



Quassaick Creek Watershed Management Plan

JUNE 2014

QCWA



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Orange County
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Orange County Land Trust

Orange County
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Orange County
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Orange County Soil &
Water Conservation District

Orange Lake Civic Association

Quassaick Creek
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Town of Newburgh

Town of Plattekill

Ulster County
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Winona Lake
Homeowners Association

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PREFACE



The Quassaick Creek Watershed Plan is a non-regulatory guidance document that recommends strategies for enhancing the Watershed, with a focus on water quality protection. It is meant to be a tool to be used to further enrich the quality of life within the Watershed through thoughtful planning, outreach, education, and science-based enhancement and restoration projects.

The primary purposes of this Plan are to heighten public awareness of the Quassaick Creek - thus creating a sense of united stewardship among watershed stakeholders – and to create a “checklist” of best management practices for guiding future development and growth in order to protect and improve the health of the Watershed.

The Plan can help municipalities and others acquire current and reliable environmental information, and it provides an overview of issues and needs that can be used in support of the acquisition of grants or other funds. While some of the recommendations in the Plan advocate for enhanced regulations at the local level, they are not intended to add unnecessary burdens to communities - the Plan strives to propose helpful solutions for dealing with critical issues in support of municipal decision-making.

The Plan focuses on environmental conditions while also recognizing the need for economic development and social equity. The environment, economy, and social equity need not be in conflict with each other, but should be seen as codependent – all are necessary for a vibrant, healthy and resilient watershed.

Attaining the Vision for the Quassaick Creek Watershed requires a sustained commitment and coordinated action by a diverse set of stakeholders. Implementation also needs to be sensitive to landscape conditions and political realities; as demonstrated in Chapter 3, not all of the Plan’s recommendations are appropriate in all locations. The Plan provides a toolkit of actions that can be undertaken independently or in concert with other actions.

The Quassaick Creek Watershed Alliance has expressed interest in shepherding the cause of the Plan, but additional partnerships will be needed in order to undertake certain management recommendations. Implementation will be best achieved if an intermunicipal watershed group with a range of committed members is dedicated to advancing the projects within the Plan. This group should seek grant funds to facilitate implementation but also participate in existing programs and undertake no-cost projects, particularly those that involve members of the community. Ongoing outreach and education about the Quassaick Creek Watershed and watershed planning goals are also critical to this Plan’s success.



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CHAPTER 1. INTRODUCTION, PROJECT CONTEXT AND GOALS



1: 1 Introduction

The Quassaick Creek Watershed Management Plan brings together an extensive amount of information, in-depth analysis of existing conditions in the Watershed, and a robust list of management recommendations for protecting and enhancing the Watershed. As detailed below, the bulk of the work undertaken to prepare this Plan occurred between the spring of 2012 and the spring 2014, although research and other efforts focused on the Quassaick Creek and its Watershed have been underway for many years.

Components of this Plan include:

- Brief narrative of historical conditions and efforts in the lower Quassaick Creek, including the background on how this watershed planning project was initiated (Chapter 1)
- Discussion of the Vision, Goals, and Objectives that were developed for the Watershed (Chapter 1)
- Assessment of Waterbodies and Watershed Resources (Chapter 2)
- Assessment of Laws, Policies, and Programs Affecting Water Quality (Chapter 3)
- Management Recommendations for the Watershed (Chapter 4)
- Appendices A - F

1: 2 Historical Context and Project Background

The Quassaick Creek has been the subject of conservation and restoration interests for decades, especially its lower corridor that forms the border between the City of Newburgh and the Town of New Windsor. At one time called the Vale of Avoca by Irish immigrants because natural beauty reminded them of a valley in Ireland, the nearly 1-mile stretch of the Creek from the Hudson River to the Holden Dam later supported up to 18 industries, many of which used the Creek's flow for powering their operations or for carrying away their waste products and wastewater. By the 1980s, the Creek was so contaminated with volatile industrial chemicals that it could reportedly be set on fire.



In their landmark book, The Riverkeepers, John Cronin and Bobby Kennedy recount the condition of this lower corridor of the Creek when they walked up the Creek in the 1980s. Kennedy writes (p. 101):

Despite the stream’s biological resilience, our investigation had its Dantean aspect. Quassaick [sic] had become a conveyance for industrial and municipal waste. Just south of Quassaick’s mouth, Consolidated Metal Junkyard’s cranes towered over giant heaps of scrap iron and wrecked and compacted car bodies. Crushed cars, drums, tires, bicycles and baby carriages, pallets and paint cans, rusted machinery, and demolition debris moved glacially into the river beckoned by a listing barge lashed to the shore . . . When I seined the Quassaick in August I noticed so many pipes and drains emptying into the mouth that I wondered that there was anything alive in this part of the creek.

Their new organization, [Riverkeeper](#), went on to file 16 lawsuits against the polluters dumping waste into the Quassaick, in addition to four lawsuits filed by the U.S. Attorney’s office. All twenty cases were settled prior to trial, due to the abundance of evidence presented by Riverkeeper; the Quassaick Creek Fund (a fund created by Riverkeeper to collect penalties from the creek’s polluters, to be used for remediation activities) collected \$200,000 in settlements, and the creek’s biggest polluters stopped polluting the creek and remediated the damage where possible.

Although these historic industrial impacts have long diminished in magnitude, the lower portion of the Creek continues to suffer from degraded water quality. In its Priority Waterbodies List, the [NYS Department of Environmental Conservation \(NYSDEC\)](#) identified the lower Quassaick Creek as having impaired aquatic life, recreation, and aesthetics due to combined sewer overflows (CSOs) and urban/stormwater runoff. The causes of impairment are listed as being nutrients and unknown toxicity. Additionally, stream water quality data commissioned annually by the [Orange County Water Authority \(OCWA\)](#) have consistently indicated that the Creek is “moderately impacted” since 2006 at a site immediately upstream of the Creek’s confluence with the Hudson River.

In the late 1990s, a group of advocates came together to form the Quassaick Creek Coalition with the goal of developing an estuary preserve in this lower corridor. The Coalition included representatives from a broad range of interests including the City, land conservation groups, various state and regional agencies, citizens, and many others. Their efforts were documented in a Capstone Project by PhD-candidate Marcy Denker, whose report “Past Industry to New Actions: Envisioning the Keystone Park for a Hudson River Estuary Trail,” relayed the history of the corridor, identified opportunities for and obstacles to the development of a trail, and proposed unique approaches and details for park development in the corridor. Ultimately, efforts to create the estuary preserve and trail were thwarted due primarily to issues relating to access through private properties.

But interest in the Quassaick Creek continued, with some members of the Quassaick Creek Coalition deciding to expand their efforts to a larger geographic area, to take a watershed approach to cleaning up and enhancing the Creek. They formed a group called the [Quassaick Creek Watershed Alliance \(QCWA\)](#), which declared:

“Our Mission is to involve individuals and entities, both public and private, as advocates for the development and implementation of a Quassaick Creek Watershed Plan. Our efforts will focus on the protection and restoration of water quality and quantity, recreational values and biodiversity of the Quassaick Creek and its tributaries to promote the health, safety and welfare of our communities. This will be done by making recommendations for sustainable land use, flood and erosion control practices and relevant regulations in this watershed.”

In 2009, the QCWA began meeting with the Orange County Planning Department (Planning) and the OCWA to determine how a watershed plan could be undertaken. Both County agencies had a history of collaborating on or leading watershed planning efforts: both led the development of the [Moodna Creek Watershed Conservation and Management Plan \(2009\)](#) and contributed to the [Wallkill River Conservation and Management Plan \(2004\)](#), and the OCWA was about to embark on a watershed plan for [Glenmere Lake](#), a local reservoir. Collaboration between Orange County and the QCWA led to a successful application to the NYS Department of State’s Local Waterfront Revitalization Program in 2010. The grant that was awarded to Planning to develop a watershed plan for the Quassaick Creek was matched by funds from the OCWA and by donated professional and volunteer services from an array of local and regional stakeholders. Funds were to be primarily used to hire a consultant to lend professional support to the

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NYSDEC’s Hudson River Estuary Program

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Orange County Department of Health

Orange County Land Trust

Orange County Municipal Planning Federation

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Orange County Soil & Water Conservation District

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development of the watershed plan and to fund additional stream water quality monitoring.

In March of 2012, Planning convened the first meeting of the Quassaick Creek Watershed Plan Advisory Committee, which was formed to guide the planning process, provide information, and to review products and documents developed for the project. The Committee agreed to meet on a bimonthly basis and to form subcommittees to carry out technical and in-depth work for the Committee. Advisory Committee members are listed in the text box on the previous page.

All members lend a unique perspective and have access to information or otherwise possess knowledge that is indispensable to the project. The Committee has rallied support and solicited interest from the public, municipal officials, and outside agencies. The QCWA members, in particular, have donated significant amounts of time to the project, gathering extensive information through outreach and research, including documenting on-the-ground conditions.

1: 3 Vision for Watershed

Developing guiding principles at the beginning of a planning project focuses the work of those involved by establishing consensus on topics to address in the Plan, thus providing direction for the planning process. The Advisory Committee developed a vision statement early in the process, and then established goals and objectives to support this vision. The goals are broad ideas, while the objectives provide further detail on how a goal can be met. The vision, goals, and objectives were refined through public meetings and discussions with municipal officials and other watershed stakeholders. The final versions are below.

VISION STATEMENT:

This watershed planning process will help to improve **water quality**, safeguard **water supplies**, enhance **ecological processes** and protect **wildlife** in the Quassaick Creek Watershed and will provide a framework for creating a **resilient** watershed that is **adaptive** to future conditions.

This vision will be attained by identifying and increasing **awareness** of local water resource issues through strategic **outreach** and **education** to the **public** and **decision-makers**, by recognizing water-related **opportunities** and **vulnerabilities** within the Watershed, and by encouraging **intermunicipal** collaboration that results in economically and ecologically **sustainable development practices**.

These ideas steered the course for the research, data gathering, and analysis that went into the Assessment of Waterbodies and Watershed Resources. The Assessment of Laws, Policies, and Programs Affecting Water Quality focused the municipal audit on laws and programs relating to objectives listed under the following goals:

- Improve water quality, and ensure drinking water sources are protected

- Improve and enhance natural watershed functions and ecological processes
- Promote watershed awareness and sustainable development practices

The ultimate intent of the full Watershed Management Plan is to enable the realization of the vision, goals, and objectives through the implementation of the watershed management strategies that are recommended in the Plan.

Goal	Objectives
ENVIRONMENTAL	
Improve water quality, ensure drinking water sources are protected and that water quantity is adequately managed	1. Develop a more comprehensive understanding of surface water and groundwater quality and quantity, including sources of impairments, throughout the watershed.
	2. Promote water quality protection measures and watershed-friendly practices throughout the watershed.
	3. Improve stormwater management, where appropriate, in order to reduce point (e.g., Combined Sewer Overflow's) & non-point source loadings.
Improve and enhance natural watershed functions and ecological processes	4. Protect, enhance, and restore critical habitat for fish and wildlife.
	5. Reduce the negative effects of hydraulic constrictions, including those created by bridges and culverts
	6. Address impacts of problematic dams through repair, removal, or other mitigation
PROGRAMMATIC	
Establish coordinated inter-municipal implementation of the Quassaick Creek Watershed Management Plan.	7. Develop a mechanism for ongoing collaboration between the municipalities and other key stakeholders
SOCIAL/CULTURAL	
Promote watershed awareness and sustainable development practices	8. Enhance awareness of and public access to of the Creek and other waterbodies in the Watershed
	9. Encourage watershed stakeholders to act in ways that are conducive to watershed protection
	10. Appropriately manage water-related cultural resources, including historic and archaeological sites 11. Identify opportunities for creative partnerships and renewable energy sources
Create a watershed that is resilient to current and future weather conditions	12. Identify areas, facilities, and infrastructure that are vulnerable to storm surges and flooding due to increasing storm intensities

CHAPTER 2. ASSESSMENT OF WATERBODIES AND WATERSHED RESOURCES



2: 1 Introduction

2: 1.1 BACKGROUND

This assessment compiles a wealth of existing information and characterizes the values and impairments of the watershed while also enhancing the reader's awareness of the Quassaick Creek, its tributaries, and water resource issues in general. This Chapter is organized with the following sub-sections to describe the physical, ecological, and human characteristics within the Watershed. Figures and maps have been included to illustrate these features, and are interspersed throughout the report.

- Section 1: Introduction
- Section 2: Geological Resources
- Section 3: Water Resources
- Section 4: Living Resources
- Section 5: Land Use and Land Cover
- Section 6: Pollutant and Nutrient Loading
- Section 7: Community Profile
- Section 8: Summary

2: 1.2 WATERSHED OVERVIEW

Quassaick Creek is one of 65 major streams and rivers that flow into the Hudson River Estuary. Hudson River Estuary tributaries vary in size from small intermittent streams that may dry-up during summer months, to larger rivers with watersheds that cover hundreds of square miles. Quassaick Creek is an average sized tributary compared to all other tributaries, draining approximately 56 square miles of land in Orange and Ulster Counties. Tributaries such as the Quassaick are interwoven components of the Hudson Estuary ecosystem and are influenced by diurnal tides (i.e., twice daily). Due to impoundments and barriers in the lower Quassaick Creek, however, tidal influence is limited to only the mouth of the Creek, east of the American Felt and Filter dam. These tributaries contribute freshwater, essential nutrients, possible contaminants, and typically form diverse habitats at their confluence with the Hudson River Estuary. In the case of Quassaick Creek, the confluence of the watershed is highly urbanized in the City of Newburgh and Town of New Windsor, however in the northern portion of the watershed, diverse natural habitats can be found.



Table 1. Basic Profile of the Quassaick Creek Watershed

Area	56 square miles
Stream Length	111.4 miles
Subwatersheds	7 subwatersheds + Upper Silver Stream Subwatershed (part of the Moodna Creek Watershed) is hydrologically connected to Washington Lake through constructed diversions
Dominant Land Use and Coverage (source: NLCD 2006)	• Deciduous Forest (29%) • Palustrine Forested Wetlands (20%) • Developed Lands (14%); includes City of Newburgh and Stewart Airport • Cultivated Crops (12%) • Mixed Forest (11%) • Miscellaneous (14%)
Jurisdictions	2 counties, 5 municipalities (4 towns, 1 city)
Drinking Water Reservoirs	Chadwick Lake, Washington Lake, Brown's Pond
Water Quality (Source: 2010 NYSDEC Priority Waterbodies List)	• Orange Lake on 303d List of Impaired Waters • Lower Quassaick Creek assessed as Moderately Impaired • Gidneytown Creek assessed as Non-Impacted
Subwatersheds with impervious Cover >10% (source: NLCD 2006)	• Patton Brook, Upper Silver Stream, Washington Lake subwatershed • Washington Lake subwatershed • Lower Quassaick subwatershed
Major Transportation Routes	• New York State Thruway (I-87) • Interstate 84 • New York State Routes 17K & 300
Significant Natural Features (source: NYSDEC 2012; Barbour 2004)	• Orange Lake and surrounding wetland complex • Hemlock Northern Hardwood Forest • Red Maple Hardwood Swamp • Little Falls corridor, Snake Hill and the Brookside Pond natural area in the Lower Quassaick subwatershed. • Forested Wetlands

The Quassaick Creek Watershed (or “Watershed”) covers portions of five municipalities in two counties (**Map 1**). Its headwaters in rural Ulster County feed the main stem of the Quassaick that flows south through the Town of Newburgh before forming the border between the historic City of Newburgh and the Town of New Windsor and ultimately forming the Quassaick Creek estuary with the Hudson River. The Quassaick Creek’s two major tributaries, Bushfield and Gidneytown Creeks, also originate in Ulster County. Bushfield Creek is located west of the Quassaick, begins in the Town of Plattekill, flows south into the Town of Newburgh, crosses under Interstate 87, and flows into the Quassaick Creek north of Interstate 84. Gidneytown Creek also originates in the Town of Plattekill, east of the Quassaick, and its watershed extends just beyond the border to the Town of Marlborough. Gidneytown Creek flows



Figure 1. Diversion gates at Silver Stream. Photo courtesy M. Principe, 2011.

south into the Town of Newburgh, and its confluence with the Quassaick occurs in the City of Newburgh. **Table 1** provides an overview of major features within the Watershed.

