Brook Subwatershed Management Strategy Implementation

	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform (billions of colonies/yr)
Estimated Current Annual Load	19,111	1,873	839,862	735,245
Estimated Annual Load with Management Strategy	15,328	1,600	764,728	558,479
Potential Annual Pollutant Load Reduction	-19.8%	-14.6%	-8.9%	-24.0%

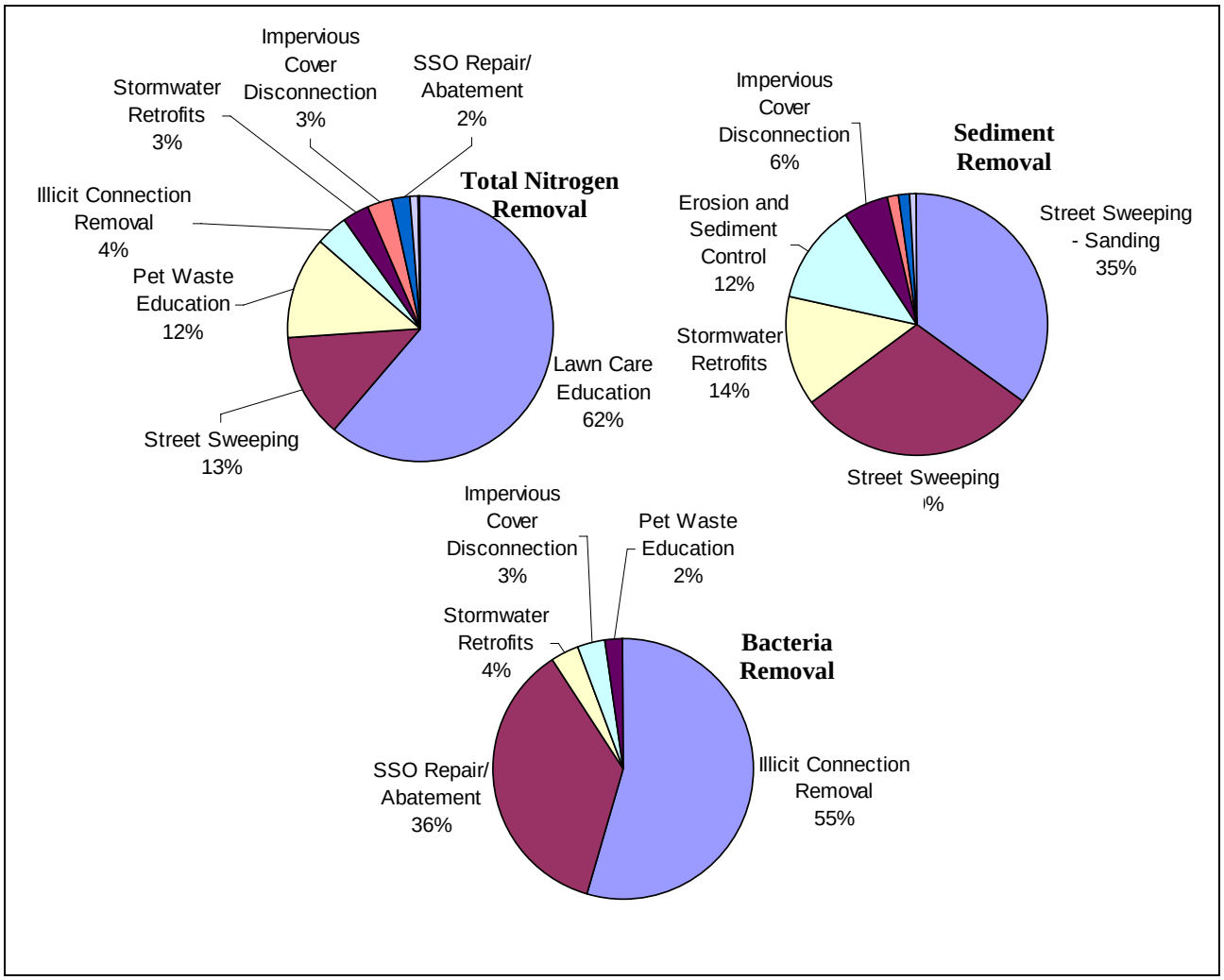


Figure 6-3: Potential Effect of Different Treatment Practices on Pollutant Load Reduction in the Grassy Sprain Brook Subwatershed

6.4 Hartsdale Brook (HB)

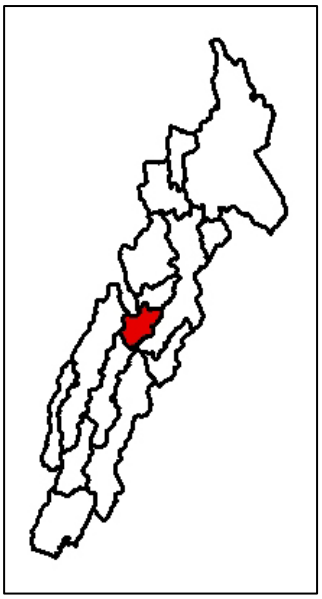


Table 6-25: Basic Profile of the Hartsdale Brook Subwatershed	
Management Group	• Subwatersheds draining to middle Bronx River tributaries. Also includes Fox Meadow Brook (FMB), Fulton Brook (FB) and Troublesome Brook (TB) subwatersheds.
Drainage Area	• 722 acres (1.2 square miles)
Stream Length	• 0.6 miles
2004 Land Use & Water Coverage	• Residential (47.1%) • Open Space (39.5%) • Non-Residential (12.4%) • Mixed (0.4%) • Undeveloped (0.1%) • Water (0.4%)
Current Imperviousness	• 20.1% of subwatershed
Jurisdictions as Percent of Subwatershed	• Greenburgh (100%)
Subwatershed Map	• See Map H-10 in Appendix H

Subwatershed Description

The 1.2 square mile Hartsdale Brook (HB) subwatershed is entirely within Greenburgh. There are 0.61 estimated stream miles in this subwatershed. A large portion of the stream network is underground, but close to half of the surface streams have a forested buffer. About a quarter of the stream corridor is publicly owned. Interestingly, after flowing underground for a distance, the stream resurfaces near the Hartsdale train station between the parking lot and the train tracks.

Almost 50% of the subwatershed is in residential use and there are two large golf courses. Central Avenue bisects the subwatershed and is lined with strip commercial and retail development, but few of these are considered hotspots. Thirty-five percent of the subwatershed is forested. A large contiguous forest tract connecting Hartsdale Brook subwatershed with Grassy Sprain Brook subwatershed and the adjacent watershed should be further investigated. The Greenburgh Nature Center is located in this subwatershed.

A map of this subwatershed (Map H-10) can be found in Appendix H.

Subwatershed Management Strategy

Implementation recommendations for the Hartsdale Brook subwatershed watershed are as follows:

1. *Assess the stream corridor to identify stream restoration, buffer reforestation, infrastructure maintenance, and discharge investigation opportunities*. The stream corridor was not assessed as part of this effort.

2. *Construct demonstration upland stormwater retrofits as opportunities arise. In addition, examine the feasibility of the retrofit opportunity identified at the vacant lot on Central*

Avenue and Healy in Greenburgh. Although this opportunity is considered low priority from a watershed perspective, it is the only opportunity identified to provide treatment of a large volume of stormwater runoff in the subwatershed.

3. *Conduct illicit discharge investigations throughout the subwatershed*.

4. *Target lawn care education to high priority neighborhoods with large areas of high maintenance turf*. Residential lawn care education was modeled to be the highest nutrient reducing activity in the subwatershed.

These findings may be applicable to the other middle Bronx River tributary subwatersheds – Fox Meadow Brook and Troublesome Brook

Management and Restoration Practice Opportunities in the Subwatershed

Of the five upland stormwater retrofit opportunities identified in the Hartsdale Brook subwatershed, two are considered watershed priorities (Table 6-26). Perimeter sand filter and bioswale demonstration projects are recommended for the Hartsdale train station, and porous pavers and bioretention are recommended for the parking lot at the Greenburgh Nature Center.

The bioretention opportunity identified for the right-of-way along Central Avenue at Marion would treat runoff from a small area, but it could serve as a demonstration of the type of stormwater treatment that may be implemented along Central Avenue in other locations. The vacant lot at the intersection of Central Avenue and Healy presents a unique opportunity to implement a large stormwater pond that would treat a large drainage area.

Table 6-26: Upland Stormwater Retrofit Opportunities in the Hartsdale Brook Subwatershed

Rank	Site ID	Location	Opportunity	Cost Range
High	HB-R1	Greenburgh (Hartsdale Train Station)	Perimeter sand filter; bioswale; demonstration project	$$
	HB-R3	Greenburgh (Greenburgh Nature Center)	Porous pavers; bioretention; educational signage	$$
Medium	HB-R2	Greenburgh (Scarsdale Country Club)	Bioretention	$$
	HB-R5	Greenburgh (Large vacant lot at the intersection of Central Avenue and Healy)	Wet extended detention pond	$$$
Low	HB-R4	Greenburgh (Right-of-way along Central Avenue at Marion)	Bioretention	$$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Neighborhood source control opportunities are identified for six subwatershed neighborhoods in Table 6-27. Three of these single family residential neighborhoods – south of Jane Street, near Thomas Street, and Windsor Park – are adjacent to the stream, and the first two are considered watershed priorities.

Table 6-27: Neighborhood Source Control Opportunities in the Hartsdale Brook Subwatershed							
Rank	**Site ID**	**Location**	**Opportunity**	**Area (acres)**	**Homes**	**Cost Range**	**Public**
High	HB-N3	Greenburgh (Single family residential neighborhood east of North Central Avenue, north of East Hartsdale Avenue, and south of Jane Street)	Buffer replanting along stream in open lots; rain gardens and rain barrels; storm drain stenciling; homeowner education on lawn care practices	80.664	244	$$	High
High	HB-N5	Greenburgh (Single family residential neighborhood bounded by Thomas Street, South Healy Avenue, Marion Avenue, and North Healy Avenue)	Homeowner education on lawn care practices; downspout disconnection / rain barrels / rain gardens; check for potential swimming pool discharges	68.919	209	$$	High
Medium	HB-N1	Greenburgh (Windsor Park residential subdivision off of West Hartsdale Avenue)	Downspout disconnection; rain barrels; rain gardens; buffer plantings; storm drain stenciling; homeowner education on lawn care practices	15.681	48	$$	Low
Medium	HB-N2	Greenburgh (Country Club Ridge Apartments on Rockledge Road)	Storm drain stenciling; rain gardens; nutrient / lawn care education; improved dumpster management	17.888	--	$	High
Medium	HB-N6	Greenburgh (Scarsdale Fairway Luxury Apartments)	Replant open spaces; downspout disconnection; parking lot retrofit (catch basin inserts, underground sand filter)	7.786	--	$$$	High
Low	HB-N4	Greenburgh (Single family residential neighborhood along South Washington Avenue)	Rain barrels; homeowner education on lawn care practices; storm drain stenciling; steep slope plantings; clean up trash / dumping	7.996	48	$	Low

Area: Neighborhood Area
Homes: Approx. Number of Homes in Neighborhood
Public: Public Involvement Potential

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Two hotspots, one privately owned and one publicly owned, are identified Tables 6-28 and 6-29. Neither is considered a priority.