The Quassaick Creek Watershed was delineated using topography and hydrology data to establish a basin boundary within which water drains to the Quassaick Creek and into the Hudson River. A starting point was the Quassaick Creek HUC-12 watershed (No. 020200080502) delineated as part of the National Watershed Boundary Dataset, published for New York State by U.S. Department of Agriculture, Natural Resource Conservation Service and U.S. Geological Survey in 2009. Watersheds for Brown's Pond and Washington Lake were added after the southeastern boundary was inspected in the field to better understand how artificial diversions near Brown's Pond and Washington Lake contribute to the Quassaick Creek. The

Watershed was then subdivided into smaller subwatersheds based on topography, hydrology, and land use patterns, and these subwatersheds essentially represent management units that will be further described in this assessment report. The delineation effort identified seven subwatersheds as directly contributing to the Quassaick Creek (**Table 2**). Chadwick Lake is the largest subwatershed, followed closely by Orange Lake and Gidneytown Creek.

Map:
1



Table 2. Subwatershed Area

Subwatershed	Area in Acres
Bushfield Creek/Middle Quassaick Subwatershed	4,518
Chadwick Lake Subwatershed	9,084
Gidneytown Creek Subwatershed	6,299
Orange Lake Subwatershed	7,793
Patton Brook Subwatershed	1,686
Lower Quassaick Subwatershed	2,609
Washington Lake Subwatershed	645
Upper Silver Stream Subwatershed*	2,990
Grand Total	35,624

* Artificially-connected subwatershed

The Upper Silver Stream subwatershed, the eighth subwatershed, is described within this assessment because it is connected to Washington Lake through constructed surficial diversions. Outflow from Brown's Pond (also known as Silver Stream Reservoir) flows north within Silver Stream before turning south and flowing under the New York State Thruway. There is a small body of water east of the Thruway that contains a weir with three gates which control water flow through a constructed diversion north to Washington Lake (**Figure 1**). This small body of water functions as a diversion basin. Based on recent observations, all three weir gates are typically open, allowing Brown's Pond and Washington Lake to be hydrologically connected. When the weir gates to Washington Lake are closed, water would continue along its natural path via Silver Stream to the Moodna watershed (**Map 1; Figure 2**). Therefore, based on the contribution of flow to Washington Lake, the Upper Silver Stream subwatershed should also be considered a contributor to the Quassaick Creek Watershed.



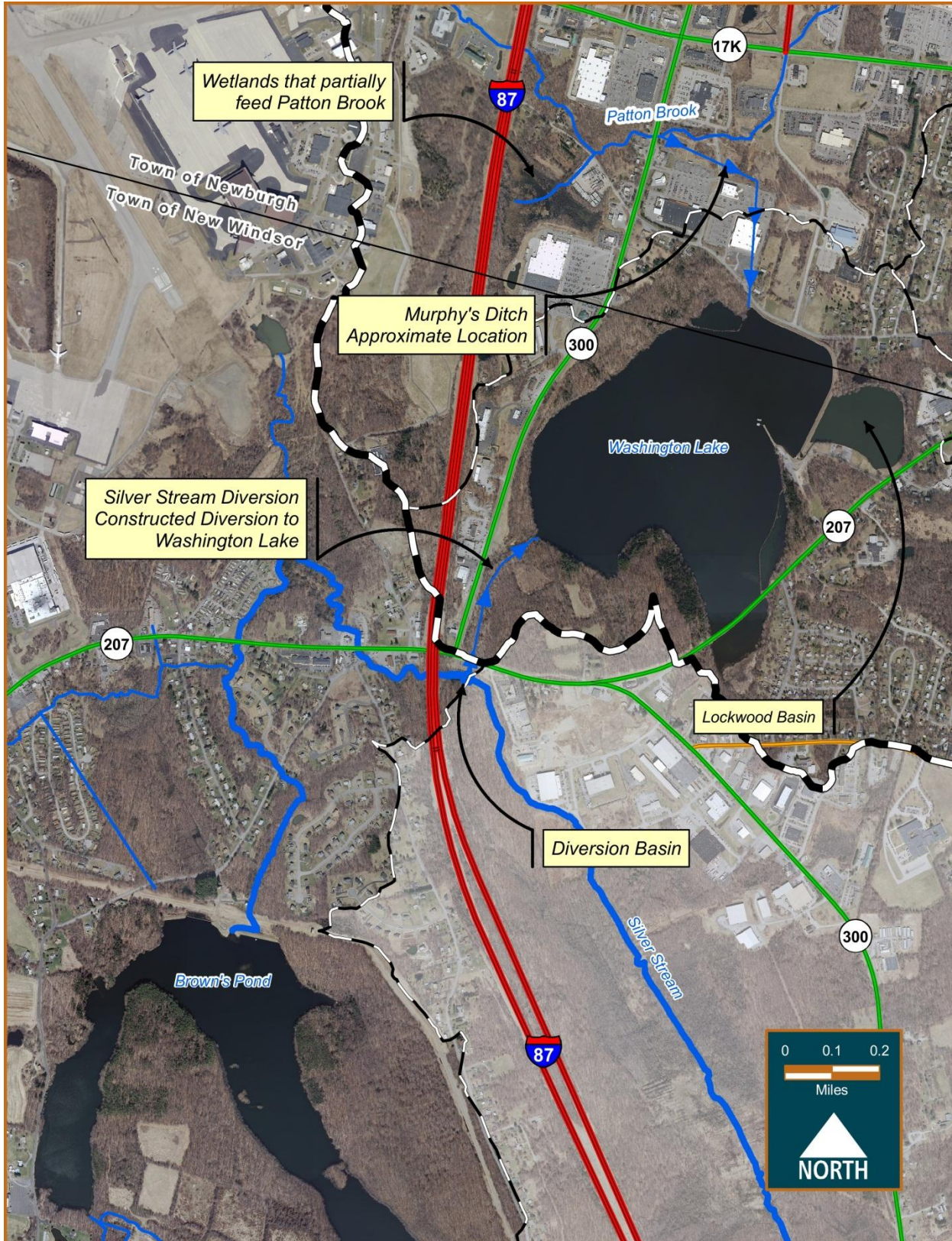


Figure 2. Graphic depicting hydrology among Upper Silver Stream, Patton Brook, and Washington Lake subwatersheds.

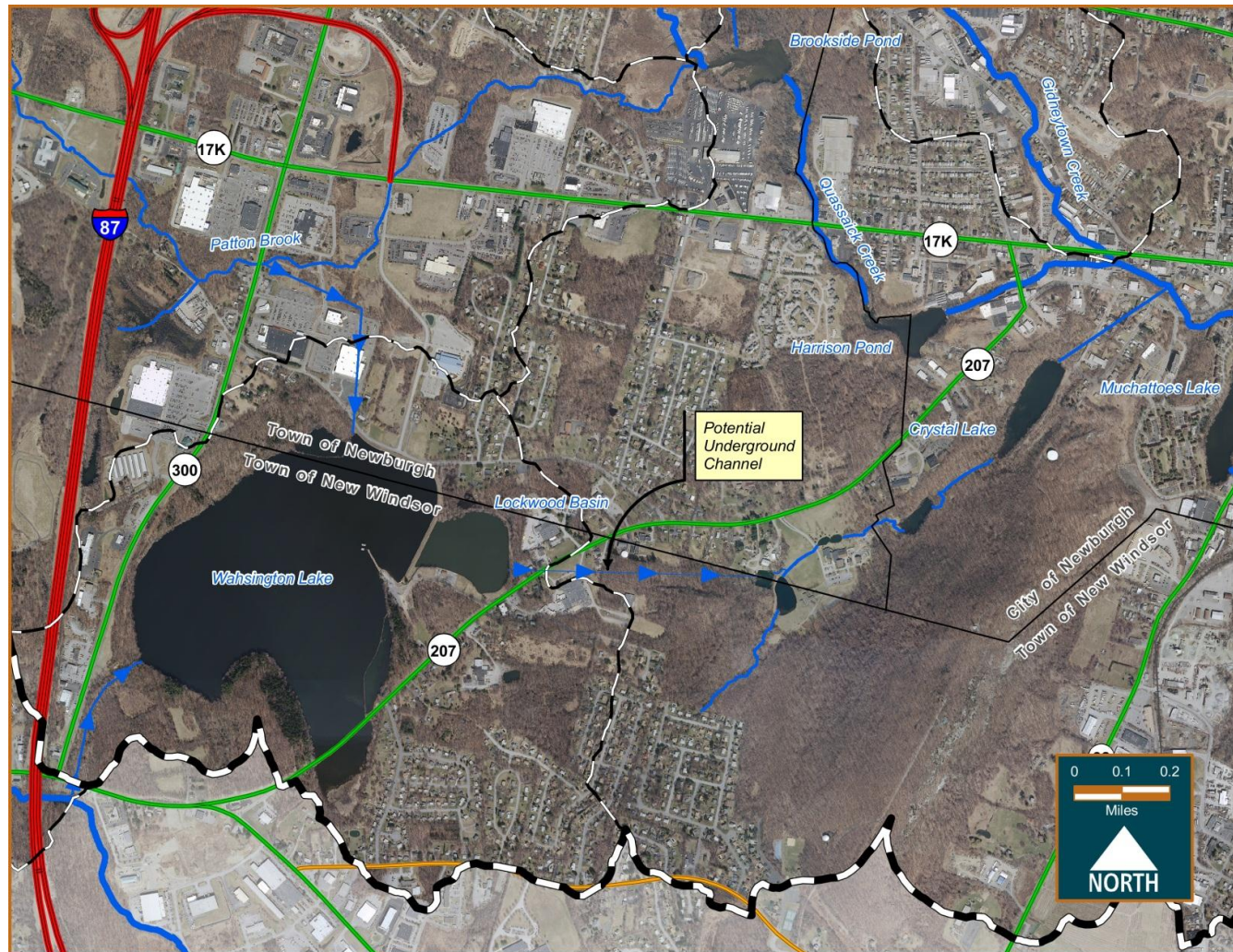


Figure 3. Graphic depicting possible hydrology between Washington Lake and the Quassaick Creek.

Another area of interest is Washington Lake, particularly its connection with Patton Brook and the Quassaick Creek (**Map 1; Figure 3**). The Washington Lake subwatershed is the smallest of the Quassaick subwatersheds with no natural tributaries and is replenished by precipitation and groundwater contributions (**Figure 2, Table 2**). In 1892, Murphy's Ditch was built to divert water from Patton Brook to Washington Lake as a supplemental water source (Warren 1961). The constructed diversion has been documented to be open to Washington Lake for much of the time. The Silver Stream diversion channel and Murphy's Ditch are used to maintain a consistent elevation in Washington Lake. Additionally, it appears that Washington Lake may be hydrologically connected to the Quassaick Creek via an underground conveyance system. Historical accounts suggest that water from Washington Lake was conveyed through a subterranean channel to a connecting reservoir approximately 2,000 feet east, and then conveyed through a pipe into the former Village of Newburgh (Warren 1961). Remnants of these channels may still exist, and there is some indication that subterranean flow from Lockwood Basin, which is the small water body slightly separated from Washington Lake, surfaces downstream of the filtration plant. This surface water indirectly enters the Quassaick Creek via a stream that contributes to the chain of ponds in the City of Newburgh, which include Miller's Pond and Crystal Lake (P. Smith, pers. comm.; **Figure 3**).

2: 2 Geological Resources

2: 2.1 GENERAL GEOGRAPHIC SETTING AND FEATURES

The Quassaick Creek Watershed has an oblong shape that is oriented north to south, and is approximately 13.5 miles long and 5.0 miles wide. It has a low, rolling relief with elevations ranging near sea level at the Hudson River to around 1,000 ft. above sea level along the border of the Towns of Marlborough and Plattekill. The Watershed is bounded by the Marlborough Mountains to the north, the Moodna Creek Watershed and Hudson Highlands to the south, and to the west by the Wallkill River watershed. In the early 1700s, the land adjacent to the Hudson River was settled, and much of the land in the Watershed was subsequently cleared for farms and orchards.

2: 2.2 GEOLOGY AND SOILS

The Quassaick Creek Watershed is underlain by alternating layers of hard sandstone and soft shale that formed long axes of "wrinkle-like" folds oriented northeast-southwest (Frimpter 1972). The hard and soft rock experiences different rates of erosion, which gave rise to a sequence of narrow ridges and valleys characteristic to this region of Orange and Ulster Counties (Frimpter 1972).

Surficial soils are predominantly comprised of glacial till that was deposited during the Pleistocene epoch when glaciers covered most of the Northeast (Nystrom 2010). There are several dozen different soil classifications within the Watershed, each of which maintains its own characteristics and

properties. Given the number and diversity of soils in the Watershed, it was helpful to characterize them by hydrologic rating, which classifies soils into one of four categories based on physical drainage properties, including texture and permeability, as well as certain physiographic properties, such as depth to bedrock and water table:

- “A” SOILS: Soils with low runoff potential. These soils have high infiltration rates and consist chiefly of deep, well drained to excessively well-drained sands or gravels.
- “B” SOILS: Soils having moderate infiltration rates, consisting chiefly of deep, moderately well drained soils with somewhat coarse textures.
- “C” SOILS: Soils having slow infiltration rates consisting chiefly of soils with a layer that slows downward movement of water, or soils with moderately fine to fine textures.
- “D” SOILS: Soils with high runoff potential (very low infiltration rates), consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, and shallow soils over nearly impervious material.

Certain soils can be assigned to dual hydrologic groupings, such as A/D, B/D, and C/D. The first letter represents the soil’s drained condition and the second letter its undrained condition where the seasonal high water table is within two feet of the surface (USDA 2007).

Soils with Group D characteristics dominate the Watershed (**Map 2**). Soils with high runoff potentials can present challenges due to drainage issues when undertaking new development, in agricultural land, areas of road construction or other large impervious surfaces, and locations of wastewater treatment. Soils classified as Group C or D (or with dual hydrologic grouping) require detailed site investigation, including percolation tests, to determine whether a specific land use will succeed. Often, these soils are not well suited for stormwater best management practices because they rely on rapid percolation through the soil to reduce the volume of stormwater flowing into nearby waterbodies.

Soils that have been altered or disrupted during construction and development are often not rated, and tend to be limited in their drainage capabilities. The Lower Quassaick subwatershed is the most developed subwatershed and, as expected, contains the highest proportion of soils without a hydrologic rating (19%, **Table 3**).

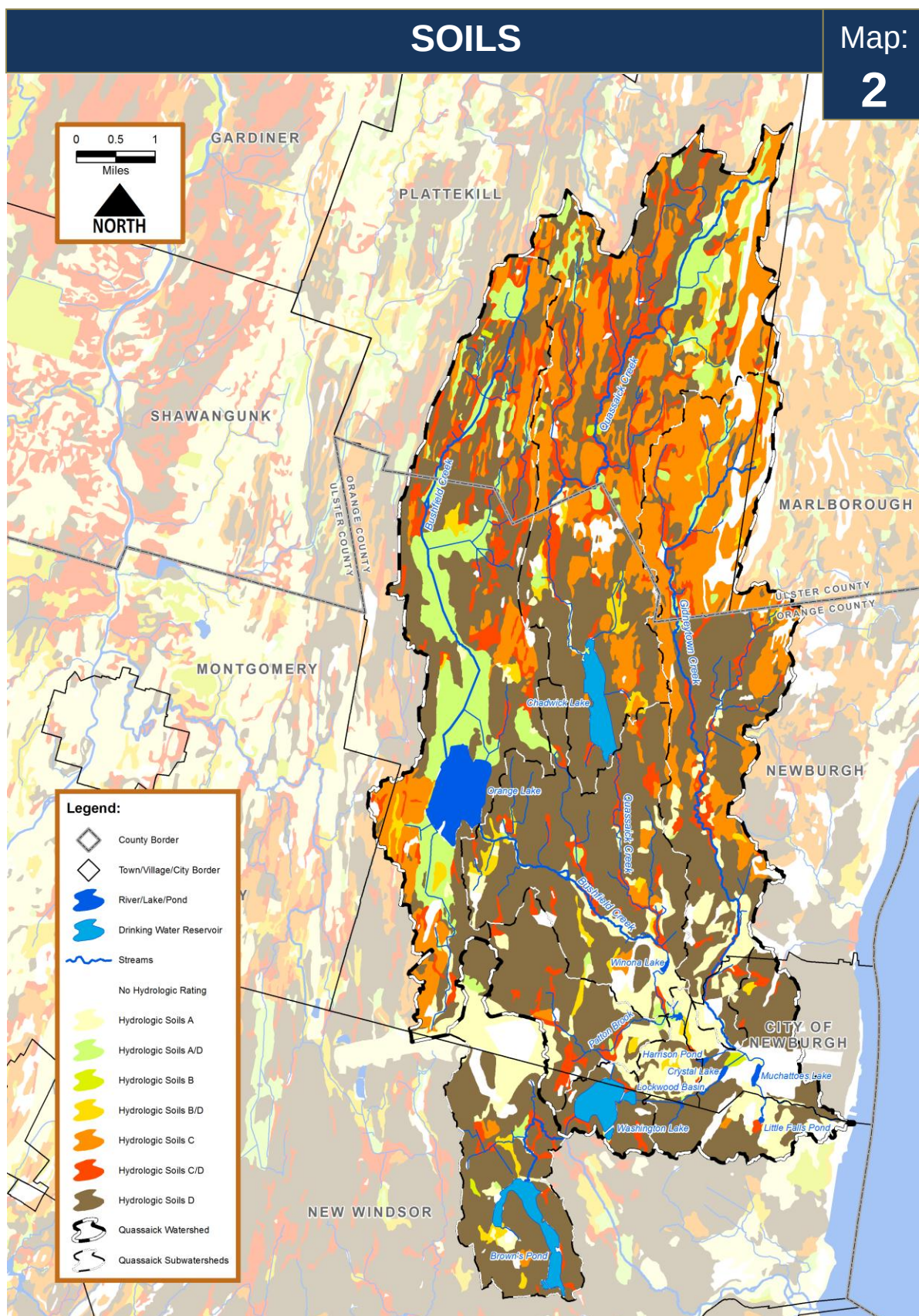


Table 3. Hydrologic Soil Groups by Subwatershed

Subwatershed	Percent by Area of Hydrologic Soil Group							
	No Rating	A	A/D	B	B/D	C	C/D	D
Bushfield Creek/ Middle Quassaick	2.7%	9.7%	1.1%	0.0%	2.9%	3.7%	6.9%	72.7%
Chadwick Lake	3.1%	2.1%	8.3%	0.2%	2.1%	32.3%	11.9%	37.2%
Gidneytown Creek	8.7%	7.6%	2.2%	0.0%	0.8%	37.5%	8.2%	34.4%
Lower Quassaick	19.0%	24.3%	0.4%	0.9%	1.6%	0.3%	1.6%	50.0%
Orange Lake	1.4%	2.2%	21.5%	0.1%	1.7%	17.1%	11.6%	38.9%
Patton Brook	3.1%	14.6%	1.2%	0.0%	1.9%	0.9%	9.5%	68.6%
Upper Silver Stream	8.8%	15.6%	1.4%	0.3%	2.3%	1.4%	3.8%	59.7%
Washington Lake	3.6%	4.7%	0.6%	0.0%	0.0%	0.0%	7.7%	54.1%
Grand Total	5.3%	7.5%	7.6%	0.2%	1.8%	19.3%	8.9%	46.2%

2: 3 Water Resources

2: 3.1 WETLANDS

Wetlands form where land and water meet for extended periods of time, producing conditions favorable for the growth of specially-adapted plants (hydrophytes) and promotes development of wetland (hydric) soils. Wetlands are often characterized based on freshwater or saltwater contribution, tidal influence, and vegetation. Wetlands often have rich biodiversity, and provide numerous ecological, economic, and social functions and values including sediment and nutrient sequestration, flood flow attenuation, shoreline stabilization, groundwater recharge, and recreational opportunities. Historically, a large portion of the wetlands in the northeast (and across the country) have been filled or drained, making preservation of existing wetlands all the more important.

In New York State, there are two sources of wetland maps that can be used to easily characterize wetland resources over large geographic scales, the [National Wetlands Inventory \(NWI\)](#) and the [New York State Department of Environmental Conservation \(NYSDEC\)](#) wetland maps. NWI wetlands and deepwater habitat (often referred to as Federal wetlands) maps were generated to be inclusive of all wetland and water resources no matter the size or depth. The NWI dataset was developed and is routinely updated by the United States Fish and Wildlife Service, the principle Federal agency that provides wetland information to the public and other agencies. In contrast, tidal wetlands of any size and freshwater wetlands generally 12.4 acres or larger are protected by New York State. There is

typically significant overlap between NYSDEC wetlands and NWI wetland polygons, which are not regulated by the state. However, it is important to show both wetland datasets because the NYSDEC wetlands map excludes smaller wetlands (<12.4 acres) that would likely occur on the NWI maps. These smaller wetlands provide meaningful functions and values and warrant protection. Because both datasets have been developed using remote geospatial data (NYSDEC supplements with field verifications) and because land uses are always changing, neither is entirely accurate. Map improvements are continually being made, and these data represent the best available wetland information for the Watershed.



Figure 4. Freshwater emergent wetlands along the upper Quassaick Creek at Old Unionville Road, in the Town of Plattekill (Courtesy B. Samuelson).

Within the Quassaick Creek Watershed, the NYSDEC has designated over 3,500 acres of wetlands (**Table 4**) with the most acres occurring in the Orange Lake Subwatershed. As would be expected based on the overlap between NYSDEC and NWI datasets, NWI also designates the greatest area of wetlands within this Subwatershed (45%) with the majority classified as Freshwater Forested/Shrub Wetland (**Map 3, Table 5**). Within the Watershed, Freshwater Forested/ Shrub Wetlands comprise 68% of the total designated NWI Wetlands (**Table 5**). Lake habitat

represents the next most abundant NWI classification with approximately 1,000 acres, and these areas closely correspond with lake waterbodies in the Watershed. As shown on **Map 3** and depicted on **Figure 4**, many forested and freshwater emergent wetlands are closely associated with streams and lakes in the Watershed.

Another wetland type within the Watershed is vernal pool habitat. Vernal pools are seasonally flooded areas formed in glaciated regions that often occur in forested land isolated from streams. While frequently not protected as wetlands, vernal pools are unique habitats that support many rare plants and animals. Because of their isolation, vernal pools are absent of fish, a major predator of amphibians, and therefore provide critical breeding and nursery areas for salamander and newt species. Vernal pools have been identified near Route 300 in the southern portion of the Watershed, but more pools may exist in the forested headwaters in the Towns of Plattekill and Newburgh.

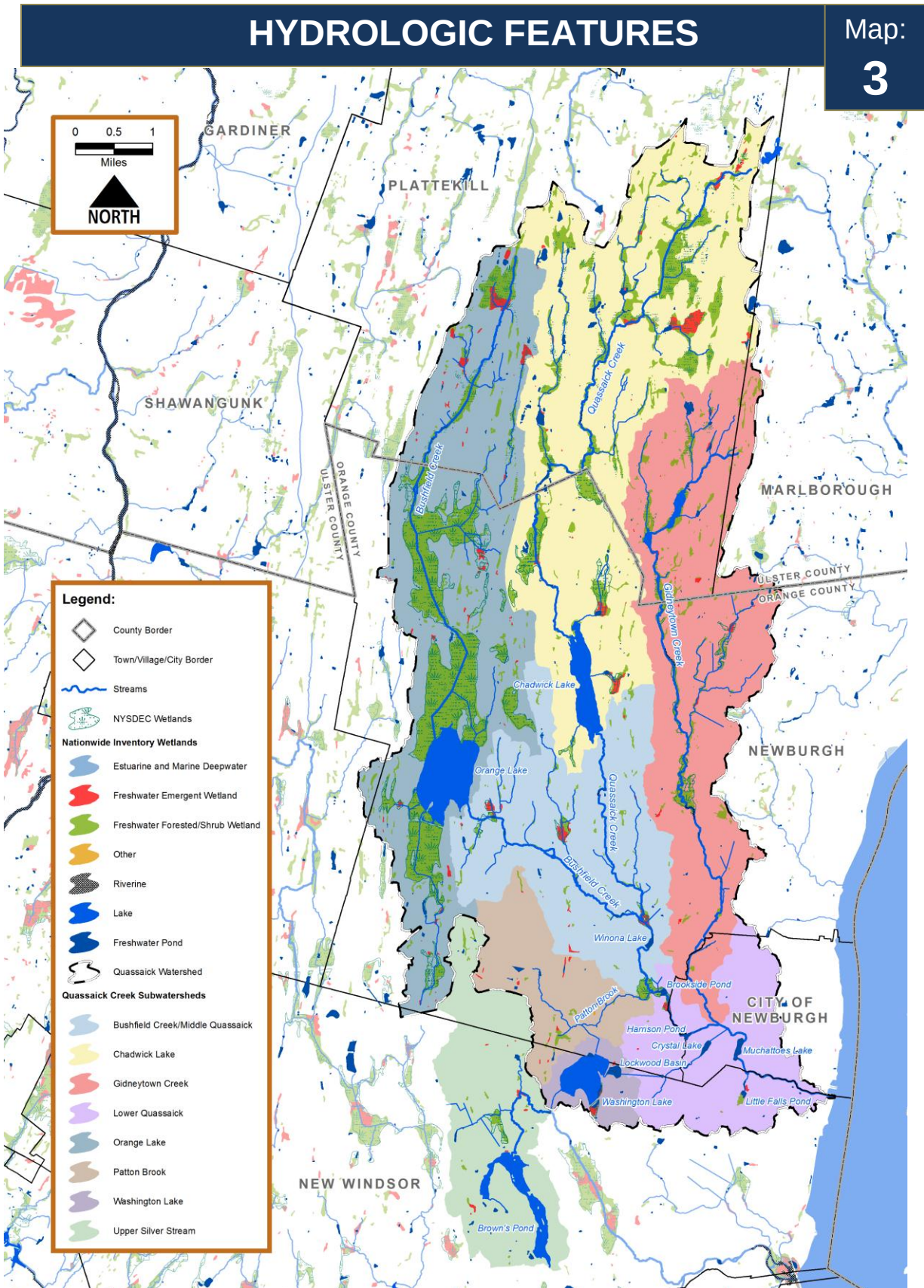


Table 4. NYSDEC and NWI Designated Wetland Areas within the Eight Subwatersheds of Quassaick Creek

Watershed	NYSDEC		NWI	
	Acres	% of subwatershed	Acres	% of subwatershed
Bushfield Creek/Middle Quassaick Watershed	83.4	1.8%	187.1	4.1%
Chadwick Lake Watershed	1,146.5	12.6%	1,579.0	17.4%
Gidneytown Creek Watershed	299.6	4.8%	481.2	7.6%
Lower Quassaick Watershed	18.2	0.7%	70.3	2.7%
Orange Lake Watershed	1,966.5	25.2%	2,300.5	29.5%
Patton Brook Watershed	7.8	0.5%	53.1	3.1%
Upper Silver Stream Watershed	28.7	1.0%	244.1	8.2%
Washington Lake Watershed	15.1	2.3%	188.3	29.2%
Quassaick Creek Watershed Grand Total	3,565.7	10.0%	5,103.5	14.3%

Table 5. NWI Classifications within Subwatersheds of Quassaick Creek (Acres)

Subwatershed	Estuarine and Marine Deepwater	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Lake	Riverine	Other*
Bushfield Creek/Middle Quassaick		45.0	119.1	22.3	0.1	0.6	
Chadwick Lake		117.2	1,144.6	105.0	210.5	1.6	
Gidneytown Creek		22.2	375.6	33.7	43.0	6.6	
Lower Quassaick	1.2	10.6	16.8	41.7			
Orange Lake		98.1	1,759.4	32.9	410.0		
Patton Brook		8.2	33.4	10.7			0.8
Upper Silver Stream		9.7	37.5	17.4	179.5		
Washington Lake		7.8	0.8	22.5	157.3		
Grand Total (acres)	1.2	318.7	3,487.3	286.3	1,000.4	8.8	0.8

*One instance of "Other" in the watershed; defined as PUSC_x (palustrine unconsolidated shore, seasonally flooded, excavated).

2: 3.2 STREAMS

In total, the Quassaick Creek Watershed contains 111.4 total stream miles; that is more than eight times the total length of the watershed. The streams within the Quassaick Creek Watershed are a valuable resource that supply high quality water to drinking water reservoirs, provide opportunities for recreation, education and research, and improve the aesthetic value of communities. Waterways are also aquatic highways for fish, invertebrates, nutrients, and pollutants, conveying these through an interconnected network. Streams are greatly affected by the surrounding land through development, stormwater, and contributing flood flows, so it is important within developed watersheds like the Quassaick Watershed to foster a greater understanding and appreciation for this resource.