Table 6-28: Privately Owned Hotspot Management Opportunities in the Hartsdale Brook Subwatershed					
Rank	**Site ID**	**Location**	**Opportunity**	**Hotspot Status**	**Cost Range**
Low	HB-H2	Greenburgh (Getty Gas station on South Central Avenue)	Covered fueling island	Potential	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Table 6-29: Publicly Owned Hotspot Management Opportunities in the Hartsdale Brook Subwatershed					
Rank	**Site ID**	**Location**	**Opportunity**	**Hotspot Status**	**Cost Range**
Low	HB-H3	Greenburgh (Town of Greenburgh fire station on South Central Avenue)	Proper vehicle washing education; dumpster replacement	Potential	$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Subwatershed Treatment Analysis Results

The following assumptions were incorporated into the WTM to assess potential subwatershed treatment resulting from the subwatershed management strategy:

- Implement lawn care and pet waste education programs: *assumes 25% of homeowners in targeted areas are reached using methods such as newspaper articles*
- Improve erosion and sediment control program inspection and maintenance: *assumes more frequent inspection and willingness to levy fines for poor performance*
- Implement programs to encourage disconnect disconnection in residential areas: *assumes this is applicable to 50% of residential areas; that 30% of these residents are reached; and that 25% of those reached are willing to disconnect downspouts*
- Implement programs to encourage disconnect disconnection in commercial areas: *assumes this is applicable to 25% of commercial areas; that 100% of these property owners are reached; and that 20% of those reached are willing to disconnect downspouts*
- Construct upland stormwater retrofits: *assumes 104 impervious acres treated*
- Replant stream buffers: *assumes 0.0 stream miles replanted*
- Stabilize stream channels: *assumes 0.0 stream miles stabilized*
- Remove illicit connections: *assumes 90% of the sewer system will be surveyed for illicit connections and 80% of the illicit connections found will be corrected (WTM default)*
- Reduce sanitary sewer overflows: *assumes a target reduction of 80% of existing load and 80% of necessary repairs made (WTM default)*
- Enhance street sweeping efforts: *assumes same treatment area, but upgraded technology to vacuum assisted sweepers*

Significant load reductions were obtained by implementing these practices, particularly for nutrients (32% and 35% total nitrogen and total phosphorus, respectively) and bacteria (50%). Sediment removal was modeled at 17%. Table 6-30 and Figure 6-4 summarize the WTM results.

For total nitrogen removal, lawn care education and stormwater retrofits account for almost 75% of the load reduction. For sediment, stormwater retrofits account for 83% of the reduction. Stormwater retrofits and illicit connection removal account for 73% of the bacterial load reduction.

Table 6-30: Potential Pollutant Load Reduction that May Result from Hartsdale Brook Subwatershed Management Strategy Implementation

	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform (billions of colonies/yr)
Estimated Current Annual Load	4,660	499	178,416	204,873
Estimated Annual Load with Management Strategy	3,178	323	148,406	105,988
Potential Annual Pollutant Load Reduction	-31.8%	-35.3%	-16.8%	-48.3%

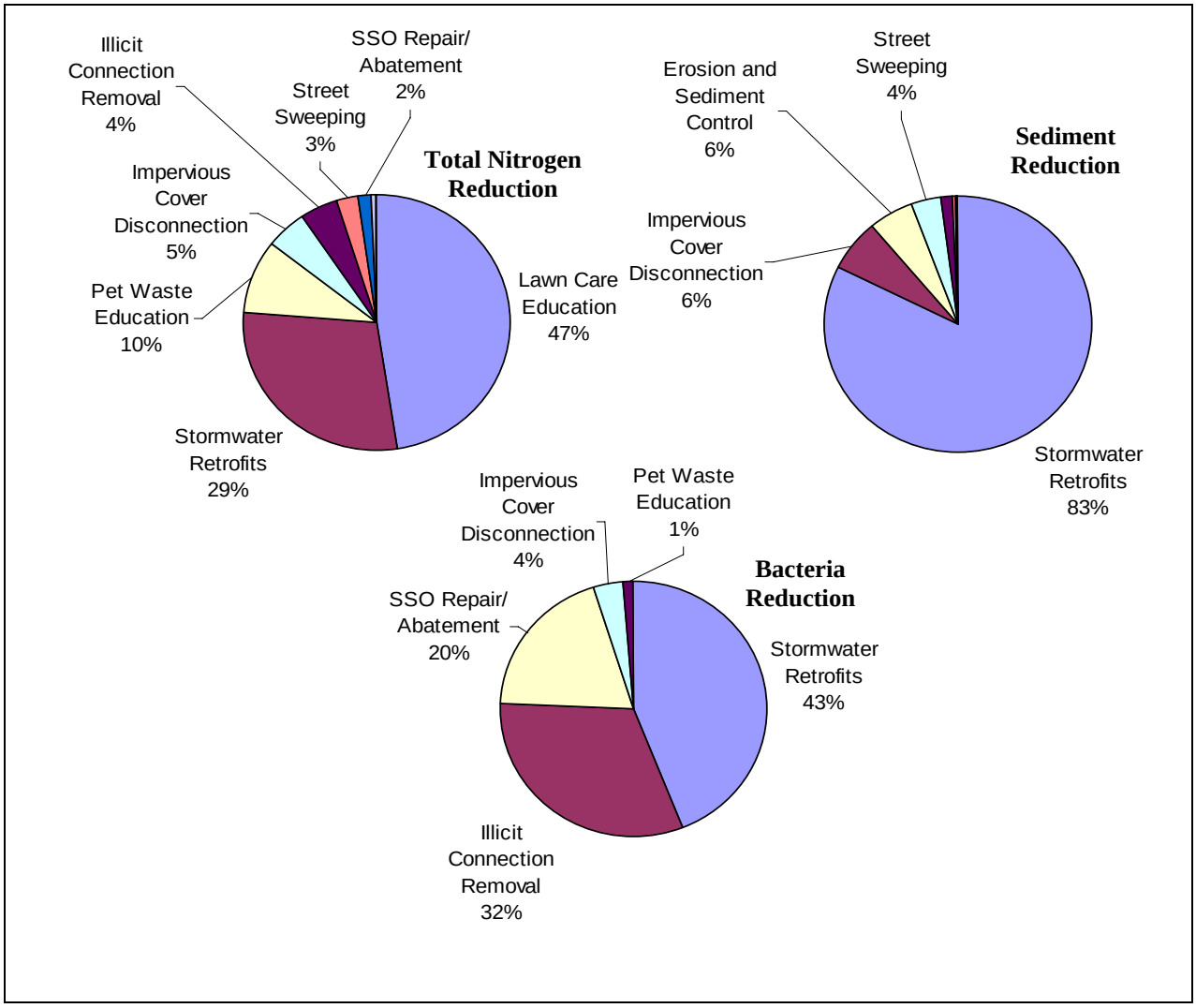


Figure 6-4: Potential Effect of Different Treatment Practices on Pollutant Load Reduction in the Hartsdale Brook Subwatershed

6.5 Manhattan Park Brook (MP)

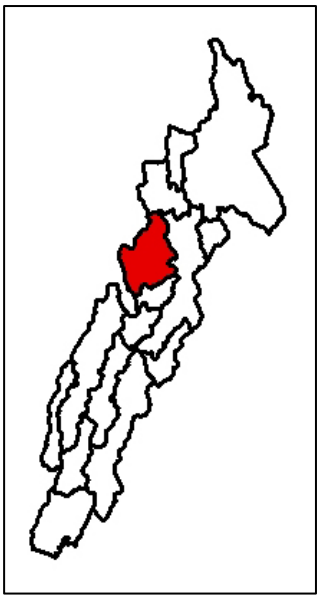


Table 6-31: Basic Profile of the Manhattan Park Brook Subwatershed	
Management Group	• Subwatersheds draining to northern Bronx River tributaries. Also includes Davis Brook (DB) and Clove Brook (CB) subwatersheds.
Drainage Area	• 2,117.9 acres (3.3 square miles)
Stream Length	• 4.4 miles
2004 Land Use & Water Coverage	• Residential (38.7%) • Non-Residential (35.8%) • Open Space (16.2%) • Mixed (8.2%) • Undeveloped (1.1%) • Water (0.1%)
Current Imperviousness	• 21.7% of subwatershed
Jurisdictions as Percent of Subwatershed	• Elmsford (12.1%) • Greenburgh (87.6%) • Mount Pleasant (0.3%)
Subwatershed Map	• See Map H-12 in Appendix H

Subwatershed Description

The Manhattan Park Brook subwatershed is mostly in Greenburgh; Elmsford and Mount Pleasant also have jurisdiction over a small portion of the drainage area. Manhattan Park Brook flows into the Bronx River at the lower end of the Bronx River Upper Direct Drainage subwatershed. The stream has been extensively channelized throughout much of its length. Portions have been lined with concrete or riprap. In the areas where it is not channelized, it is entrenched.

The buffer width has been impacted by development, which appears to be more recent than in other subwatersheds, and the stream is experiencing localized scour as it adjusts. There is an extensive amount of stream encroachment in both residential and commercial areas. About one-quarter of the stream corridor has a forested buffer; almost 20% of corridor is publicly owned.

Interstate 287 splits the subwatershed; the northern portion of the subwatershed appears to be more suburban and rural in character. About 27% of the subwatershed is forested; with a large contiguous tract in the northern portion that should be further investigated. Residential development accounts for about 40% of subwatershed land use. The New York School for the Deaf is in the subwatershed; this site was not assessed but may warrant further investigation. Tarrytown Road is mostly commercial with several large shopping centers and car-related services.

A map of this subwatershed (Map H-12) can be found in Appendix H.

Subwatershed Management Strategy

Implementation recommendations for the Manhattan Park Brook subwatershed watershed are as follows:

1. *Conduct illicit discharge investigations throughout the subwatershed*. Modeled illicit discharge removal and sanitary sewer overflow repair had a significant impact on bacteria and reduction.

2. *Follow up with identified infrastructure assessment and trash removal opportunities*. These are listed in Table 6-38.

3. *Investigate the conservation potential of the contiguous forest tract in the north-central portion of the subwatershed*. This represents a significant portion of the remaining forest cover in the subwatershed, and it should be conserved if possible. In addition, invest in invasive plant species management planning for the other riparian and upland forest areas.

4. *Increase watershed awareness through additional educational signage*. Place large "Entering / Leaving the Bronx River Watershed" signs on Interstate 287. Place storm drain markers on inlets in dense commercial areas.