The Chadwick Lake subwatershed has the most designated stream miles of all eight subwatersheds. The Quassaick Creek and its tributaries make up the majority of stream length found in this subwatershed (approximately 30 miles, 98% of streams within Chadwick Lake subwatershed), and these stream miles all occur upstream of Chadwick Lake, the largest drinking water reservoir in the Watershed. Gidneytown Creek, Orange Lake, and Bushfield Creek/Quassaick subwatersheds have comparable stream lengths, at 22.6, 23.8, and 18.2 total miles, respectively. Together with Chadwick Lake, these subwatersheds' streams make up 85% of the stream miles of the entire watershed. The subwatershed with by far the least amount of linear stream length was the Washington Lake subwatershed with less than 1.3 miles of stream length, which is due to the small size of the subwatershed. Patton Brook and the Lower Quassaick also both have comparably short stream lengths (**Map 3, Table 6**).

Table 6. Stream Length of Major Streams per Subwatershed

Subwatersheds	Streams	Stream Length (Miles)	Total Miles
Bushfield Creek/ Middle Quassaick Watershed	Other	5.6	18.2
	Bushfield Creek Tributaries (Unnamed)	2.2	
	Bushfield Creek	3.7	
	Quassaick Creek	4.4	
	Quassaick Creek Tributaries (Unnamed)	2.4	
Chadwick Lake	Other	0.6	29.9
	Bushfield Creek	0.1	
	Quassaick Creek	10.6	
	Quassaick Creek Tributaries (Unnamed)	18.6	
Gidneytown Creek	Other	3.3	22.6
	Gidneytown Creek	10.3	
	Gidneytown Creek Tributaries (Unnamed)	9.0	
Lower Quassaick	Other	0.2	5.8
	Quassaick Creek	3.8	
	Quassaick Creek Tributaries (Unnamed)	1.9	
Orange Lake	Other	7.3	23.8
	Bushfield Creek	8.4	
	Bushfield Creek Tributaries (Unnamed)	8.1	
Patton Brook	Patton Brook	2.6	2.8
	Patton Brook Tributaries (Unnamed)	0.2	
Upper Silver Stream	Other	2.7	7.0
	Silver Stream	3.2	
	Silver Stream Diversion	<0.1	
	Silver Stream Tributaries (Unnamed)	1.0	
Washington Lake	Silver Stream Diversion	1.3	1.3
Grand Total			111.4

2: 3.3 LAKES AND RESERVOIRS

As with streams, the Quassaick Creek Watershed has a large number of lakes and reservoirs. NWI designates just over 1,000 acres of lakes and drinking water reservoirs within the Quassaick Creek Watershed, many of which in the southern half of the Watershed were formed by impounding a



Figure 5. Lake Washington. Photo courtesy M. Principe, 2011.

stream. The largest lake area in the Watershed is Orange Lake at over 400 acres (41% of the total lake area in the Watershed). Orange Lake does not serve as a drinking water reservoir and is not open for public recreation. Portions of Orange Lake are surrounded by year-round and seasonal development and provide only private recreational opportunities such as boating, fishing, and swimming (Town of Newburgh Comprehensive Plan Update 2005) (**Map 3, Table 7**).

The other major lake waterbodies in the Watershed include Chadwick Lake, Washington Lake, and Brown's Pond, all of which are represented by subwatersheds and are drinking water reservoirs (**Figure**

5). Chadwick Lake is the major source of drinking water to the Town of Newburgh contributing over 2.0 million gallons per day (mgd; Town of Newburgh 2005, OCWA 2010a). As shown in **Map 7**, the Town of Newburgh owns parkland around Chadwick Lake, thereby successfully protecting the lakeshore from deforestation and other infringement. Currently, this lake experiences elevated levels of algal growth during the growing season and as such it is considered eutrophic. Washington Lake provides drinking water to the City of Newburgh, contributing 9.5 mgd (OCWA 2010a). Brown's Pond in New Windsor serves the City of Newburgh as a supplemental source of potable water and the Town of New Windsor as an emergency source. While the City of Newburgh owns substantial tracts of land around the borders of the reservoir, most of the watershed is unprotected and thus vulnerable to development, examples of which have recently added significant amounts of sediment to Silver Stream (OCWA 2010b). In addition, like Chadwick Lake, Brown's Pond also experiences elevated levels of algal growth during the growing season and as such it too is considered eutrophic.

Table 7. Major Waterbodies by Subwatershed

Subwatershed	Waterbody	Area (Acres)		
		Lake	Drinking Water Reservoir	Total
Bushfield Creek/ Middle Quassaick Watershed	Winona Lake	5.5		5.5
Chadwick Lake	Chadwick Lake		209.6	209.6
Lower Quassaick	Brookside Pond	5.4		33.1
	Crystal Lake	6.9		
	Harrison Pond	5.6		
	Little Falls Pond	3.8		
	Muchattoes Lake	11.4		
Orange Lake	Orange Lake	402.2		402.2
Upper Silver Stream	Silver Stream Reservoir/ Brown's Pond		189.8	189.8
Washington Lake	Washington Lake		174.0	187.8
	Lockwood Basin		13.7	
Grand Total		440.8	587.1	1,027.9

Significant erosion is taking place downstream of the primary spillway of Winona Lake Dam that impounds a reach of the Quassaick Creek in the Bushfield Creek/Middle Quassaick subwatershed (**Figure 6**). Based on observations from the Winona Lake Homeowner's Association and the Quassaick

Creek Watershed Alliance, a breach in the Winona Lake spillway was greatly increase in April 2007 during a large storm. During a site visit in 2009, Stone Environmental Inc. estimated the breach at 20-ft wide through which all flow passes (under low flow conditions). As noted in **Table 7**, Winona Lake is currently 5.5 acres in size, but was approximately 9 acres prior to the breach. Flow from the breach is directed at an eroding bank, which is now nearly vertical. A house is situated at the top of this bank and the safety of this house would be threatened should substantial erosion continue.



Figure 6. Winona Lake Dam breach, July 2012.

Minor stabilization measures have been undertaken during 2007-2010 to temporarily arrest the eroding bank. These included armoring the toe of the bank with boulders and concrete slabs and planting trees and shrubs as part of the [Trees for Tribes](#) program. The primary mechanism driving bank erosion appears to be the flow from the breach impinging on the channel. The stream channel also appears incised, exposing excessively tall sandy banks that are susceptible to erosion. According to the memo prepared by Stone Environmental, Inc. on September 8, 2009, if the stream is actively incising its

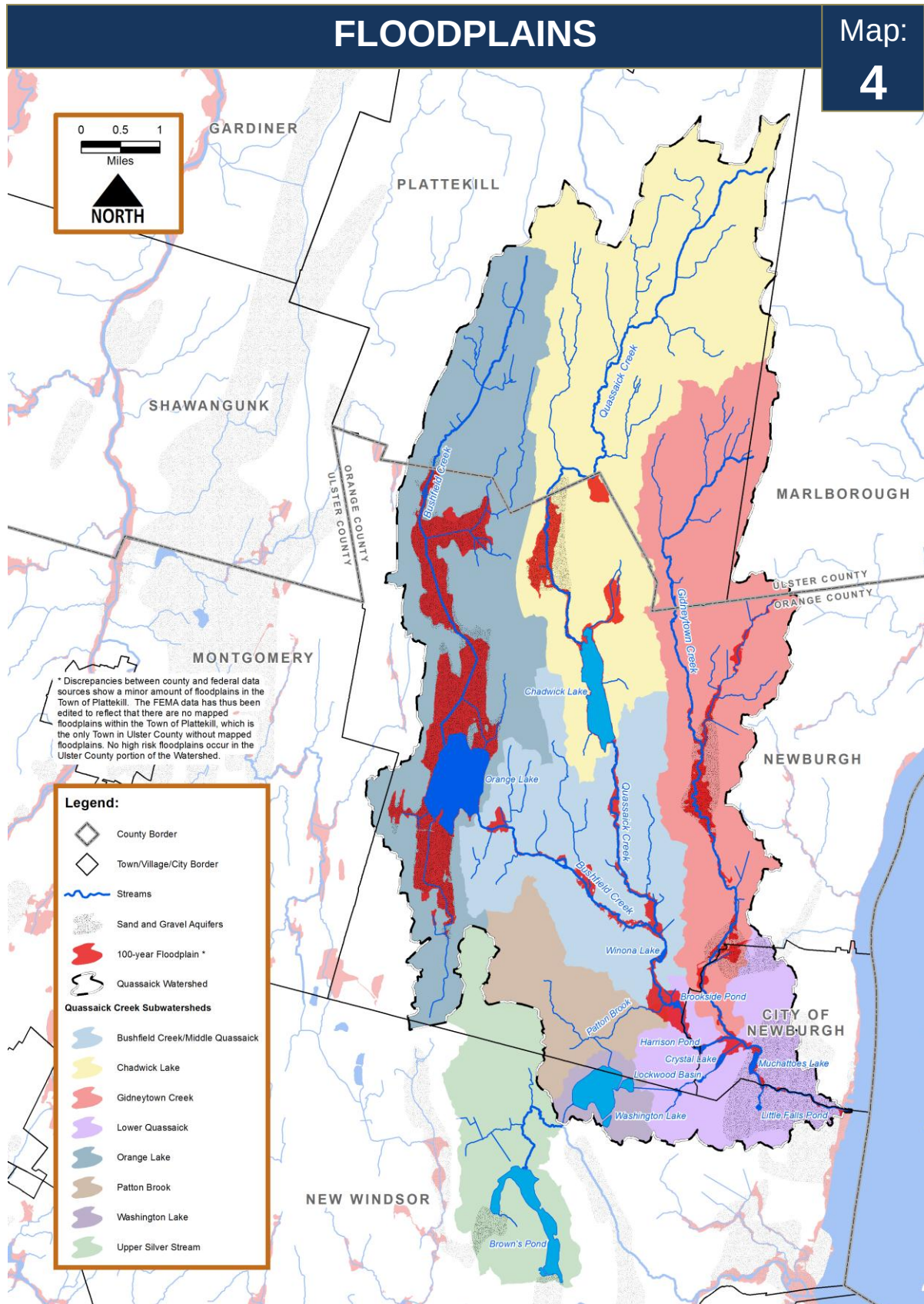
bed below the spillway breach, erosion control work on the stream banks would be ineffective, and this could also undermine portions of the remaining spillway, unless grade control is established. The memo recommended conducting an assessment and remediation study to fully evaluate the range of alternatives. Since this site visit was performed and memo prepared, no further work has been performed. Although neither the bank erosion nor the breach have significantly worsened since 2009, an investigation into potential corrective actions is necessary in the near term, as described further in **Chapter 4**.

2: 3.4 GROUNDWATER HYDROLOGY

Groundwater resources in Orange and Ulster Counties are almost fully derived from precipitation percolating through the soil and into pore spaces of bedrock or fractures in the bedrock (Frimpter 1972). However, not all precipitation reaches the bedrock, and most is either lost to evaporation, transpiration from trees, crops, or other vegetation; drains into a stream network or other waterbody; or is collected by municipal stormwater systems and discharged. Frimpter (1972) estimated that 50-75% of the precipitation falling in Orange and Ulster Counties was lost through these mechanisms, and present-day losses would be expected to be greater due to the increased development in the region. Sand and gravel aquifers, which generally represent the best sources of large quantities of groundwater, occur in several areas of the Watershed and are depicted on **Map 4**. A large area is located along Bushfield Creek, north and south of Orange Lake, and along the Hudson River in the City of Newburgh and Town of New Windsor. Isolated pockets have been identified within the Gidneytown Creek valley where Interstate 84 crosses the stream and northward near Fostertown (Frimpter 1972). Other isolated occurrences of saturated sand and gravel are mapped within the Quassaick Creek valley near the Orange/Ulster County boundary, north of Chadwick Lake (Frimpter 1972), and south of Brown's Pond.

2: 3.5 FLOODPLAINS

The Quassaick Creek Watershed contains over five square miles of high risk floodplains (**Map 4**). The [Federal Emergency Management Agency \(FEMA\)](#) National Flood Insurance Program (NFIP) defines a high risk floodplain as an area that has one percent annual chance of flooding (i.e., 100-year floodplain). Homes and businesses that fall within these high risk areas are required to buy flood insurance (NFIP 2012). Six of the eight subwatersheds contain high risk floodplains (**Table 8**). The majority of these floodplains lie within the Orange Lake subwatershed (57%).



Upper Silver Stream and Washington Lake subwatersheds do not contain any high risk floodplains.

No high risk flood areas occur in the Ulster County portion of the Watershed. FEMA has no mapped flood areas within the Town of Plattekill and is the only town in Ulster County where this occurs. The Town of Marlborough contains FEMA mapped flood areas; however these areas are located outside of the Quassaick Creek Watershed.

Table 8. High Risk Flood Areas in the Quassaick Creek Watershed

Subwatershed	High Risk Flood Area		% of Watershed
	Acres	Square Miles	
Bushfield Creek/Middle Quassaick	318.1	0.497	7.0%
Chadwick Lake	546.0	0.853	6.0%
Gidneytown Creek	345.5	0.540	5.5%
Lower Quassaick	188.3	0.294	7.2%
Orange Lake	1,890.1	2.953	24.3%
Patton Brook	20.2	0.032	1.2%
Quassaick Creek Watershed Grand Total	3,308.3	5.169	9.3%

Although major flooding is not known to occur within the Watershed, minor seasonal flooding occurs in some areas, such as around the Quaker Street culvert on the Bushfield Creek. Following the unprecedented rainfall resulting from tropical storms Irene and Lee during August and September 2011, the Quassaick Creek Watershed Alliance identified a few areas that are prone to flooding during major storms, including: Cronomer Hill Park ball field, Route 52 at Innis Road, Little Brook Lane, and Conklin Service Station at Stewart Avenue.