5. *Pursue pollution prevention and source control education opportunities in high priority neighborhoods and at privately-owned hotspots*.

6. *Explore possible upgrades to street sweeping practices.* This may include switching to a more effective technology.

7. *Construct high and medium priority upland stormwater retrofits on both public and private property*. Look for additional large-scale stormwater retrofit opportunities on public property and at the New York School for the Deaf; this site was not assessed but may warrant further investigation.

8. *Construct the high priority riparian corridor restoration project in Old Tarrytown Park.* Invasive plant species removal, in-stream habitat improvement, and riparian plantings will enhance recreation and riparian habitat.

These findings may be applicable to the other northern Bronx River tributary subwatersheds – Davis Brook and Clove Brook.

Management and Restoration Practice Opportunities in the Subwatershed

Eight upland stormwater retrofit opportunities are available in the subwatershed (Table 6-32). Five of these are considered watershed priorities, primarily due to their high visibility and demonstration site potential. Implementation of all eight retrofits could provide treatment of stormwater runoff from up to 30 impervious acres.

Table 6-32: Upland Stormwater Retrofit Opportunities in the Manhattan Park Brook Subwatershed				
Rank	**Site ID**	**Location**	**Opportunity**	**Cost Range**
High	MP-R1	Greenburgh (Crossroads Plaza on Tarrytown Road)	Bioretention; grass swale; perimeter sand filter; expanded tree pits; underground sand filter; remove a concrete slab over stream; planter boxes at downspouts; covered storage for sand/salt; tree planting	$$$
	MP-R4	Greenburgh (Greenburgh Elementary School on Hillside Avenue)	Remove impervious cover; incorporate more efficient parking and bus lanes; increase landscaping; stormwater treatment practices; demonstration site	$$
	MP-R5	Greenburgh (Greenburgh Town Hall)	Pervious paving; bioretention / rain gardens	$$
	MP-R6	Greenburgh (Greenburgh Library)	Perimeter sand filters; bioretention; revegetation of slopes with native plant demonstration area; permeable paving	$$
	MP-R20	Greenburgh (Westchester Community College)	Pervious pavers; curb cuts; enhance pervious areas on campus	$$$
Medium	MP-R2	Elmsford (Bed, Bath & Beyond shopping center on Tarrytown Road)	Perimeter or underground sand filters	$$
	MP-R7	Greenburgh (Greenburgh Housing Authority apartment building on Manhattan and Elm)	Bioretention; catch basin inserts; improved dumpster management	$$
Low	MP-R3	Greenburgh (Danon Corporate Offices on Hillside Avenue)	Bioretention	$$
$: Estimated Planning Level Cost ≤ $100,000 $$: $100,000 < Estimated Planning Level Cost ≤ $500,000 $$$: Estimated Planning Level Cost > $500,000				

Two subwatershed riparian corridor restoration opportunities are presented in Table 6-33. The first, at the Old Tarrytown Park in Greenburgh (MP-S1) is considered a watershed priority; a concept for this site is provided in Appendix J.

At this site, the stream flows south from an established red maple swamp on the New York School for the Deaf property. Approximately 200 feet north of the Old Tarrytown Road crossing, a series of gabions has caused ponding, sediment deposition and invasive plant species establishment. The stream is then culverted for 200 feet under the Old Tarrytown Park south of Old Tarrytown Road. There are indications (floatable debris lines) that this culvert is undersized and that the stream flows over the road into the park. Potential restoration techniques to consider include:

- Replacing the gabions with grade control structures.
- Replacing the culvert and/or daylighting the stream through Old Tarrytown Park.
- Removing and managing invasive plant species.

The second opportunity is on the Knollwood Golf Course, west of Knollwood Road (100A) and north of Knollwood Drive. After being discharged from a golf course pond, the stream flows south, and for approximately 200 feet has only mowed grass for riparian vegetation. From here it enters a wooded area where there is some bank erosion and it has been encroached upon by a roadway. The stream is then culverted under the golf course parking lot. Stormwater runoff from the parking lot is causing erosion of the stream bank where the stream exits the piped section. Potential restoration techniques to consider include:

- Stabilizing the eroding banks.
- Installing a stormwater retrofit to capture parking lot runoff and prevent erosion at south end of parking lot.
- Improving riparian buffer by planting native trees and shrubs in open areas along the upper reach.

Table 6-33: Riparian Corridor Restoration Opportunities in the Manhattan Park Brook Subwatershed

Rank	Site ID	Location	Opportunity	ISM (acres)	Stream (linear feet)	Reforest (acres)	Cost Range
High	MP-S1	Greenburgh (Along Manhattan Park Brook at the Old Tarrytown Park, south of Old Tarrytown Road)	Redesign channel; replace culvert and/or daylight stream; remove and manage invasive plant species	< 1	200	< 1	$
Low	MP-S2	Greenburgh (Knollwood Golf Course)	Stabilize eroding banks; stormwater retrofit; improve buffer	0	2,400	3	$$$

ISM: Invasive Species Management
Stream: Stream Restoration
Reforest: Reforestation
$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Three pervious area management and restoration opportunities are available in the subwatershed (Table 6-34). Mohawk Camp and School on Old Tarrytown Road in Greenburgh presents perhaps the best opportunity for reforestation of over four acres. However, this may conflict with current land use for outdoor activities. The vacant lot on at the intersection of Tarrytown Road and Dobbs Ferry Road is small, but it is an opportunity for stream buffer enhancement.

Table 6-34: Pervious Area Management and Restoration Opportunities in the Manhattan Park Brook Subwatershed

Rank	Site ID	Location	Opportunity	Area (acres)	Cost Range
High	MP-P3	Greenburgh (Greenburgh Housing Authority complex on Manhattan Avenue)	Native species plantings with signage; benches; pathways	0.6	$$
Medium	MP-P1	Greenburgh (Vacant lot at the intersection of Tarrytown Road and Dobbs Ferry Road)	Reforestation; stream buffer enhancement	1.0	$
Low	MP-P2	Greenburgh (Mohawk Camp and School on Old Tarrytown Road)	Native tree plantings; educational signage	4.7	$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Source control opportunities for five neighborhoods are summarized in Table 6-35. Three of these neighborhoods are considered watershed priorities. These neighborhoods offered many opportunities for residential stewardship. Over 70 acres of rooftops could be disconnected and redirected to pervious areas. Other recommended activities include storm drain stenciling, household hazardous waste education, and stream buffer management.

Table 6-35: Neighborhood Source Control Opportunities in the Manhattan Park Brook Subwatershed

Rank	Site ID	Location	Opportunity	Area (acres)	Homes	Cost Range	Public
High	MP-N3	Greenburgh (Single family residential neighborhood bounded by Hillside Avenue, North Road, Winnetou Road, and the Manhattan Park Brook subwatershed boundary)	Rain barrels / downspout disconnection; lawn conversion, storm drain stenciling; household hazardous waste education; stream buffer management education and replanting	106	641	$$$	High
High	MP-N4	Greenburgh (Single family residential neighborhood bounded by Mclean Avenue, Hillside Avenue, I-287, and Manhattan Avenue)	Downspout disconnection / rain barrels; turf conversion; storm drain stenciling; household hazardous waste education	40	121	$	Medium
High	MP-N5	Greenburgh (Greenburgh Housing Authority Apartments off of Old Tarrytown Road)	Storm drain stenciling; dumpster management; downspout disconnection; lawn conversion - increased landscaping; catch basin cleanouts	7.9	--	$	High
Medium	MP-N1	Elmsford / Greenburgh (Single family residential neighborhood bounded by Knollwood Rd., Sprain Brook Parkway, and Sky Meadow Place)	Storm drain stenciling; downspout disconnection / rain barrels / rain gardens; homeowner lawn care education; turf conversion	167	505	$$$	High
Low	MP-N2	Greenburgh (Single family residential neighborhood along Winding Ridge Road)	Rain barrels / downspout disconnection; homeowner lawn care education	29	118	$	Medium

Area: Neighborhood Area
Homes: Approx. Number of Homes in Neighborhood
Public: Public Involvement Potential

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Two of the four hotspots opportunities identified in this subwatershed are publicly-owned; the other two are privately-owned (Table 6-36 and 6-37). The highest priority hotspot in this subwatershed is the Elmsford maintenance facility. This facility is in the process of moving to a new location (outside of the Bronx River); however the vehicle fueling services will remain here.

Table 6-36: Privately Owned Hotspot Management Opportunities in the Manhattan Park Brook Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
Medium	MP-H1	Greenburgh (Crossroads Plaza on Tarrytown Road)	Stormwater retrofit; improved dumpster management and material storage	Confirmed	$$$
Medium	MP-H5	Greenburgh (Gas station at the intersection of Tarrytown Road and Knollwood Road)	Follow-up site investigation; stormwater retrofit	Confirmed	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Table 6-37: Publicly Owned Hotspot Management Opportunities in the Manhattan Park Brook Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
High	MP-H6	Elmsford (Elmsford Maintenance Facility)	Retrofit fueling island with underground practice, cover, or catch basin insert	Severe	$$$
Medium	MP-H2	Greenburgh (Town of Greenburgh storage yard on Stadium Road)	Covered storage; stormwater retrofit	Potential	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Infrastructure assessment and trash removal opportunities are listed in Table 6-38. Greenburgh and Elmsford should follow up with these.