2: 3.6 WATER QUALITY CLASSIFICATIONS AND IMPAIRMENTS

Water quality in the Watershed has been assessed by the State and by Orange County using the following methods:

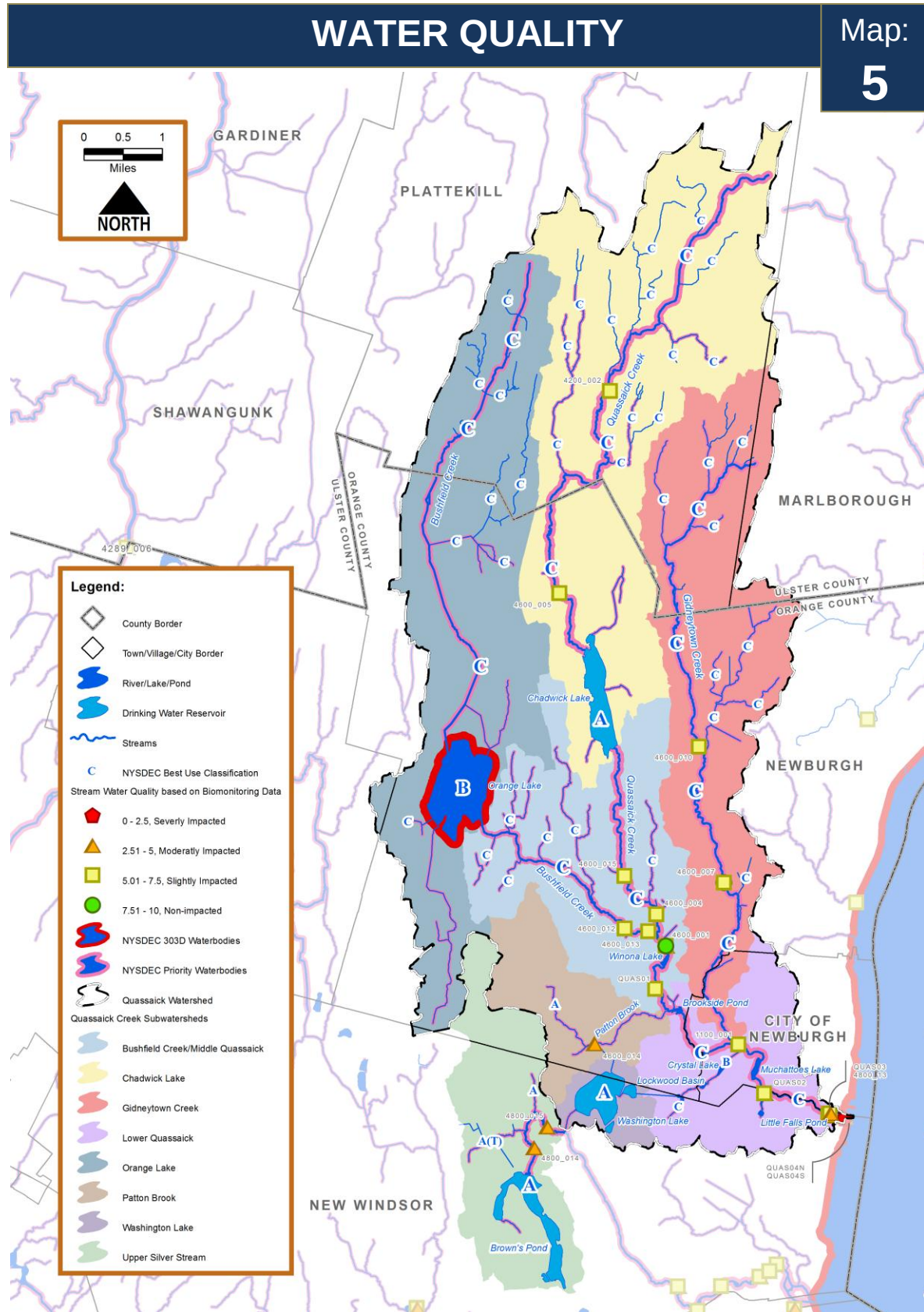
- [NYSDEC Stream Classification](#) is based on the best use for a waterbody and is not necessarily indicative of the actual conditions in that stream:
 - The classifications A, AA, A-S and AA-S indicate a best usage for a source of drinking water, swimming and other recreation, and fishing.
 - Classification B indicates a best usage for swimming and other direct contact recreation, and fishing.
 - Classification C indicates a best usage for fishing and other non-contact recreation.

- Classification D indicates a best usage of fishing, but these waters will not support fish propagation.
- [NYSDEC Waterbody Inventory and Priority Waterbodies List \(WI/PWL\)](#) is a statewide database that characterizes water quality, the degree to which water uses are supported, progress toward the identification of water quality problems and sources, and activities to restore and protect each assessed waterbody. This assessment provides the foundation for both the biennial Section 305(b) Water Quality Report on all waters within New York State, and for the development of the State Section 303(d) List. The PWL assessments are performed every five years, and the Lower Hudson River Basin is being performed in 2012, but data are not yet available.
- [NYSDEC Section 303\(d\) List of Impaired Waters](#): When a waterbody does not meet water quality standards and does not support water uses based on its classification, development of a Total Maximum Daily Limit (TMDL) is required.
- Orange County Biomonitoring Project (2004-2010, 2012, 2014): Biomonitoring is a method of evaluating water quality by sampling the macroinvertebrates in a waterbody. Macroinvertebrates are organisms large enough to see with the naked eye and include various taxa (groups) including aquatic insects, clams, snails, worms, and crustaceans. These organisms vary in their sensitivity to water pollution, with some types being extremely sensitive and others being more tolerant to pollution. The relative abundance of pollution-sensitive and pollution-tolerant species, and their diversity, provides a robust and reliable indication of the overall water quality at a given site.

Impairments to water quality can be broadly categorized as resulting from point and non-point sources. These terms describe the nature by which pollutants enter the Watershed. Point source pollution can be defined as a single location or source of pollutant output which, when controlled, does not yield further emission of that pollutant. An example is a discharge pipe from a sewage plant or a leak from an industrial facility. Non-point pollution sources are much more indirect and do not result from a single output point. These pollutants may enter the Watershed through several non-discrete points, and can include a wide range of contaminants from fertilizers to pesticides. Most non-point source pollution in the Quassaick Creek Watershed is discharged to streams via stormwater runoff.

2: 3.6.1 NYSDEC STREAM CLASSIFICATIONS

Class C streams (best use for fishing) dominate the Watershed (**Map 5**). For their entire length, the main stems of the Quassaick, Bushfield and Gidneytown Creeks are each rated Class C. Patton Brook, a tributary to the Quassaick, is a Class A stream because it is occasionally source water to Washington Lake. The unnamed stream from Crystal Lake to the Quassaick is a Class B stream representing a best use that includes direct contact recreation like swimming. This



tributary, which is located in the Lower Quassaick subwatershed, has the highest use classification of any stream unassociated with a drinking water source.

Washington and Chadwick Lakes and Brown's Pond are Class A, representing their use as a drinking water source. Tributaries flowing from Brown's Pond are also Class A streams. Orange Lake is a Class B waterbody, with a best use that includes swimming and other direct contact recreation. However, the water quality in Orange Lake does not fully support these uses as described in Sections 3.6.2 and 3.6.3.

Waters with classifications of A, B, and C may also have a standard of (T), indicating that it may support a trout population, or (TS), indicating that it may support trout spawning (TS). NYSDEC places special protection measures on waters with classifications of C(T) or higher to protect these valuable and sensitive fisheries resources. A permit is required for most types of work within these stream beds or along their banks (i.e., within 50-ft of water line). In the Watershed, these special requirements apply to Class A and B waters, like Washington and Chadwick lakes, Brown's Pond, Patton Brook, and the unnamed tributary from Crystal Lake, and also apply to small lakes along these waterbodies that are 10 acres or less in size. There are no waterbodies designated as (T) or (TS) in the Quassaick Creek Watershed. A tributary to Silver Stream and Silver Stream upstream of the constructed diversion to Washington Lake is designated A(T)

2: 3.6.2 WATERBODY INVENTORY AND PRIORITY WATERBODIES LIST

Five waterbody segments within the Watershed were last evaluated in 2008 (**Table 9**). Washington Lake, Brown's Pond and Chadwick Lake were assessed, but no impacts were identified. The lower Quassaick Creek was identified as having impaired aquatic life, recreation, and aesthetics due to combined sewer overflows (CSOs) and stormwater runoff. Orange Lake was classified as impaired in 2008 due to nutrients from habitat modifications and wastewater/stormwater. There may be other waterbodies that do not meet their best use classification, but these have not been assessed by the State. Several segments have been identified by NYSDEC as priority waterbodies, but not assessed to date, including Quassaick middle, Quassaick upper, Crystal Lake, Gidneytown Creek, and Muchattoes Lake.

Table 9. Watershed Resources Assessed as part of the 2008 NYSDEC Waterbody Inventory and Priority Waterbodies List

Water Index Number	Waterbody Segment	Category	Causes	Sources
H-89-2-P225	Lake Washington (1303-0012)	No Known Impact	--	--
H-89-2-P226a	Browns Pond Reservoir (1303-0013)	No Known Impact	--	--
H-94	Quassaick Creek, Lower, and minor tribs (1301-0079)	Minor Impacts	Nutrients, Unknown Toxicity	Combined Sewer Overflow, Urban/Storm Runoff
H-94-6-P340	Orange Lake (1301-0008)	Impaired Segment	Nutrients	Habitat Modification, On-Site/ Septic Systems, Urban/ Storm Runoff
H-94-P341a	Chadwick Lake (1301-0190)	No Known Impact	--	--

Water quality data for Orange Lake were collected from 1994 through 1998 and more recently in 2005 and 2011 by the Orange Lake Civic Association and the Orange Lake Fish and Game Association as part of the [NYSDEC Citizen Statewide Lake Assessment Program \(CSLAP\)](#). These data indicate that the lake continues to be characterized as eutrophic, or highly productive, based on low water transparency, and high nutrient (primarily phosphorus) and algae levels (NYSDEC 2009; CSLAP 2011). In 2005 and 2011, total phosphorus levels consistently exceeded the State phosphorus and water clarity guidance values (NYSDEC 2009, CSLAP 2011). An encouraging result in 2011 was the slightly decreased chlorophyll *a* concentrations, which on average were exceedingly high for the region in 2005, and decreased in 2011 to just within the state's criteria for eutrophic waterbodies. New York State characterizes waterbodies with chlorophyll *a* concentrations exceeding 8 mg/L as eutrophic, and Orange Lake's average concentration in 2011 was 11.77 mg/L (NYSDEC 2009; CSLAP 2011).

2: 3.6.3 NYSDEC Section 303d List of Impaired Waters

Orange Lake was added to the 2010 [NYS Section 303\(d\) List of Impaired Waters](#), and also appears on the draft 2012 303(d) List. The lake is included on Part 1 of the List, indicating a waterbody with an impairment requiring TMDL development due to phosphorus. Although Orange Lake was recently added to the 303(d) List, this was based on the full evaluation of waterbodies in the Lower Hudson Basin being completed in 2008 (5-year revolving schedule, re-assessed in 2012).

Efforts to improve water quality in and around Orange Lake have been ongoing since 1995. In 1995, sewer lines were installed at approximately 85% of the homes in the vicinity of the lake. The Town of

Newburgh recently constructed catch basins with sumps and snouts around the periphery of the lake. The Lake Orange Civic Association has undertaken biological control measures by monitoring the geese population, which can significantly contribute to high phosphorus loading and reduce water clarity. The Lake Association also recently received a permit from NYSDEC to stock the lake with non-reproductive triploid carp in an effort to control Eurasian milfoil (NYSDEC 2010).

2: 3.6.4 Orange County Biomonitoring Project (2004-2010, 2012)

The [NYSDEC](#), the Orange County Water Authority (OCWA), and the Orange County Planning Department have conducted [stream water quality biomonitoring](#) at several sites within the Quassaick Creek Watershed (**Table 10**). This method of gauging water quality is based on the abundance and diversity of pollution-sensitive and pollution-tolerant aquatic macroinvertebrate species; they are collected in accordance with protocol defined by New York State and their numbers are collectively analyzed to develop a site-specific Biological Assessment Profile (BAP) score. The score can range from 0-10 and are categorized as severely-impacted (BAP of 0-2.49), moderately-impacted (BAP of 2.50-4.99), slightly-impacted (BAP of 5.00-7.49), and non-impacted (BAP of 7.50-10.0).

From 2012-2013, the County Planning Department worked with volunteers and Watershed Assessment Associates to sample fourteen (14) sites in the Watershed. Additionally, the NYSDEC sampled two (2) sites in 2013 (**Table 10**). This abundance of data was made possible through the Department of State grant that funded this Quassaick Watershed Plan as well as by a dedicated group of volunteers belonging to the [Quassaick Creek Watershed Alliance](#), who had been



Figure 7. Biomonitoring kick-net sampling within the Quassaick Creek. Photo courtesy P. Smith, 2012.

trained to collect macroinvertebrates following the NYSDEC's protocol. This resulted in a cost-savings that enabled an increase in the total number of sites sampled as well as monitoring of the Gidneytown and Bushfield Creeks, neither of which had been sampled using the biomonitoring method in the past.

In addition to the BAP score, biomonitoring lab analysis produces Impact Source Determination (ISD) information for each site. The ISD helps identify a likely source of impact affecting the sample community (**Table 11**). Below is an excerpt from the Quassaick Creek Biomonitoring Project Report for years 2012 & 2013, produced by Watershed Associates, which describes the results from 2012 & 2013. These BAP scores are also listed in **Table 10** and most are shown in **Map 5**.

Station 4200_002. The upper most station on the Quassaick Creek received BAP scores of 7.3 in 2012 and 7.2 in 2013, corresponding to a slight impact classification (**Table 1**). ISD indicated natural conditions in 2012 and results were inconclusive in 2013.

Station 4600_001. Quassaick Creek station received a BAP score of 7.7 in 2012, corresponding to a BAP classification of non-impact. This station was sampled by OCWA in 2005, 2008, and 2009 with BAP scores of 4.8, 6.72, and 5.33, respectively, corresponding to slight impact classifications (**Table 1**). The 2012, the ISD was inconclusive.

Station 4600_004. Quassaick Creek station received a BAP score of 6.4 in 2012, corresponding to a BAP of slight impact. This station was sampled by OCWA in 2004, receiving a BAP score of 6.3, slight impact classification (**Table 1**). The 2012 ISD results indicated natural conditions and nonpoint source inputs.

Station 4600_005. Quassaick Creek station received a BAP score of 5.1 in 2012 and 5.4 in 2013, corresponding to a BAP impact classification of slight impact. This station was sampled by OCWA in 2004, receiving a BAP score of 7.3, slight impact classification (**Table 1**). The 2012 and 2013 ISD results were inconclusive.

Station 4600_006. Quassaick Creek station was sampled only in 2012, receiving a BAP score of 6.5, corresponding to a slight impact classification. (**Table 1**). ISD results were inconclusive.

Station 4600_007. Gidneytown Creek station received a BAP score of 7.1 in 2012 and 6.9 in 2013, corresponding to a BAP impact classification of slight impact. This station was sampled by OCWA in 2004, receiving a BAP score of 9.2, non-impact (**Table 1**). The 2012 ISD indicated natural conditions and impoundment effects. The 2013 ISD was inconclusive.

Station 4600_010. Gidneytown Creek station was sampled only in 2012, receiving a BAP score of 6.4, corresponding to a slight impact classification. (**Table 1**). ISD results were inconclusive.

Station 4600 012. Bushfield Creek station was sampled only in 2012, receiving a BAP score of 7.4, corresponding to a slight impact classification. (**Table 1**). ISD indicated natural conditions and non-point source nutrient inputs.

Station 4600 013. Bushfield Creek station received BAP scores of 7.0 in 2012 and 6.9 in 2013, corresponding to slight impact classifications (**Table 1**). In 2012, ISD indicated natural conditions and impoundment effects; in 2013, ISD indicated natural conditions, as well as non-point source and toxic inputs.

Station 4600 016. Patton Brook received a BAP 4.6 in 2013, corresponding to moderately impact classification (**Table 1**). ISD indicated toxic inputs.

Station 4600 015. Quassaick Creek station, sampled only in 2013, received a BAP score of 6.5, corresponding to a slight impacted classification. (Table 1). ISD indicated natural conditions.