Table 6-38: Infrastructure Assessment and Trash Removal Opportunities in the Manhattan Park Brook Subwatershed			
Management Practice	**Reach**	**Location**	**Opportunity**
Infrastructure Assessment	Reach MP-5	Greenburgh (Reach MP-5)	Stabilize or retrofit broken outfalls in reach MP-5
	Reach MP-10	Greenburgh (Reach MP-10)	Repair exposed pipes in reach MP-10
	Reach MP-11	Greenburgh (Reach MP-11)	Repair exposed pipes in reach MP-11
	Reach MP-12	Greenburgh (Reach MP-12)	Repair exposed pipes in reach MP-12
	Reach MP-14	Greenburgh (Reach MP-14)	Stabilize or retrofit broken outfalls in reach MP-14
	Reach MP-14	Greenburgh (Reach MP-14)	Repair concrete weir in reach MP-14
	Reach MP-17	Greenburgh (Reach MP-17)	Repair exposed pipes in reach MP-17
Trash Removal	Reach MP-3	Elmsford (Reach MP-3)	Remove trash in reach MP-3
	Reach MP-4	Elmsford / Greenburgh (Reach MP-4)	Remove trash in reach MP-4
	Reach MP-7	Greenburgh (Reach MP-7)	Remove trash in reach MP-7
	Reach MP-14	Greenburgh (Reach MP-14)	Remove trash in reach MP-14

Subwatershed Treatment Analysis Results

The following assumptions were incorporated into the WTM to assess potential subwatershed treatment resulting from the subwatershed management strategy:

- Implement lawn care and pet waste education programs: *assumes 25% of homeowners in targeted areas are reached using methods such as newspaper articles*
- Improve erosion and sediment control program inspection and maintenance: *assumes more frequent inspection and willingness to levy fines for poor performance*
- Implement programs to encourage disconnect disconnection in residential areas: *assumes this is applicable to 50% of residential areas; that 30% of these residents are reached; and that 25% of those reached are willing to disconnect downspouts*
- Implement programs to encourage disconnect disconnection in commercial areas: *assumes this is applicable to 25% of commercial areas; that 100% of these property owners are reached; and that 20% of those reached are willing to disconnect downspouts*
- Construct upland stormwater retrofits: *assumes 30 impervious acres treated*
- Replant stream buffers: *assumes 0.5 stream miles replanted*
- Stabilize stream channels: *assumes 0.5 stream miles stabilized*
- Remove illicit connections: *assumes 90% of the sewer system will be surveyed for illicit connections and 80% of the illicit connections found will be corrected (WTM default)*

- Reduce sanitary sewer overflows: *assumes a target reduction of 80% of existing load and 80% of necessary repairs made (WTM default)*
- Enhance street sweeping efforts: *assumes same treatment area, but upgraded technology to vacuum assisted sweepers*

Potential load reductions that may obtained by implementing these practices are estimated at 19% and 16% for nutrients (total nitrogen and total phosphorus, respectively), 6% for sediment and close to 24% for bacteria. Table 6-39 and Figure 6-5 summarize the WTM results.

Lawn care education, pet waste education, and downspout disconnections account for 75% of the total nitrogen load reduction. For sediment, stormwater retrofits, street sweeping, and downspout disconnection combined account for almost 75% of the load reduction. Removing illicit connections and repairing sanitary sewer overflows account for almost 90% of total bacteria load reductions.

Table 6-39: Potential Pollutant Load Reduction that May Result from Manhattan Park Brook Subwatershed Management Strategy Implementation

	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)	Fecal Coliform (billions of colonies/yr)
Estimated Current Annual Load	13,716	1,620	576,506	694,459
Estimated Annual Load with Management Strategy	11,081	1,359	542,838	529,637
Potential Annual Pollutant Load Reduction	-19.2%	-16.1%	-5.8%	-23.7%

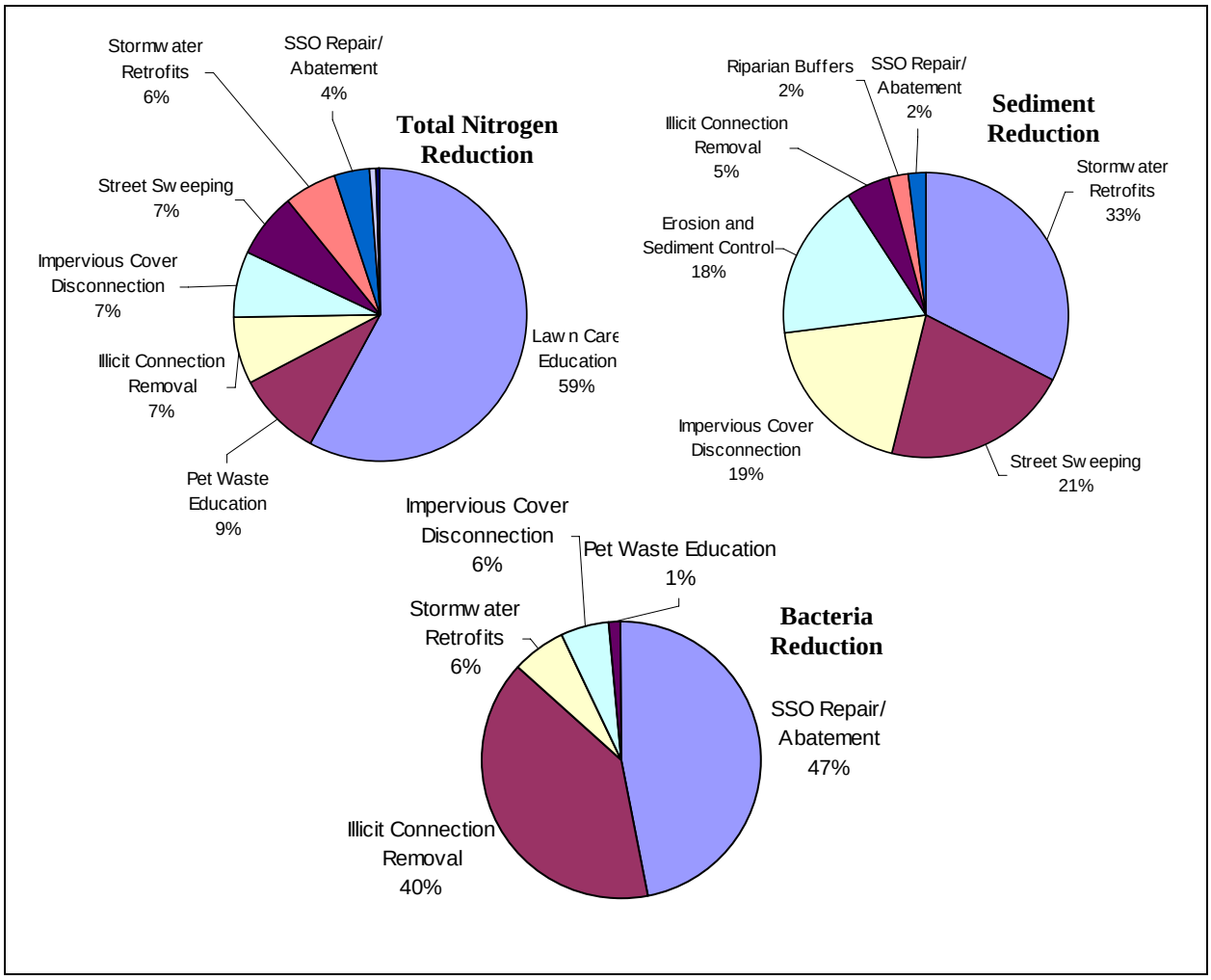


Figure 6-5: Potential Effect of Different Treatment Practices on Pollutant Load Reduction in the Manhattan Park Brook Subwatershed

Section 7. Other Subwatersheds

This section describes the 10 subwatersheds that were not selected for detailed planning and assessment. A basic description (i.e., land use, impervious cover, jurisdictions) of each subwatershed is provided. This is drawn primarily from the *Baseline Assessment* (CWP, 2006a), but in some cases, includes basic field observations about the subwatershed.

Although not priority subwatersheds, limited field assessments were conducted in some of these subwatersheds. For these subwatersheds, management and restoration practice opportunities are summarized by project type. The overall watershed ranking is provided, along with relative planning level cost information. For residential pollution prevention and source control education opportunities, the level of potential community involvement is also included. In addition, the subwatershed management strategies outline in Section 6 for the priority subwatersheds provide some insight into potential restoration opportunities and management priorities that may be applied in the remaining subwatersheds (Table 7-1).

Table 7.1: Bronx River Subwatershed Categorization

Non-Priority Subwatersheds	Representative Subwatershed
Bronx River Lower Direct Drainage	Bronx River Middle Direct Drainage
Bronx River Upper Direct Drainage	Bronx River Middle Direct Drainage
Clove Brook	Manhattan Park Brook
Davis Brook	Manhattan Park Brook
Fox Meadow Brook	Hartsdale Brook or Fulton Brook
Grassy Sprain Brook Direct Drainage	Grassy Sprain Brook
Kensico Reservoir	--
Sprain Brook	Grassy Sprain Brook
Troublesome Brook	Hartsdale Brook or Fulton Brook
White Plains Reservoirs	--

7.1 Bronx River Lower Direct Drainage (BRL)

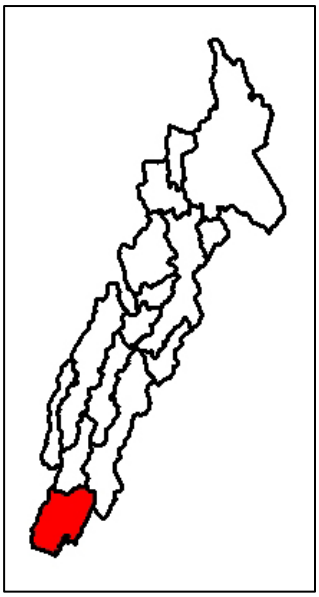


Table 7-2: Basic Profile of the Bronx River Lower Direct Drainage Subwatershed	
Management Group	• Subwatersheds drain to the mainstem of the Bronx River. Also includes Bronx River Middle Direct Drainage (BRM) and Bronx River Upper Direct Drainage (BRU) subwatersheds.
Drainage Area	• 2,117.9 acres (3.3 square miles)
Stream Length	• 2.4 miles
2004 Land Use & Water Coverage	• Residential (54.1%) • Non-Residential (24.4%) • Water (7.9%) • Open Space (7.8%) • Mixed (5.8%) • Undeveloped (0.0%)
Current Imperviousness	• 43.7% of subwatershed
Jurisdictions as Percent of Subwatershed	• Mount Vernon (19.5%) • Yonkers (80.5%)
Subwatershed Map	• See Map H-1 in Appendix H

Subwatershed Description

The Bronx River Lower Direct Drainage subwatershed is 3.3 square miles and borders the New York City portion of the Bronx River watershed. The subwatershed falls mainly within Yonkers though Mount Vernon also has jurisdiction within the drainage area.

The subwatershed contains 2.39 miles of the Bronx River mainstem; there are no surface tributaries to the mainstem in this subwatershed. Most of the mainstem, which is paralleled by the Bronx River Parkway, contains high amounts of legacy sediment. Portions of the Bronx River are over-widened and lack good riparian vegetative cover. Only 6.5% of the riparian corridor is forested; however 90% of the riparian corridor is publicly owned. Invasive plant species are prevalent throughout the subwatershed but attempts to control them are evident in some reaches.

Approximately 2% of the subwatershed is forested. This subwatershed contains very dense development; 54% of the land use is residential. Current impervious cover for the subwatershed is 43.7%, which is the highest of all subwatersheds. The estimated hotspot density is 14.4 hotspots per square mile, again the highest of all subwatersheds. The Yonkers Raceway and Cross County Mall are two notable land uses in the subwatershed (Figure 7-1). Redevelopment activities are taking place at both locations.

Upland assessments were not conducted in this subwatershed, but a few hotspots and potential stormwater retrofit locations were evaluated. Portions of the stream corridor were assessed. A map of this subwatershed (Map H-3) can be found in Appendix H.

Figure 7-1: Development activity at the Yonkers Raceway (left) and the Cross County Mall with dense residential development in the background (right).