Station 4800 013. Quassaick Creek station, sampled in 2013, received a BAP score of 4.8, moderate impact (**Table 1**). ISD indicated nonpoint source, organic, complex, siltation and impoundment effects. This station was also sampled by OCWA and NYS DEC SBU in 1987, 1992, 1997, 1998, 1999, 2002, 2005 – 2010. BAP scores were similar to the 2013 results, and water quality impact classification has remained in the moderate impact category since 2006.

Station 4800 014. Silver Stream station, sampled only in 2013, received a BAP score of 4.2, corresponding to a moderate impact classification. (**Table 1**). ISD indicated organic and complex inputs.

Station 4800 015. Silver Stream station, sampled only in 2013, received a BAP score of 3.8, corresponding to a moderate impact classification. (**Table 1**). ISD indicated organic and toxic inputs.

The majority of stations are slightly impacted and the ISD for the majority of these stations indicates natural conditions or natural and non-point source inputs (or are inconclusive). The 2012 and 2013 flow rates, however, were higher than in previous sampling years (2004 – 2010) due to increased precipitation; increased flow may dilute the impact of point sources, which are expected in this urban watershed. It is possible that water quality during such a high flow state is the highest attainable water quality these stations will achieve under current land use conditions. Longitudinal assessment will aid in determining of the types of anthropogenic influences on this watershed.

Additional information about the methodology and results, as well as recommendations, can be found in the full Report, located at the project website:

http://waterauthority.orangecountygov.com/quassaick_watershed.html

As shown in **Table 10**, one station has been the subject of monitoring efforts for over two decades; Station 4600_002/QUAS03, located on the Quassaick Creek just above the tidal estuary, has been sampled by either Orange County or the NYS DEC using the biomonitoring method 15 times since 1987 (**Figure 8**). The BAP scores for this site have ranged from a low of 2.58 in 1987 to a high of 6.59 in 2012.

Table 10. Biomonitoring Results for the Quassaick Creek Watershed (From NYSDEC Stream Biomonitoring, WAA 2008, WAA 2010, WAA 2014).

Sampling Program	Stream Name	Station ID	1987	1992	1997	1998	1999	2002	2004	2005	2006	2007	2008	2009	2010	2012	2013
Orange County Monitoring Program	Gidneytown Creek	4600_010														6.42	
	Gidneytown Creek	4600_007							9.20							7.10	6.90
	Bushfield Creek	4600_012														7.41	
	Bushfield Creek	4600_013														6.97	6.90
	Quassaick Creek	4200_002														7.34	7.20
	Quassaick Creek	4600_005							7.30							5.14	5.40
	Quassaick Creek	4600_004							6.30							6.40	
	Quassaick Creek	4600_001								4.80			6.72	5.33		7.68	
	Quassaick Creek	1100_001							6.70							6.46	
	Quassaick Creek	4600_015															6.50
	Silver Stream	4800_014															4.20
	Silver Stream	4800_015															3.80
	Patton Brook	4600_016															4.60
(sampled by both) NYSDEC Monitoring Program	Quassaick Creek	4800_013 QUAS03	2.58	6.18	5.15	4.49	5.54	4.51		5.10	4.40	4.21 4.33	4.95	4.73	4.02	6.59	4.80
	Quassaick Creek	QUAS01	7.15													7.31	
	Quassaick Creek	QUAS02	4.55				5.13										
	Quassaick Creek	QUAS04N	2.9														
	Quassaick Creek	QUAS04S	1.42														
	Gidneytown Creek	GIDN01														7.62	



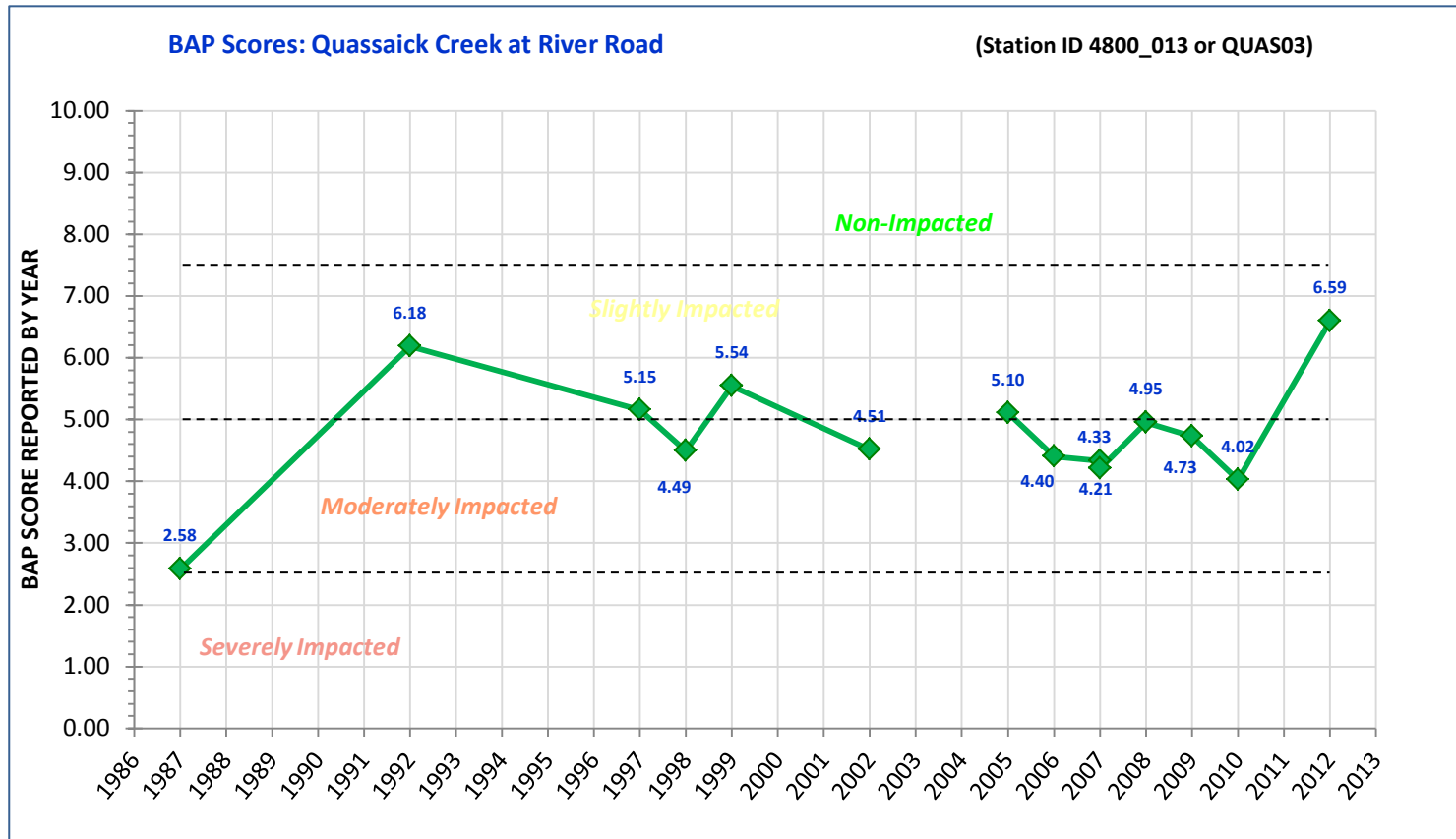
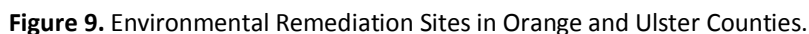


Figure 8. Biological Assessment Profile (BAP) scores from 1987 to 2012 for Quassaick Creek at River Road (Station 4800_013 or QUAS03).

A number of State superfund and environmental restoration sites (i.e., remediation sites) occur in the Watershed, mostly in the City of Newburgh and along the boundary between the Towns of Newburgh and New Windsor (**Figure 9**). For several of the State superfund sites symbolized in orange, remediation



work has been initiated (e.g., site characterization, investigation, design, action), but work is on-going. Exceptions to this are the Stewart Air National Guard Base (Site #336022), New Windsor Town Landfill located on Silver Stream Road (Site #336019) and the Macbeth Kollmorgen Corporation site in New Windsor (adjacent to Washington Lake; Site #336037), which have been properly remediated and are currently being maintained and monitored. All state superfund sites located within subwatersheds to drinking water reservoirs have been properly remediated, and the on-going management and monitoring of these sites helps to protect these resources from groundwater contamination. The Environmental Restoration Program sites symbolized in yellow represent non-registry sites where efforts are underway to address the contamination. These brownfield sites were contaminated, but through State funding, land owners were able to initiate a site investigation and subsequent remediation efforts to clean up the site. Voluntary Cleanup Program, sites shown in blue, is a program designed to enhance private-sector cleanups of brownfields. Often these land owners receive tax credits or other incentives to promote the cleanup and redevelopment of these historically contaminated sites.

No State superfund or remediation sites (e.g., Environmental Restoration, Voluntary Cleanup) occur within the Ulster County portion of the Watershed.

2: 3.8 WATER AND WASTEWATER TREATMENT AND INFRASTRUCTURE

In Orange County, the Towns of Newburgh and New Windsor and the City of Newburgh are primarily dependent on surface water for drinking water. The Town of Newburgh serves 22,800, the City of Newburgh serves 28,000, and the Town of New Windsor serves 20,276 people. The sources of water supply for the City of Newburgh are the drainage basins of Patton Brook, Upper Silver Stream, and Washington Lake. The water produced by these drainage areas is stored in two major storage reservoirs: Brown's Pond and Washington Lake. Present day operations for the City's water supply does not include the utilization of Lockwood Basin as a drinking water source (locally referred to as Masterson's Pond). When these sources of supply are not available or need to be supplemented, a tap on the New York City Catskill Aqueduct can be used as an emergency supply. The City of Newburgh has an agreement in place with New York City which provides for a 4.5 million gallon per day allotment, if use of the aqueduct water becomes necessary. In addition, the City of Newburgh recently constructed a pump station and pipeline which allows for water to be delivered directly from the Catskill aqueduct tap or Brown's Pond to the filtration plant. This new configuration now provides for a truly independent source of supply should the Washington Lake supply become unavailable. The Town of New Windsor is reliant on the New York City water supply as its primary drinking water supply.

As described earlier, Washington Lake can be supplemented by Brown's Pond and Patton Brook via constructed diversions referred to as Silver Stream Diversion and Murphy's Ditch, respectively.

Depending on the need, water is obtained from either the Silver Stream diversion or Murphy's Ditch to maintain the elevation in the lake (OCWA/HDR 2012). As a general rule, Brown's Pond is maintained at full pool elevation and drawn down as little as possible, i.e., water is not released from the reservoir downstream to Washington Lake. This preserves an excess supply for both the City of Newburgh as well as the Town of New Windsor should it be necessary for its use. In addition, during low runoff periods the gates at the Silver Spring diversion basin are left open so the runoff generated within the lower portion of the Upper Silver Stream subwatershed is captured in Washington Lake. Murphy's Ditch is generally kept closed due to its dynamic hydrology, and is only activated when a significant precipitation event is predicted and there is a need for additional supply in Washington Lake (OCWA/HDR 2012). Anecdotal observations by members of the Quassaick Creek Watershed Alliance from 2011-2012 indicate that Murphy's Ditch has been open for many months, with the only known recent closure during the 2011 Tropical Storms (August/September 2011).

Four water filtration plants are located in these three municipalities (**Map 6**). In the Town of Newburgh, the Chadwick Lake Filtration Plant provides up to 2.0 mgd to the water supply. In the City of Newburgh, the Washington Lake Filtration Plant provides up to 9.5 mgd. In New Windsor, the Riley Road Filtration Plant and Stewart Airport Filtration Plant Aqueduct Taps provide 3.0 mgd and 0.5 mgd to the water supply of the area (OCWA 2010a). Residents and businesses in the Towns of Newburgh and New Windsor that are outside the designated water districts, tap from private, individual wells.

Based on the recent [Orange County Water Master Plan](#), both the Towns of Newburgh and New Windsor are in need of new or upgraded water treatment facilities. The Town of Newburgh needs a new facility due to a USEPA consent decree and the Town of New Windsor needs to upgrade and increase the capacity of its existing system. In response to these needs, a number of options for regionalizing the area's water supply infrastructure are currently under consideration as part of the Northeast Orange County Water Supply Implementation Plan. With the implementation plan currently underway, the three municipalities are committed to sharing water resources in the region. It is believed that such a regional approach to water supply management will result in cost efficiencies, energy conservation, and overall water management flexibility to meet the demand associated with the region's growing population (OCWA 2010a). Additionally, the [New York City Department of Environmental Protection](#) is currently progressing plans to improve portions of the Catskill and Delaware aqueducts. Although the project may temporarily disrupt water supplies within this region during construction, the project will improve the overall reliability of water supply in the northeast Orange County region.

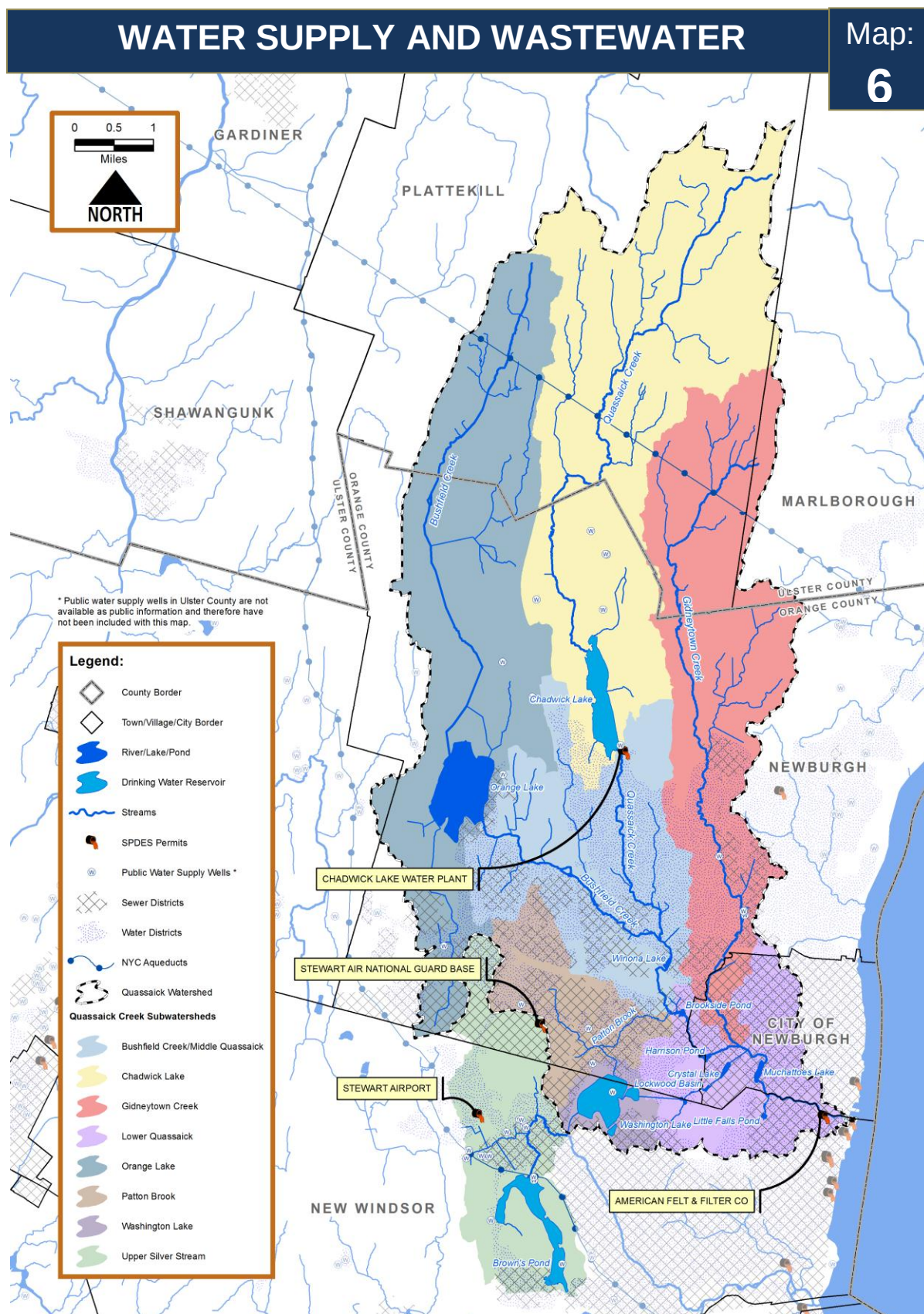
The Town of Marlborough in Ulster County is also reliant on the New York City water supply system for drinking water, specifically the Delaware Aqueduct fed by the Rondout Reservoir. The Marlborough-Milton water district has an auxiliary storage reservoir that can distribute drinking water to a portion of

the district as an emergency supply (Stearns and Wheeler 1989). Individual and community wells supply the residents of the Town of Plattekill with drinking water (Stearns and Wheeler 1989), and there appear to be no municipal drinking water systems in place.