Management and Restoration Practice Opportunities in the Subwatershed

The three upland stormwater retrofit opportunities identified are all considered low priority from an overall watershed perspective (Table 7-3). These include small projects at two schools – tree plantings and removal of impervious cover. The Cross County Mall was visited, but since it is undergoing some redevelopment activities, a retrofit concept was not developed. This may present an opportunity to incorporate demonstration stormwater management practices as redevelopment proceeds at the site.

A potential riparian corridor restoration project on the Bronx River was identified, beginning at the Broad Street crossing and continuing south to the Oak Street crossing (Table 7-4). Portions of the floodplain lack good vegetative cover and are mowed regularly. Invasive plant species are prevalent. Restoration and retrofit techniques that may be applied at this site include:

- Widening the riparian buffer by planting native trees and shrubs in open areas along the Bronx River Parkway.
- Stabilizing stormwater outfalls in the downstream left bank.
- Removing and managing the invasive plant species including but not limited to: Japanese knotweed, multiflora rose, garlic mustard and phragmites.
- Removing the unused path section and relocating the current path to expand floodplain wetland areas.
- Connecting the river to floodplain depressions through access channels and deepening depressions for flood storage.
- Diverting storm drains from the roadway at the exit ramp to a storage area in the cloverleaf.

Opportunities were identified at four privately owned hotspots to educate property owners on improved pollution prevention practices (Table 7-5). At the Lincoln BBQ restaurant, improved grease storage is a priority – traces of grease and wash water led to a nearby storm drain inlet. At two car washes assessed, it is suspected that wash water may be entering storm drain inlets. The need for improved dumpster management was also noted at several private businesses; this involves keeping dumpsters covered so that water does not get into, through, and out of the

dumpsters into nearby storm drain inlets. Finally, the need for covered storage for salt and other materials was noted at the Cross County Mall maintenance area.

Table 7-3: Upland Stormwater Retrofit Opportunities in the Bronx River Lower Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Cost Range
Medium	BRL-R2	Yonkers (AB Davis School)	Tree plantings in front of school and next to track	$
	BRL-R3	Yonkers (Franko School)	Convert asphalt to pervious area; pervious pavement	$
Low	BRL-R1	Mount Vernon (Cross County Mall)	Incorporate stormwater demonstration projects into new development plans	$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Table 7-4: Riparian Corridor Restoration Opportunities in the Bronx River Lower Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	ISM (acres)	Stream (linear feet)	Reforest (acres)	Cost Range
Medium	BRL-S1	Yonkers / Mount Vernon (Along the Bronx River from the Broad Street crossing to the Oak Street crossing)	Widen riparian buffer; stabilize stormwater outfall; remove and manage invasive plant species; reconnect and expand floodplain; stormwater retrofit	10	0	5	$$

ISM: Invasive Species Management
Stream: Stream Restoration
Reforest: Reforestation
$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Table 7-5: Privately Owned Hotspot Management Opportunities in the Bronx River Lower Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
High	BRL-H4	Mount Vernon (Lincoln BBQ Restaurant)	Secondary containment for grease storage; waste storage and wash water disposal education	Confirmed	$
Medium	BRL-H1	Yonkers (Cross County Mall)	Secondary containment for salt storage; catch basin inserts or other retrofit; pollution prevention education	Confirmed	$$$
Medium	BRL-H2	Mount Vernon (Bubble Bath Auto Spa)	Illicit discharge investigation	Potential	$
Low	BRL-H3	Mount Vernon (Commercial strip - car wash, auto repair, barbecue, two gas stations - near West Lincoln Avenue and North 8th Avenue)	Catch basin cleanouts; dumpster management, wash water disposal, and waste storage education; investigate car wash drainage	Potential	$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

7.2 Bronx River Upper Direct Drainage (BRU)

Table 7-6: Basic Profile of the Bronx River Upper Direct Drainage Subwatershed	
Management Group	• Subwatersheds drain to the mainstem of the Bronx River. Also includes Bronx River Lower Direct Drainage (BRL) and Bronx River Middle Direct Drainage (BRM) subwatersheds.
Drainage Area	• 3,213 acres (5.0 square miles)
Stream Length	• 5.8 miles
2004 Land Use & Water Coverage	• Residential (56.5%) • Non-Residential (23.9%) • Open Space (15.8%) • Water (1.5%) • Undeveloped (1.4%) • Mixed (0.8%)
Current Imperviousness	• 29.8%of subwatershed
Jurisdictions as Percent of Subwatershed	• Greenburgh (22.7%) • Mount Pleasant (4.4%) • North Castle (12.6%) • Scarsdale (15.9%) • White Plains (44.4%)
Subwatershed Map	• See Map H-3 in Appendix H

Subwatershed Description

The Bronx River Upper Direct Drainage subwatershed drains five-square miles across White Plains, Greenburgh, Scarsdale, North Castle, and Mount Pleasant. In this subwatershed, the mainstem of the Bronx River extends from the base of the Kensico Reservoir to the confluence with Fox Meadow Brook. The Bronx River and some small tributaries total to 5.8 miles of streams.

Much of the mainstem contains large amounts of legacy sediment. The channel planform geometry is relatively stable; no major sites of active bank scour were observed. Certain sections of the stream have been dammed, and sediment is filling the ponds behind the dams. Portions of the stream are over-wide and lack good vegetative cover.

A significant portion of the stream corridor was set aside in the 1920's for the Bronx River Parkway, which now parallels the channel for much of its length. More than a third (39%) of the riparian corridor is forested and 64% of the riparian corridor is publicly owned.

Invasive plant species are prevalent throughout the watershed; however, attempts to control them are evident in some reaches. Approximately 20% of the subwatershed is forested and 29.8% is impervious cover. The predominant land use in the subwatershed is residential. In the northern portion of the subwatershed, industrial and transport-related land use is adjacent to the stream corridor (Figure 7-2).

Upland assessments were not conducted in this subwatershed, but a few hotspots were evaluated. The stream corridor was assessed. A map of this subwatershed (Map H-3) can be found in Appendix H.

Figure 7-2: Typical land use and activities observed along Lafayette Avenue in the northern portion of the Bronx River Upper Direct Drainage subwatershed.

Management and Restoration Practice Opportunities in the Subwatershed

The stormwater retrofit opportunity identified is considered low priority from an overall watershed perspective (Table 7-7). The concept involves allowing Fulton Brook to overtop its banks into the forested area behind the Verizon Building to provide treatment. However, this would require tree removal and excavation, and there is not enough area to provide sufficient water quality treatment.

Several riparian corridor restoration opportunities are available in the subwatershed (Table 7-8). One of these, along the Bronx River Parkway under the Interstate 287 crossing, is considered a watershed priority. A more detailed concept for this site is provided in Appendix J. The other sites are considered medium priorities from an overall watershed perspective.

Site BRU-S2 extends from the Fisher Lane Bridge crossing south approximately 2,400 feet to the Cemetery Road crossing, and site BRU-S3 extends from the County Center parking area access bridge crossing north approximately 3,400 feet to the Cemetery Road crossing. At both locations, vegetative cover is lacking, the area is mowed regularly, and invasive species are prevalent. There are some existing depression areas that occasionally receive overbank flood waters. Restoration and retrofit techniques that may be applied at both sites include:

- Widening the riparian buffer by planting native trees and shrubs in open areas along the Bronx River Parkway.
- Removing and managing the invasive plant species.
- Expanding and enhancing floodplain wetland areas.
- Diverting stormwater flow from the mainstem Bronx River into stormwater retrofit areas in the open areas of the Bronx River Parkway.

Site BRU-S4 is along a small tributary to the Bronx River. This reach begins in a wooded area north of Edge Park Road and west of the Bronx River Parkway that receives stormwater from a residential area. A decommissioned railroad berm with a blocked and undersized culvert causes the area to flood. The culverted stream passes under the Parkway for 250 feet and resurfaces in the floodplain east of the Parkway where it is then channelized. Invasive plant species are prevalent. Recommended restoration and retrofit techniques are similar to the other sites: remove and manage invasive plant species; expand and enhance floodplain wetlands; and create stormwater overflow areas along the Parkway.

Several private businesses along Lafayette Avenue were assessed as potential hotspots (Table 7-9). Due to limited access, these assessments were limited and follow-up inspections are warranted at all of the light-industrial operations along this road. An assessment was also attempted at the Metro North Welfare Facility on Fisher Lane, but again, due to limited access, a follow-up inspection is recommended for this and for all other Metro facilities in the watershed.

Finally, discharge investigation and infrastructure assessment opportunities are listed in Table 7-10. The appropriate municipalities should follow up with these.

Table 7-7: Upland Stormwater Retrofit Opportunities in the Bronx River Upper Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Cost Range
Low	BRU-R1	White Plains (Verizon Building near the County Center)	Forested wetland	$$$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Table 7-8: Riparian Corridor Restoration Opportunities in the Bronx River Upper Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	ISM (acres)	Stream (linear feet)	Reforest (acres)	Cost Range
High	BRU-S1	Greenburgh / White Plains (Between Old Kensico Road and the Bronx River Parkway under the Interstate 287 crossing)	Stormwater retrofit; reforestation; remove and manage invasive plant species; widen buffer	0	0	1	$
Medium	BRU-S2	White Plains (In north White Plains, along the Bronx River from the Fisher Lane Bridge crossing south to the Cemetery Road crossing)	Widen riparian buffer; remove and manage invasive plant species; expand floodplain; stormwater retrofit	5	0	2	$

Table 7-8: Riparian Corridor Restoration Opportunities in the Bronx River Upper Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	ISM (acres)	Stream (linear feet)	Reforest (acres)	Cost Range
	BRU-S3	White Plains (Along the Bronx River from the County Center parking lot access bridge north to the Cemetery Road crossing)	Widen riparian buffer; remove and manage invasive plant species; expand floodplain wetland area; stormwater retrofit	5	0	10	$$
	BRU-S4	Greenburgh / North Castle (Along a tributary to the Bronx River, extending from Edge Park Road east to the confluence with the Bronx River)	Remove and manage invasive plant species; expand floodplain wetland; stormwater retrofit	2	0	0	$$

ISM: Invasive Species Management
Stream: Stream Restoration
Reforest: Reforestation

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Table 7-9: Privately Owned Hotspot Management Opportunities in the Bronx River Upper Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
Medium	BRU-H1	North Castle (Aggregate loading operation on Lafayette Avenue)	Covered material storage; stabilized entranceway	Potential	$$
High	BRU-H2	North Castle (Metro North Welfare Facility on Fisher Lane)	Follow-up site investigation; pollution prevention plan review	Potential	$
Low	BRU-H3	North Castle (A&C Furia Electric Motor Company on Lafayette Avenue)	Follow-up site investigation	Potential	$
Low	BRU-H4	North Castle (Michael Bellatoni Landscaping on Lafayette Avenue)	Follow-up site investigation	Potential	$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Table 7-10: Discharge Investigation and Infrastructure Assessment Opportunities in the Bronx River Upper Direct Drainage Subwatershed