The southern portion of the Quassaick Creek Watershed contains municipal sewer districts. Within subwatersheds that supply drinking water reservoirs, Patton Brook, and Washington Lake subwatersheds are sewered, as are small areas north and south of Brown's Pond (**Map 6**). The Chadwick Lake subwatershed is not sewered, but the lake is protected by large areas of undeveloped land along its shores.

City of Newburgh maintains a combined sanitary and stormwater system which collects and conveys wastewater from a portion of the city to the Newburgh Wastewater Treatment Plant (WWTP). The WWTP, which is located at the foot of Renwick Street outside the Watershed, is operated as a service to the City via a private firm, Severn Trent Services. The majority of the Town of Newburgh that contains sewer districts conveys waste to the City's WWTP through an intermunicipal agreement, "the 13.5 million gallon per day (MGD) wastewater treatment plant utilizes the activated sludge system and produces an average daily flow of 6.3 MGD" (City of Newburgh 2011). Effective preventative and corrective measures are in place to maintain and increase the lifespan of the WWTP.

The Town of Newburgh also has a small sewer district in the Gidneytown Creek subwatershed which collects and conveys sewage from residential subdivisions to the Newburgh Nob Hill Sewer District Sewage Treatment Plant. The Town of New Windsor portion of the Watershed, along with areas south of the Watershed, collects and conveys sewage to the New Windsor Sewage Treatment Plan which is located on Caesars Lane, outside of the Watershed. The remainder of the Watershed, which consists of the northern portion of the Town of Newburgh and the southern portion of the Town of Plattekill, do not contain sewer districts. Wastewater treatment within this portion of the Watershed is typically performed by individual or community septic systems that are within the general vicinity of the user.



2: 4 Living Resources

2: 4.1 HABITAT CHARACTERISTICS, INCLUDING DAM & BARRIER INVENTORY

An extensive biodiversity study of the lower portion of the Quassaick Creek was conducted by Spider Barbour (2004) and focuses on habitat types and characteristics such as animals and vegetation, along with notes of invasive species. The Lower Quassaick Creek subwatershed has steep slopes in some areas and low-lying pools and ponds that serve as potential breeding habitat for amphibians. Information on the northern portion of the Watershed in Ulster County is scarce and has been characterized in Section 6 based on land use/land cover data. Prior to this, a study of the Quassaick Watershed was performed in 1988-1989 with funding from the [Hudson River Foundation](#) as part of the Baseline Assessment of Tributaries to the Hudson River (BATH; Stevens et al. 1994). Although somewhat dated, this study provides data on the upper portions of the Quassaick Creek and a station each on the Bushfield and Gidneytown creeks, and describes interannual, seasonal patterns that are often lacking in many more recent studies.



Figure 10. Low-head impoundment at the American Felt and Filter Site on the Quassaick Creek. Photo courtesy P. Smith, 2012.

The habitat of the Quassaick Creek Watershed is characterized by riparian forested areas and wetlands in the northern extent of the watershed, and transitions to predominantly urban land along the Quassaick and its tributaries towards the southern half of the Watershed. Various forest habitats such as deciduous, evergreen and mixed forests make up a substantial portion of the watershed, especially in the northern parts near the Ulster/Orange County border into

Plattekill and Marlborough. Shallow emergent marsh environments provide primary habitat for many

marsh birds such as bitterns and rails along with many song birds. Floodplain forests exist with soils that are inundated or saturated only intermittently at times of very high water or copious amounts of groundwater output from streamside seeps (Barbour 2004).

A key concern along the streams is the number of dams and other barriers, particularly in the Lower and Quassaick subwatershed. Many of these impoundments are small, low head dams constructed as the City of Newburgh expanded and industries developed along the Quassaick Creek from the late 1700s into the 1900s. These barriers are currently being evaluated by the [Quassaick Creek Watershed Alliance](#) to better understand the barriers' effects in hindering upstream fish passage and on water flow and pooling.

Dams can serve important functions like water supply storage, power generation, flood control, and recreation (e.g., fishing, kayaking). With the region's reliance on surface water drinking reservoirs, many impoundments in the Watershed are critical to maintaining an adequate and safe drinking water supply. However, there are a number of aging, low-head impoundments in the Watershed, remnants of the region's industrial history, which may no longer be serving a purpose. There are two dams within the lower 1 mile segment of the Quassaick Creek: the Strooks Felt Mill Dam is roughly 0.6 miles (1 km) upstream from the Hudson River, and the Holden Dam is another 0.4 miles further upstream. The Strooks Felt Mill Dam is 7.5 ft. (2.3 m) high with a large concrete apron (Schmidt and Cooper 1996, Barbour 2004). The Washington Lake Reservoir Dam controls the storage of up to 1.5 billion gallons of water and can regulate the water released to the rest of the downstream system and into the drinking water system (Barbour 2004).

A list of barriers catalogued by State and Federal governments is provided in **Table 11** below and is displayed on **Map 6**. This list includes dams that are within the NYSDEC's Dam Safety Unit's dam inventory; these dams have a State ID number in the Table. The National Oceanic and Atmospheric Administration (NOAA) has identified several additional low head impoundments, natural barriers like rapids, rock ledges, and falls (occasionally formed from former, derelict dams), and constructed barriers like culverts and bridges in the Quassaick Creek Watershed. For example natural falls, rock ledges/rapids form potential natural barriers in the lower Quassaick Creek, and near Muchattoes Lake are twin culverts (C. Alderson, pers. comm.). Several impoundments exist within the Gidneytown Creek, but these have not been inventoried.

Table 11. List of barriers/structures by subwatershed

Subwatershed	State ID	Name of Barrier/Structure	Waterbody Impounded	Number in Map 7
Gidneytown Creek	194-3666	Rizzo Farm Pond Dam	Gidneytown Creek	
	194-3053	Diachishin Lake Dam	Gidneytown Creek	22
	n/a	Unnamed Dam	Gidneytown Creek	49
	n/a	Huckleberry Turnpike Culvert	Gidneytown Creek	48
	n/a	Unnamed Dam	Gidneytown Creek	46
	n/a	Unnamed Dam	Gidneytown Creek	47
Bushfield Creek/ Middle Quassaick	194-0944	Winona Lake	Quassaick Creek	12
	194-5291	Carney Pond Dam	Quassaick Creek	13
	194-1075	Newburgh Pond #1 Dam	Bushfield Creek	16
	194-1074	Newburgh Pond #2 Dam	Bushfield Creek	15
	194-1073	Newburgh Pond #3 Dam	Bushfield Creek	14
	n/a	Rock Weir with Culverts	Bushfield Creek	58
	194-5764	DeCarlo Dam	Quassaick Creek	17
	194-3133	Town Hall Park Dam	Quassaick Creek	18
	n/a	Unnamed Dam	Bushfield Creek	33
	n/a	Unnamed Dam	Bushfield Creek	34
	194-0570	Orange Lake Dams	Quassaick Creek	19
	n/a	Unnamed Culvert/Bridge	Quassaick Creek	61
	n/a	Little Brook Lane Culverts	Quassaick Creek	54
	194-0945	Little Brook Farm Dam	Quassaick Creek	55
Orange Lake	n/a	Quaker Street Culvert	Bushfield Creek	50
	n/a	Unnamed Dam	Bushfield Creek	39
	n/a	Indian Dam	Bushfield Creek	38
	n/a	Unnamed Dam	Bushfield Creek	35
	n/a	Unnamed Dam	Bushfield Creek	36
	n/a	Unnamed Dam	Bushfield Creek	37



Table 11. List of barriers/structures by subwatershed

Subwatershed	State ID	Name of Barrier/Structure	Waterbody Impounded	Number in Map 7
Chadwick Lake	194-0583	Chadwick Lake Dam	Quassaick Creek	20
	n/a	NYS Route 32 Culvert	Quassaick Creek Tributary	25
	n/a	Unnamed Dam	Quassaick Creek	26
	194-5776	Unnamed Dam	Quassaick Creek	27
	n/a	Unnamed Dam	Quassaick Creek Tributary	32
	n/a	East Road Culvert	Quassaick Creek Tributary	51
	194-0600	Groom Mill Pond Dam	Quassaick Creek	23
	n/a	Tea Kettle Street Culvert	Quassaick Creek	28
	n/a	Unnamed Dam	Quassaick Creek	29
	194-5821	Plattekill Rod and Gun Club	Quassaick Creek Tributary	30
	n/a	Unnamed Dam	Quassaick Creek Tributary	32
Lower Quassaick	195-0535A	Strooks Felt Mill Dam	Quassaick Creek	2
	n/a	Riffles	Quassaick Creek	57
	n/a	Unnamed Dam	Quassaick Creek	60
	195-0535B	Holden Dam	Quassaick Creek	4
	n/a	Riffles	Quassaick Creek	24
	195-0535C	Walsh Road Dam	Quassaick Creek	5
	194-0545	Harrison Dam	Quassaick Creek	9
	n/a	Little Falls Park Culvert	Quassaick Creek Tributary	56
	n/a	Little Falls Dam #1	Quassaick Creek Tributary	52
	n/a	Little Falls Dam #2	Quassaick Creek Tributary	41
	n/a	Little Falls Dam #3	Quassaick Creek Tributary	40
	195-0535D	Muchattoes Lake Dam	Quassaick Creek	7



Table 11. List of barriers/structures by subwatershed

Subwatershed	State ID	Name of Barrier/Structure	Waterbody Impounded	Number in Map 7
	194-0535F	Crystal Lake Dam	Quassaick Creek Tributary	8
	194-0535G	Miller's Pond Dam	Quassaick Creek Tributary	42
	n/a	Laborers Local 17 Dam #2	Quassaick Creek Tributary	43
	n/a	Laborers Local 17 Dam #1	Quassaick Creek Tributary	44
	n/a	City of Newburgh Water Treatment Dam	Quassaick Creek Tributary	45
	195-0544	McDole Mill Pond Dam	Quassaick Creek	10
	194-0547	Brookside Pond Dam	Quassaick Creek	11
Upper Silver Stream	195-2525	Newburgh Dam	Silver Stream	1
	195-0531	Silver Stream Reservoir Dam	Silver Stream	53
Washington Lake	195-5705	Lockwood Basin Dam	Silver Stream	3
	195-0536	Washington Lake Dam	Silver Stream/ Patton Brook (diverted)	6

2: 4.2 FLORA AND FAUNA

2: 4.2.1 Flora

Tree Species

Within riparian communities, many native tree species occur such as American sycamore (*Platanus occidentalis*), eastern cottonwood (*Populus deltoides*), tulip tree (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), bitternut hickory (*Carya cordiformis*), red mulberry (*Morus rubra*), black willow (*Salix nigra*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), black locust (*Robinia pseudo-acacia*), ash-leaf maple (*Acer negundo*), Norway maple (*Acer platanoides*) and tree-of-heaven (*Ailanthus altissima*) (Barbour 2004). Old, relatively undisturbed forests are dominated by large red maple (*Acer rubrum*) and black oak (*Quercus velutina*). In areas of recent disturbance, the forest canopy consists of mostly medium sized trees with an understory of smaller, younger trees and large shrubs. Examples include sugar maple (*Acer saccharum*), American elm (*Ulmus americana*), and black walnut (*Juglans nigra*).

Shrub and Herbaceous Species

Exotic shrub and herb species include Morrow honeysuckle (*Lonicera morrowii*), Oriental bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata*) and mugwort (*Artemisia vulgaris*). Examples of native shrubs and herbs found in Quassaick Creek Watershed as documented by Barbour are skunk cabbage (*Symplocarpus foetidus*), wild ginger (*Asarum canadense*), cut-leaf toothwort (*Cardamine concatenata*), rattlesnake fern (*Botrychium virginianum*), zigzag goldenrod (*Solidago flexicaulis*) and Canada moonseed (*Menispermum canadense*). These species occur in undisturbed forest environments. In the area surrounding Muchattoes Lake shrubs including silky dogwood (*Cornus amomum*), cranberry-bush (*Viburnum opulus*) and black cherry (*Prunus serotina*) are present. Herbs along the shore included purple loosestrife (*Lythrum salicaria*), clearweed (*Pilea pumila*), arrow-arum (*Peltandra virginica*), water-purslane (*Ludwigia palustris*) and frog's-hair (*Eleocharis acicularis*) (Barbour 2004).

Elsewhere, in the sloped forests on the banks of the lower Quassaick Creek, are other herbaceous species such as motherwort (*Leonurus cardiaca*), Asiatic dayflower (*Commelina communis*) and foxtail grass (*Setaria glauca*). Native herbs include jumpseed (*Polygonum virginianum*), orange touch-menot (*Impatiens capensis*) and tall goldenrod (*Solidago gigantea*).

Shallow emergent marsh environments contain herbaceous vegetation such as cattail (*Typha* sp.), bulrush (*Scirpus hattorianus*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*).

2: 4.2.2 FAUNA

Birds

Over the course of 11 years, from 1991-2002 the National Audubon Society (NAS) conducted annual winter bird surveys throughout most of the Quassaick Creek Watershed. During these surveys, 115 bird species were observed and recorded (NAS 2002). Barbour (2004) also conducted a bird survey during his biodiversity study. The species observed are presented in **Appendix A**.