Management Practice	Reach	Location	Opportunity
Discharge Investigation	Reach BRU-1	Greenburgh / North Castle (Reach BRU-1)	Investigate discharge at outfall OT-1 in reach BRU-1
	Reach BRU-3	Greenburgh / White Plains (Reach BRU-3)	Investigate discharge at outfall OT-1 in reach BRU-3
Infrastructure Assessment	Reach BRU-5	White Plains (Reach BRU-5)	Repair culvert reach BRU-5
	Reach BRU-5	White Plains (Reach BRU-5)	Stabilize outfall OT-4 in reach BRU-5
	Reach BRU-8	Greenburgh / Scarsdale (Reach BRU-8)	Repair culvert in reach BRU-8

7.3 Clove Brook (CB)

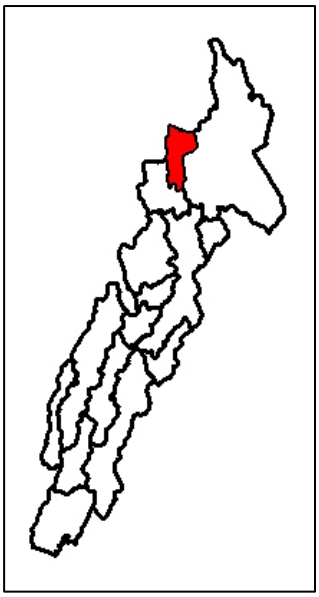


Table 7-11: Basic Profile of the Clove Brook Subwatershed	
Management Group	• Subwatersheds draining to northern Bronx River tributaries. Also includes Davis Brook (DB) and Manhattan Park Brook (MP) subwatersheds.
Drainage Area	• 848 acres (1.3 square miles)
Stream Length	• 1.8 miles
2004 Land Use & Water Coverage	• Non-Residential (36.2%) • Water (4.5%) • Residential (32.3%) • Open Space (0.4%) • Undeveloped (26.7%) • Mixed (0.0%)
Current Imperviousness	• 15.7% of subwatershed
Jurisdictions as Percent of Subwatershed	• Mount Pleasant (100%)
Subwatershed Map	• See Map H-4 in Appendix H

Subwatershed Description

The Clove Brook subwatershed drains 1.3 square miles in Mount Pleasant. There are 1.84 miles of stream in this subwatershed, and the headwaters have been impounded by small ponds.

The subwatershed appears to be stable from a geomorphic standpoint; less than 10% of the channel had areas of minor bank scour. In the upper subwatershed, the stream has good access to the floodplain. Approximately 65% of the riparian buffer is forested, and less than 1% of the riparian corridor is publicly owned.

Over 13% of Clove Brook subwatershed is covered with wetlands. Approximately 48% of the subwatershed is forested; there is a large contiguous forest tract in the headwaters of the subwatershed. The downstream reaches have been impacted by residential development. Impacts from this development have caused channelization and a reduced buffer width.

Over 30% of subwatershed is residential; however 26.7% of the subwatershed is undeveloped. Current impervious cover for the subwatershed is 15.7%. This subwatershed has some schools and corporate complexes, and contains the old Kensico waterworks facilities and NYC DEP reservoir offices. A corporate center, the Summit, has its own maintenance facility and stormwater management is present. Also present is a large Pepsi corporate office and a Christian conference center.

Upland assessments were not conducted in this subwatershed, but a couple of potential stormwater retrofits were evaluated. Portions of the stream corridor were assessed. A map of this subwatershed (Map H-4) can be found in Appendix H.

Management and Restoration Practice Opportunities in the Subwatershed

Two stormwater retrofit opportunities in the subwatershed are considered medium priorities from the overall watershed perspective (Table 7-12). The first is at the old Kensico Treatment Facilities. Several opportunities are available at this location due to available space. However, future planned use of the area is unknown. Bioretention may be used to treat runoff from the road, and pervious pavers are an option for the boat storage area.

The Legionnaires of Christ Conference Center has significant parking areas that appear to get sporadic use. This presents an opportunity to pursue volume reducing practices through the use of grass or pervious pavers, infiltration trenches, and swales.

Discharge investigation, infrastructure assessment, and trash removal opportunities are listed in Table 7-13. Mount Pleasant should follow up with these.

Table 7-12: Upland Stormwater Retrofit Opportunities in the Clove Brook Subwatershed

Rank	Site ID	Location	Opportunity	Cost Range
Medium	CB-R1	Mount Pleasant (Old Kensico Treatment Facilities)	Bioretention; pervious pavement	$$
	CB-R2	Mount Pleasant (Legionnaires of Christ Conference Center)	Pervious pavers; infiltration trenches; swales; tree planting	$$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Table 7-13: Discharge Investigation, Infrastructure Assessment, and Trash Removal Opportunities in the Clove Brook Subwatershed

Management Practice	Reach	Location	Opportunity
Discharge Investigation	Reach CB-7	Mount Pleasant (Reach CB-7)	Investigate potential sewer leak in reach CB-7
Infrastructure Assessment	Reach CB-6	Mount Pleasant (Reach CB-6)	Repair V-notch weir in reach CB-6
Trash Removal	Reach CB-6	Mount Pleasant (Reach CB-6)	Remove trash in reach CB-6 from the riparian area and from behind the grate on the outlet from the reservoir

7.4 Davis Brook (DB)

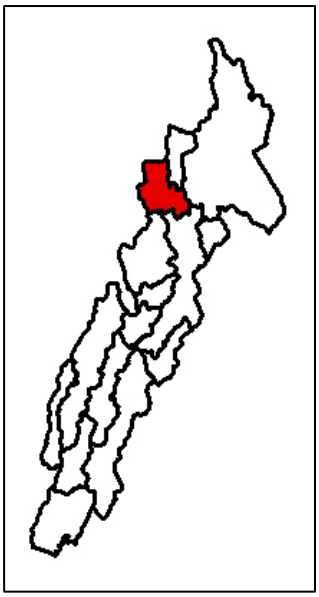


Table 7-14: Basic Profile of the Davis Brook Subwatershed	
Management Group	• Subwatersheds draining to northern Bronx River tributaries. Also includes Clove Brook (CB) and Manhattan Park Brook (MP) subwatersheds.
Drainage Area	• 1,373 acres (2.1 square miles)
Stream Length	• 3.2 miles
2004 Land Use & Water Coverage	• Non-Residential (60.7%) • Residential (18.8%) • Undeveloped (13.9%) • Open Space (5.3%) • Mixed (1.1%) • Water (0.3%)
Current Imperviousness	• 13.4% of subwatershed
Jurisdictions as Percent of Subwatershed	• Greenburgh (1.0%) • Mount Pleasant (99.0%)
Subwatershed Map	• See Map H-5 in Appendix H

Subwatershed Description

The 2.1 square mile Davis Brook subwatershed is in Mount Pleasant and Greenburgh. There are 3.21 miles of streams in this headwater subwatershed; a series of wetlands on Davis Brook in Valhalla is identified as the headwaters of the Bronx River.

Most of the Davis Brook has a limited floodplain, and in many areas it is highly entrenched. Invasive species are the dominant vegetation in some areas, especially in the lower end of the subwatershed. Thirty-six percent of the riparian buffer is forested; about 10% of the riparian area is publicly owned. Most of the banks are stable, and there are some areas of good physical habitat. In the lower reaches the stream is contained in culverts for long stretches and impacted by poorly aligned stream crossings.

The current imperviousness of the subwatershed is 13.4%, and it has approximately 30% forest cover. The predominant land use is non-residential at 60.7%. A significant portion of the subwatershed is cemeteries and associated business enterprises. The County's Grasslands facility is in the subwatershed (Figure 7-3), and both the New York Transit Authority's railway and the Taconic Parkway parallel portions of the stream. Over 190 acres of undeveloped land still remains in the subwatershed.

Upland assessments were not conducted in this subwatershed, but a few hotspots were evaluated. The stream corridor was assessed and several riparian corridor restoration opportunities were identified. A map of this subwatershed (Map H-5) can be found in Appendix H.

Figure 7-3: The County's Grasslands facility in the Davis Brook subwatershed

Management and Restoration Practice Opportunities in the Subwatershed

Five riparian corridor restoration opportunities are available in this subwatershed (Table 7-15). Site DB-S1 at the County's DPW Grasslands Facility is considered a high priority from the overall watershed perspective. A concept design for this site is provided in Appendix J. Concept designs were also developed for sites DB-S2, along the Davis Brook near the intersection of Lakeview Avenue and Taconic State Parkway, and DB-S3, at the train station parking lot in Valhalla.

Two additional riparian corridor restoration opportunities are considered low priority from the overall watershed perspective. Recommendations for site DB-S4, along the Davis Brook near the Commerce Street crossing, include: removing and managing invasive plant species, expanding and enhancing floodplain wetlands, and providing stormwater treatment between the rock gym parking lot and the floodplain wetland. Recommendations for site DB-S5, along the Davis Brook near Lakeview Avenue, include replacing the failing concrete structure with a natural channel design grade control structure; removing and managing invasive plant species; and enhancing the wetland seep area.

At both privately-owned hotspots assessed (Table 7-16), covered storage is recommended. The County's DPW Grasslands Facility was evaluated as a severe, high priority stormwater hotspot (Table 7-17). The County should conduct a thorough review of operations at the facility.

Discharge investigation, infrastructure assessment, and trash removal opportunities are listed in Table 7-18. Mount Pleasant should follow up with these.

Table 7-15: Riparian Corridor Restoration Opportunities in the Davis Brook Subwatershed

Rank	Site ID	Location	Opportunity	ISM (acres)	Stream (linear feet)	Reforest (acres)	Cost Range
High	DB-S1	Mount Pleasant (Westchester County DPW Grasslands facility)	Remove and manage invasive plant species; expand/enhance floodplain; realign stream; stormwater retrofit	10	1,200	2	$$
Medium	DB-S2	Mount Pleasant (Along the Davis Brook, at a monument business near the intersection of Lakeview Avenue and Taconic State Parkway)	Remove and manage invasive plant species; expand floodplain; realign stream; stormwater retrofit	2	1,000	2	$$
	DB-S3	Mount Pleasant (Train station parking lot in Valhalla)	Remove blockage at water main crossing; remove and manage invasive plant species; expand floodplain; stormwater retrofit	1	500	0	$$
Low	DB-S4	Mount Pleasant (Along the Davis Brook from the Commerce Street crossing south between the Taconic State Parkway and the parking lot of a rock gym)	Remove and manage invasive plant species; expand floodplain; stormwater retrofit	5	0	0	$
	DB-S5	Mount Pleasant (Along Davis Brook, 300 feet south of Lakeview Avenue along a landscaping business)	Natural grade control structure; remove and manage invasive plant species; enhance wetland seep	1	1,000	0	$$

ISM: Invasive Species Management
Stream: Stream Restoration
Reforest: Reforestation

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Table 7-16: Privately Owned Hotspot Management Opportunities in the Davis Brook Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
Low	DB-H1	Mount Pleasant (Businesses along Railroad Avenue near Lakeview Avenue, includes monuments, car repair, tree service, and land excavation businesses)	Stormwater retrofit; lot paving; covered materials storage	Potential	$$$
Low	DB-H2	Mount Pleasant (Grayrock Florist and Memorials)	Covered material storage; materials storage education	Potential	$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Table 7-17: Publicly Owned Hotspot Management Opportunities in the Davis Brook Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
High	DB-H4	Mount Pleasant (Westchester County DPW Grasslands facility)	Underground practice maintenance; pollution prevention plan review; wetland / buffer encroachment and dumping education	Severe	$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Table 7-18: Discharge Investigation, Infrastructure Assessment, and Trash Removal Opportunities in the Davis Brook Subwatershed

Management Practice	Reach	Location	Opportunity
Discharge Investigation	Reach DB-7	Mount Pleasant (Reach DB-7)	Investigate discharge at outfall OT-2 in reach DB-7
Infrastructure Assessment	Reach DB-8	Mount Pleasant (Reach DB-8)	Stabilize broken outfalls in reach DB-8
Trash Removal	Reach DB-4	Mount Pleasant (Reach DB-4)	Remove trash in reach DB-4
	Reach DB-7	Mount Pleasant (Reach DB-7)	Remove trash in reach DB-7; monitor for illegal dumping
	Reach DB-8	Mount Pleasant (Reach DB-8)	Remove trash in reach DB-8

7.5 Fox Meadow Brook (FMB)

Table 7-19: Basic Profile of the Fox Meadow Brook Subwatershed		
Management Group	• Subwatersheds draining to middle Bronx River tributaries. Also includes Fulton Brook (FB), Hartsdale Brook (HB), and Troublesome Brook (TB) subwatersheds.	
Drainage Area	• 928 acres (1.5 square miles)	
Stream Length	• 2.2 miles	
2004 Land Use & Water Coverage	• Residential (88.9%) • Open Space (6.8%) • Non-Residential (4.2%)	• Undeveloped (0.1%) • Mixed (0.0%) • Water (0.0%)
Current Imperviousness	• 19.9% of subwatershed	
Jurisdictions as Percent of Subwatershed	• Scarsdale (91.4%)	• White Plains (8.6%)
Subwatershed Map	• See Map H-6 in Appendix H	

Subwatershed Description

The 1.5 square mile Fox Meadow Brook subwatershed is in Scarsdale and White Plains. There are 2.18 stream miles in this subwatershed. Roughly 19% of the stream corridor is publicly owned and 32% is forested.

Current impervious cover for the subwatershed is 19.9%. Ninety percent of the subwatershed is in residential land use. Non-residential land use is minimal, and the hotspot density is only two hotspots per square mile.

Field assessments were not conducted in this subwatershed. A map of this subwatershed (Map H-6) can be found in Appendix H.

7.6 Grassy Sprain Brook Direct Drainage (GSD)

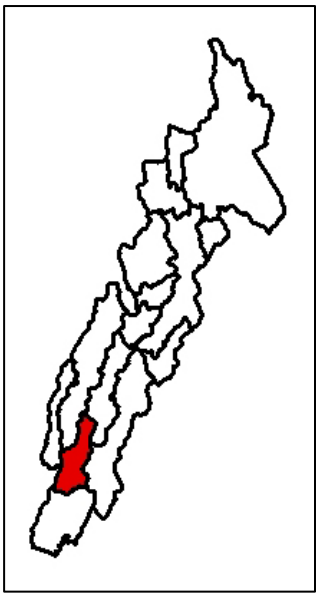


Table 7-20: Basic Profile of the Grassy Sprain Brook Direct Drainage Subwatershed	
Management Group	• Subwatersheds drain to Grassy Sprain Brook, the largest tributary to the Bronx River. Also includes Grassy Sprain Brook (GSB) and Sprain Brook (SB) subwatersheds.
Drainage Area	• 1,263 acres (2.0 square miles)
Stream Length	• 1.4 miles
2004 Land Use & Water Coverage	• Residential (63.3%) • Non-Residential (31.9%) • Open Space (2.2%) • Mixed (1.3%) • Undeveloped (1.3%) • Water (0.0%)
Current Imperviousness	• 34.6% of subwatershed
Jurisdictions as Percent of Subwatershed	• Yonkers (100%)
Subwatershed Map	• See Map H-9 in Appendix H

Subwatershed Description

The Grassy Sprain Brook Direct Drainage subwatershed is at the mouth of the Grassy Sprain Brook, the largest tributary to the Bronx River. The subwatershed drains 2.0 square miles in Yonkers. There are 1.37 estimated stream miles in this subwatershed, of which 13% has a forested riparian buffer. Only 3% of the stream corridor is publicly owned.

Current impervious cover for the subwatershed is 34.6% and only 11% of the subwatershed is forested. The predominant land use in the subwatershed is residential, at 63.3%. The estimated hotspot density is eight hotspots per square mile. A notable hotspot observed during field work is the salt storage area for the City of Yonkers (Figure 7-4).

Field assessments were not conducted in this subwatershed, but one potential hotspot was evaluated. A map of this subwatershed (Map H-9) can be found in Appendix H.

Figure 7-4: Salt storage area in City of Yonkers

Management and Restoration Practice Opportunities in the Subwatershed

One stormwater hotspot was assessed in the subwatershed – a salt storage area for the City of Yonkers (Table 7-21). This is located at the top of a hill above the Grassy Sprain, surrounded by wooded area. There is no containment, and salt was traced to storm drain inlets. If possible, a cover for stored salt would be desirable. In addition, stormwater retrofits at storm drain inlets should be considered.

Table 7-21: Publicly Owned Hotspot Management Opportunities in the Grassy Sprain Brook Direct Drainage Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
Medium	GSD-H1	Yonkers (City of Yonkers salt storage)	Covered salt storage area; stormwater retrofit	Confirmed	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

7.7 Kensico Reservoir (KR)

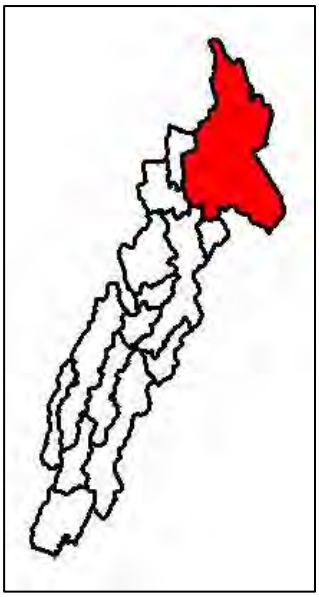


Table 7-22: Basic Profile of the Kensico Reservoir Subwatershed	
Management Group	• Subwatersheds drain to water supply reservoirs. Also includes White Plains Reservoirs subwatershed.
Drainage Area	• 7,948 acres (12.4 square miles)
Stream Length	• 12.2 miles
2004 Land Use & Water Coverage	• Water (52.0%) • Residential (24.5%) • Non-Residential (13.1%) • Open Space (6.6%) • Undeveloped (3.5%) • Mixed (0.3%)
Current Imperviousness	• 6.0% of subwatershed
Jurisdictions as Percent of Subwatershed	• Harrison (9.9%) • Mount Pleasant (25.4%) • New Castle (4.6%) • North Castle (59.9%) • White Plains (0.1%)
Subwatershed Map	• See Map H-11 in Appendix H

Subwatershed Description

The Kensico Reservoir subwatershed drains 12.4 square miles in North Castle, Harrison, Mount Pleasant, New Castle, and White Plains. The Kensico Reservoir is one of many components in the New York City water supply system. It has a capacity of 30.6 billion gallons, stores water from the Catskill and Delaware aqueducts, and supplies 85% of Westchester County residents and New York City with drinking water. According to Malcolm Pirnie, 1975, there is no hydraulic connection between the Kensico Reservoir and the downstream section of the Bronx River. There is, however, a connection between the reservoir and Davis Brook, a tributary to the Bronx River. Also, the large fountain pools in front of the Kensico Dam (Figure 7-5), when in operation, are filled with water drained from the Kensico Reservoir. This water circulates through the fountain pools and is discharged directly into the Bronx River (Doscher, 2005).

There are approximately 12.17 miles of stream in the subwatershed. Approximately 9% of the stream corridor is publicly owned and 68% is forested. Current impervious cover for the subwatershed is 6.0%, and 47.5% of the subwatershed is forested. Almost a quarter of the land use is residential.

Field assessments were not conducted in this subwatershed. A map of this subwatershed (Map H-11) can be found in Appendix H.

Figure 7-5: The Kensico Reservoir dam

7.8 Sprain Brook (SB)

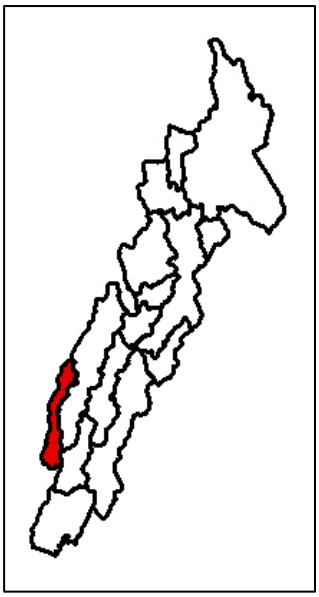


Table 7-23: Basic Profile of the Sprain Brook Subwatershed	
Management Group	• Subwatersheds drain to Grassy Sprain Brook, the largest tributary to the Bronx River. Also includes Grassy Sprain Brook (GSB) and Grassy Sprain Brook Direct Drainage (GSD) subwatersheds.
Drainage Area	• 1,088 acres (1.7 square miles)
Stream Length	• 7.6 miles
2004 Land Use & Water Coverage	• Residential (50.0%) • Non-Residential (23.7%) • Open Space (21.3%) • Undeveloped (4.6%) • Mixed (0.4%) • Water (0.1%)
Current Imperviousness	• 22.0% of subwatershed
Jurisdictions as Percent of Subwatershed	• Greenburgh (29.3%) • Yonkers (70.7%)
Subwatershed Map	• See Map H-13 in Appendix H

Subwatershed Description

Sprain Brook drains to the Grassy Sprain Brook, which is the largest tributary to the Bronx River. The Sprain Brooks subwatershed is 1.7 square miles within Greenburgh and Yonkers. There are approximately 3.35 miles of streams in the subwatershed, which have been highly impacted by the New York State Thruway (Interstate 87).

The Thruway has confined the stream to a small floodplain along much of its mainstem. Much of the mainstem has been entrenched or contained in culverts, and the riparian vegetation consists of a mix of native and invasive species. The buffer is limited by roadways on both sides of the stream for large sections of its lower reaches, and is forested along 28% of its length. Approximately 12% of the stream corridor is publicly owned. Despite these impacts, areas of good in stream habitat are present, especially in the headwaters.

Wetlands cover over 10% of the subwatershed, mostly in its northern portion. Current impervious cover for the subwatershed is 22%, and almost 30% of the subwatershed is forested.

About half of the land use in the subwatershed is residential, and about one-quarter is non-residential. Notable publicly-owned land uses in the subwatershed include the City of Yonkers Water Works Building / Sign Shop, the Westchester County Resource Recovery Center, and a toll plaza for the Thruway (Figure 7-6).

Upland assessments were not conducted in this subwatershed, but a hotspot and a few upland stormwater retrofit opportunities were identified. The stream corridor was assessed. A map of this subwatershed (Map H-13) can be found in Appendix H.

Figure 7-6: Publicly-owned location in the Sprain Brook subwatershed, including the City of Yonkers Water Works facility (top); the Westchester County Resource Recover facility (bottom left); and a toll plaza on the New York State Thruway.

Management and Restoration Practice Opportunities in the Subwatershed

Several stormwater retrofit opportunities on publicly-owned land are available in the subwatershed (Table 7-24). At the City of Yonkers Water Works Building, an underground treatment practice, such as a perimeter sand filter, is recommended.

A large, grassy right-of-way adjacent to the toll plaza on the New York State Thruway presents an opportunity to create a stormwater wetland using the existing drainage infrastructure. Standing water in a large, paved pull-off next to this area is indicative of site drainage; a portion of this paved area could be converted into a preliminary treatment cell for the proposed wetland. A low priority retrofit opportunity near this site (SB-R5) would involve creating a dry swale and a stormwater wetland in the exit ramp clover to provide treatment of runoff from the Thruway.

Numerous opportunities to apply bioretention, sand filters, and additional inlet treatment exist at the Westchester County Resource Recovery Center. The Sprain Ridge Park and Ride is a new, large parking lot that does not have any stormwater management practices. Existing landscaped areas can be converted to bioretention facilities, and additional bioretention islands can be created throughout the parking lot.

One hotspot was assessed in the subwatershed, the City of Yonkers Water Works Building and Sign Shop (Table 7-25). This is a confirmed hotspot and is considered a watershed priority. Uncovered storage; dumping of asphalt, paint, and other materials; and encroachment on the Sprain Brook were observed. Opportunities include providing covered material storage; providing treatment of stormwater runoff; providing education on proper material storage and disposal; and increasing general awareness and stewardship of the Sprain Brook.

Discharge investigation, infrastructure assessment, and trash removal opportunities are listed in Table 7-26. Greenburgh and Yonkers should follow up with these.

Table 7-24: Upland Stormwater Retrofit Opportunities in the Sprain Brook Subwatershed

Rank	Site ID	Location	Opportunity	Cost Range
High	SB-R1	Yonkers (City of Yonkers Water Works Building / Sign Shop)	Move traffic operations maintenance to different location; pollution prevention; perimeter sand filter	$$$
Medium	SB-R3	Yonkers (Toll plaza on New York State Thruway)	Stormwater wetland	$$
	SB-R4	Greenburgh (Sprain Ridge Park and Ride)	Bioretention	$$
	SB-R6	Yonkers (Westchester County Resource Recovery Center)	Bioretention; sand filters; inlet treatment	$$
Low	SB-R2	Yonkers (Yonkers Ice Rink)	Underground practice (e.g., sand filter)	$$
	SB-R5	Yonkers (New York State Thruway right-of-way, adjacent to Home Depot)	Swale; stormwater wetland	$$$
	SB-R7	Yonkers (Home Depot, adjacent to New York State Thruway)	Perimeter sand filter	$$

$: Estimated Planning Level Cost ≤ $100,000
$$: $100,000 < Estimated Planning Level Cost ≤ $500,000
$$$: Estimated Planning Level Cost > $500,000

Table 7-25: Publicly Owned Hotspot Management Opportunities in the Sprain Brook Subwatershed

Rank	Site ID	Location	Opportunity	Hotspot Status	Cost Range
High	SB-H1	Yonkers (City of Yonkers Water Works Building / Sign Shop)	Covered storage; stormwater retrofit; materials storage and proper disposal of paint and asphalt education; increased stewardship of Sprain Brook	Confirmed	$$$

$: Estimated Planning Level Cost ≤ $10,000
$$: $10,000 < Estimated Planning Level Cost ≤ $25,000
$$$: Estimated Planning Level Cost > $25,000

Table 7-26: Discharge Investigation, Infrastructure Assessment, and Trash Removal Opportunities in the Sprain Brook Subwatershed			
Management Practice	**Reach**	**Location**	**Opportunity**
Discharge Investigation	Reach SB-6	Yonkers (Reach SB-6)	Investigate discharge at outfall OT-1 in reach SB-6
	Reach SB-12	Greenburgh (Reach SB-12)	Investigate discharge at outfall OT-2 in reach SB-12
Infrastructure Assessment	Reach SB-2	Yonkers (Reach SB-2)	Remove sediment and debris blocking the culvert under the old railroad grade in reach SB-2
	Reach SB-6	Yonkers (Reach SB-6)	Stabilize the outfalls in reach SB-6
	Reach SB-12	Greenburgh (Reach SB-12)	Stabilize the outfalls in reach SB-12
Trash Removal	Reach SB-2	Yonkers (Reach SB-2)	Remove trash in reach SB-2
	Reach SB-4	Yonkers (Reach SB-4)	Remove trash in reach SB-4
	Reach SB-10	Greenburgh (Reach SB-10)	Remove trash in reach SB-10
	Reach SB-12	Greenburgh (Reach SB-12)	Remove trash in reach SB-12
	Reach SB-13	Greenburgh (Reach SB-13)	Remove trash in reach SB-13
	Reach SB-15	Greenburgh (Reach SB-15)	Remove trash in reach SB-15
	Reach SB-17	Greenburgh (Reach SB-17)	Remove trash in reach SB-17
	Reach SB-18	Yonkers (Reach SB-18)	Remove trash in reach SB-18
	Reach SB-19	Yonkers (Reach SB-19)	Remove trash in reach SB-19
	Reach SB-20	Yonkers (Reach SB-20)	Remove trash in reach SB-20
	Reach SB-22	Yonkers (Reach SB-22)	Remove trash in reach SB-22
	Reach SB-24	Yonkers (Reach SB-24)	Remove trash in reach SB-24

7.9 Troublesome Brook (TB)

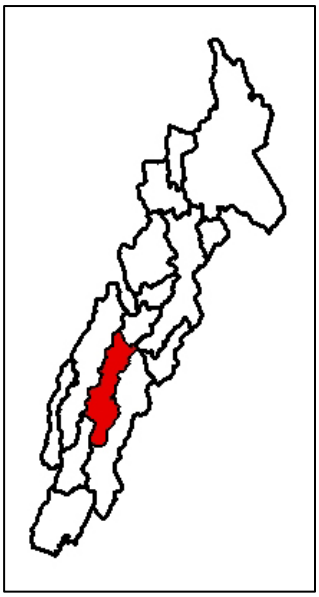


Table 7-27: Basic Profile of the Troublesome Brook Subwatershed		
Management Group	• Subwatersheds draining to middle Bronx River tributaries. Also includes Hartsdale Brook (HB), Fox Meadow Brook (FMB), and Fulton Brook (FB) subwatersheds.	
Drainage Area	• 1,725 acres (2.7 square miles)	
Stream Length	• 2.1 miles	
2004 Land Use & Water Coverage	• Residential (75.5%) • Non-Residential (18.6%) • Open Space (4.6%)	• Water (0.8%) • Undeveloped (0.5%) • Mixed (0.1%)
Current Imperviousness	• 29.6% of subwatershed	
Jurisdictions as Percent of Subwatershed	• Greenburgh (40.8%)	• Yonkers (59.2%)
Subwatershed Map	• See Map H-14 in Appendix H	

Subwatershed Description

The Troublesome Brook subwatershed is 2.7 square miles across Yonkers and Greenburgh. There are approximately 2.7 stream miles in the subwatershed. Only 10% of the stream corridor is forested, and only 11% is in public ownership.

Current imperviousness of the subwatershed is 29.6%, and 15% is forested. Much like Fulton Brook and Hartsdale Brook, this subwatershed is bisected by Central Avenue (Route 100), which is lined with extensive commercial development (Figure 7-7). Three-quarters of the subwatershed is in residential land use.

Field assessments were not conducted in this subwatershed. A map of this subwatershed (Map H-14) can be found in Appendix H.

Figure 7-7: Commercial land uses observed along Central Avenue in the Troublesome Brook subwatershed included a carwash (left) and a restaurant with grease storage in the rear (right).

7.10 White Plains Reservoirs (WPR)

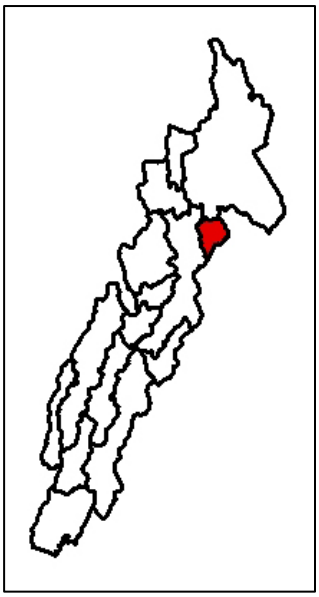


Table 7-28: Basic Profile of the White Plains Reservoirs Subwatershed		
Management Group	• Subwatersheds drain to water supply reservoirs. Also includes Kensico Reservoir subwatershed.	
Drainage Area	• 576 acres (0.9 square miles)	
Stream Length	• 0.1 miles	
2004 Land Use & Water Coverage	• Water (72.1%) • Undeveloped (12.0%) • Open Space (8.7%)	• Residential (7.2%) • Mixed (0.0%) • Non-Residential (0.0%)
Current Imperviousness	• 1.7% of subwatershed	
Jurisdictions as Percent of Subwatershed	• Harrison (16.7%) • North Castle (11.4%)	• White Plains (72.0%)
Subwatershed Map	• See Map H-15 in Appendix H	

Subwatershed Description

The White Plains Reservoirs subwatershed drains 0.9 square miles in White Plains, Harrison, and North Castle. There are approximately 0.12 miles of streams in this subwatershed. Approximately 79% of the stream corridor is forested, but only 22% of it is publicly owned.

The subwatershed has the lowest imperviousness in the watershed at 1.7%, and the highest forest cover at 76%. Only 7.2% of the subwatershed is in residential land use, and there is no mixed or non-residential land use. The most notable features of the subwatershed are the drinking water supply reservoirs.

Field assessments were not conducted in this subwatershed. A map of this subwatershed (Map H-15) can be found in Appendix H.

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