Reptiles and Amphibians

A variety of reptiles and amphibians commonly found throughout New York State were also observed in the Quassaick Creek watershed during the Barbour biodiversity study (2004). These include wood turtle (*Clemmys insculpta*), painted turtle (*Chrysemys picta*), common snapping turtle (*Chelydra serpentina*), northern water snake (*Nerodia sipedon*), green frog (*Rana clamitans*), pickerel frog (*Rana palustris*), and northern two lined salamander (*Eurcea bislineata*).

Mammals

A variety of mammals are commonly found in the Quassaick Creek watershed. Mammals observed during the Barbour biodiversity study (2004) include eastern gray squirrel (*Sciurus carolinensis*), eastern cottontail (*Sylvilagus floridanus*), and white-tailed deer (*Odocoileus virginianus*). Other mammals that are found throughout the Hudson River Valley include eastern chipmunk (*Tamias striatus*), groundhog (*Marmota monax*), North American beaver (*Castor canadensis*), black bear (*Ursus americanus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), striped skunk (*Memphitis memphitis*), opossum (*Didelphis virginiana*), red fox (*Vulpes vulpes*) and gray fox (*Urocyon cinereoargenteus*).

Fish

The fish indigenous to the Quassaick Creek Watershed are those that are common across the northeastern United States fresh and tidal waters. In a study by Lake and Schmidt (1998), 35 fish species from 14 different families were collected from the Quassaick Creek within a mile of where the creek enters the Hudson River. These species included four classifications of estuarine fish; anadromous, catadromous, potamodromous and residential. Additional species are known to be found in the Hudson River where the Quassaick Creek enters it at approximately river mile 60. Upstream species diversity is lower because of the many dams and impoundments that prevent or impede fish passage. Available data comes from Lake and Schmidt's study at the mouth of the Quassaick (1998) and an impingement and entrainment report on a nearby New Windsor power plant on the Hudson River (ASA Analysis and Communication 2010). The migratory species such as striped bass (*Morone saxatilis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), and blueback herring (*Alosa aestivalis*) are scarce past the impoundments along the length of the watershed. American eel (*Anguilla rostrata*) have been documented within the Lower Quassaick subwatershed, but the extent of upstream migration within the watershed is unclear. As the salt front moves north up the Hudson River, fish such as bluefish (*Pomatomus saltatrix*), bay anchovy (*Anchoa mitchilli*), and hogchoker (*Trinectes maculatus*) may enter the tributary to feed.

Eel Monitoring

The Quassaick Creek Watershed Alliance participated in the New York State eel monitoring in 2012. They monitored each Sunday from March 25 to May 5, alternating morning and afternoon to better match the low tide schedule. In all, the Alliance counted eels on 9 separate days for an estimated 57 man-hours of volunteer time. (Photo Courtesy P. Smith).



Other species that may utilize the mouth of the creek include Atlantic menhaden (*Brevoortia tyrannus*), summer flounder (*Paralichthys dentatus*), and Atlantic tomcod (*Microgadus tomcod*) (ASA Analysis and Communications 2010).

The creeks also support a population of warm water fish as such as largemouth bass (*Micropterus salmoides*), pumpkinseed (*Lepomis gibbissus*), and chain pickerel (*Esox niger*). In the middle Watershed the species assemblage species more common to moving water, like shiners, suckers and dace: blacknose dace (*Rhinichthys atratulus*), longnose dace (*Rhinichthys cataractae*), white sucker (*Catostomus commersoni*), tessellated darter (*Etheostoma olmstedii*), and common shiner (*Luxilus cornutus*) (Stevens et al. 1994). Common fish species based on studies of the Quassaick Watershed are presented in **Appendix A**.

Insects and other Invertebrates

Various insects and invertebrates were observed during the Barbour (2004) biodiversity study as well. These include numerous species of damselflies and dragonflies (Odonata) and moths and butterflies (Lepidoptera). Aquatic macroinvertebrates that were observed during this study included crayfish (Cambaridae), caddisfly larvae (Trichoptera), and physid snails (Physidae). Stream biomonitoring reports from 2004-2010 support Barbour's findings by collecting the same species while additionally finding fly (Diptera), beetle (Coleoptera), and mayfly larvae (Ephemeroptera), crustaceans (Amphipoda and Isopoda), and bivalve molluscs (Veneroida) (OCWA 2010a).

2: 4.3 PROTECTED SPECIES AND HABITATS

The Barbour biodiversity study (2004) identified two occurrences of the wood turtle, a species of special concern in New York, in and near the Quassaick Creek. This report also identified the presence of two rare plants in the Quassaick corridor (woodland agrimony and narrow-leaved sedge) and mapped out six significant natural areas in and around the Quassaick.

Two Significant Natural Communities listed by the [New York Natural Heritage Program \(NHP\)](#) occur in the Watershed. A substantial portion of the Orange Lake subwatershed is mapped as Red Maple Hardwood Swamp, which is a low-lying wetland community that is seasonally flooded, which transfers upstream nutrients to the floodplain (**Table 12, Map 7**). A small area in the Chadwick Lake subwatershed is mapped as Hemlock Northern Hardwood Forest, also a Significant Natural Community. These communities are important because they maintain the hydrologic integrity of these stream drainages with upland vegetated buffers (**Table 12, Map 7**).

RARE SPECIES AND SIGNIFICANT NATURAL HABITATS

Map:
7

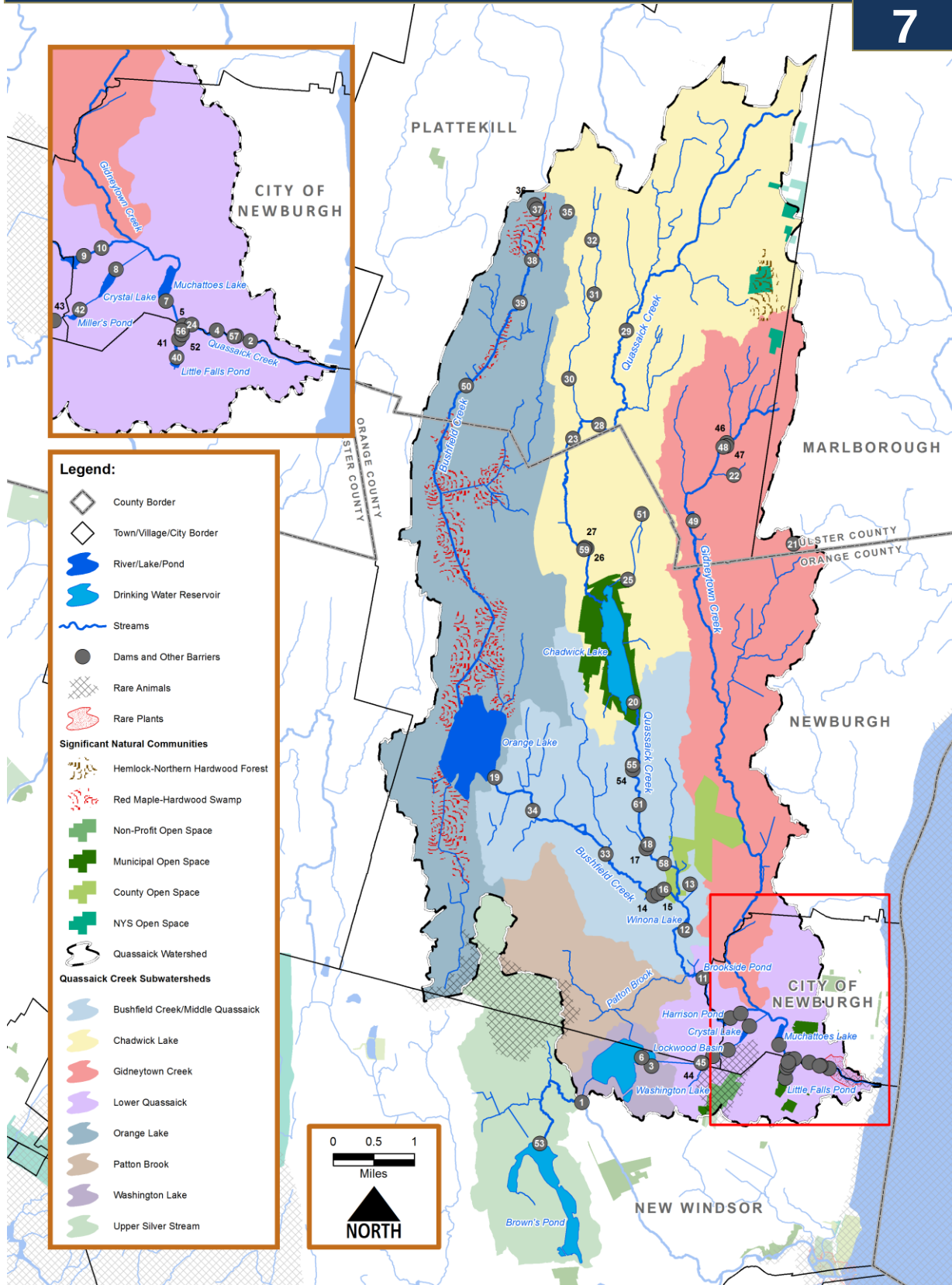


Table 12. Significant Natural Communities identified in the Quassaick Creek Watershed by the New York Natural Heritage Program

Community	Community Description	Subwatersheds with Communities Present
Hemlock Northern Hardwood Forest	Modestly sized, diverse, mature forest undergoing invasive pest species induced canopy mortality. Located on the edge of, but with excellent connectivity (100%) to its moderately large, mature to maturing predominantly forested land.	Chadwick Lake
Red Maple Hardwood Swamp	A mature and very large swamp with very high species diversity (>90 Species) and a wide habitat variety based on physiology, hydrology, micro-habitat, etc. Few exotic species	Orange Lake

Several species listed protected by the [Endangered Species Act \(ESA\)](#) may occur or have habitat in Orange and Ulster Counties (**Table 13**). The bald eagle was delisted on August 8, 2007. While there are no ESA requirements for bald eagles, the species continues to receive protection under the [Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act](#). A nesting pair of bald eagles has been observed near Orange Lake. Bog turtles are identified as potentially having habitat in the Watershed; however there are no recent records of bog turtles in the Watershed and with most mapped wetlands in the Watershed being forested, suitable habitat may be sparse. Indiana and Northern long-eared bats are likely to utilize areas in the Watershed for summer roosting, based on the proximity of caves in Ulster County where many species of bats in NY have been documented to hibernate. Northern long-eared bat is currently a proposed endangered species (**Table 13**).

Portions of the Watershed are also mapped as being Important Areas for State-protected species: the upland sandpiper and woodland agrimony (NYNHP 2011 and confirmed in Barbour 2004). NHP also identifies two fish species where the Quassaick enters the Hudson; shortnose and Atlantic sturgeon, although it is not likely that these species use the Quassaick Creek itself (**Table 13, Map 7**).

Table 13. State and/or Federally listed species identified in the Quassaick Creek Watershed by the New York Natural Heritage Program

Common Name	Scientific Name	State Status	Federal Status	Habitat Description	Subwatersheds with Habitat
Fauna					
Bald eagle	<i>Haliaeetus leucocephalus</i>	T	Delisted; MBTA	Migratory and nesting near large bodies of water, generally away from people	Orange Lake, Chadwick Lake, Upper Silver Stream
Indiana bat	<i>Myotis sodalis</i>	E	E	Winter (Ulster only): Cave hibernacula; Summer: trees with exfoliating bark near canopy gaps	All have potential summer roosting habitat
Northern long-eared bat	<i>Myotis septentrionalis</i>	N/L	E(p)	Similar to Indiana bat habitat. More opportunistic roosts, including smaller trees and structures.	All have potential summer roosting habitat
Bog turtle	<i>Clemmys muhlenbergii</i>	E	T	Open-canopy wet meadows, sedge meadows, and calcareous fens	Limited, if any
Upland sandpiper	<i>Bartramia longicauda</i>	T	MBTA	Breeding; obligate grassland species	Orange Lake, Upper Silver Stream, Patton Brook
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	E	E	Spawning	N/A – Hudson River
Atlantic sturgeon	<i>Acipenser oxyrinchus</i>	N/L	E	Spawning	N/A – Hudson River
Flora					
Woodland agrimony	<i>Agrimonia rostellata</i>	T	N/L	Rich mesic forests	Gidneytown & others
Small whorled pogonia	<i>Isotria medeoloides</i>	N/L	T	Moist woods	Historic record; most likely extirpated from region

Notes: Threatened: T, Endangered: E, Not Listed: N/L, Proposed Endangered: E(p); Migratory Bird Treaty Act: MBTA

Sources: US Fish and Wildlife Service online county listings (July 2012); NYSDEC NHP data request (June 2012)

2: 5 Land Use and Land Cover

2: 5.1 OVERVIEW

According to the Town of Newburgh Comprehensive Plan (2005), the majority of the Town is comprised of residential and industrial/commercial development. High density residential land use is located in a number of different areas around the Town while industrial and commercial land uses are



mostly located along the Town's major corridors, particularly around Interstates 87 and 84 and Route 17K. Significant land holdings in the Watershed are owned by the Thruway Authority, New York State Department of Transportation, the Port Authority of NY/NJ (Stewart Airport), and the US Army (Stewart Air National Guard). Recreation and entertainment, community services, and public services can be found throughout the Town. Agriculture, vacant, and forest lands make up the majority of land located in the northern part of the Town. The City of Newburgh and the north end of New Windsor are similarly comprised mostly of residential (single-family), commercial and industrial developed land. The majority of the land along the border between the two municipalities is heavily developed (City of Newburgh City Council 2011, Town of New Windsor 2009).

Within the Town of Plattekill, agriculture has historically been the prominent land use category. However, during recent years, residential development has increased, causing conflicts between development trends and active agricultural land. A good deal of Plattekill remains devoted to agriculture, predominantly apple orchards. However, throughout the last 50 years, portions of the town have been developed into residential uses, linked to the region's economy and improved accessibility to the entire Hudson Valley and New York Metropolitan Areas via the New York State Thruway and Interstate 84 (Town of Plattekill 2003). In Marlborough, land use has seen a dramatic shift away from agricultural land to residential development since 1969 when agricultural land was approximately 64% of the town land. As of the most recent land use survey in 2001, agricultural land is now approximately 40% while land cover of residential development increased by over 400% (Town of Marlborough 2002). Additionally, up to the early 1970s, the Town of Plattekill was a seasonal destination for New York City residents, which resulted in the creation of many bungalows and villas. Since then, many of these houses have been converted to year-round residences and present concerns regarding sub-standard sized lots and well/septic separation.

According to the land use analysis completed for this report (using 2006 National Land Cover Data), the entire Quassaick Creek watershed is divided mostly between five groups of land use categories. Deciduous Forest land use encompasses the most land in the watershed at greater than 29% (16.4 mi²). This is followed by Palustrine Forested Wetlands (20%, 10.9 mi²), the combination of all Developed Land (14%), Cultivated Crops (12%, 6.9 mi²), and Mixed Forest (11%, 6.1 mi²). Complete percentage breakdown by subwatershed is available in **Table 14** and a land use map is presented in **Map 8**.

LAND USE / LAND COVER

Map:
8

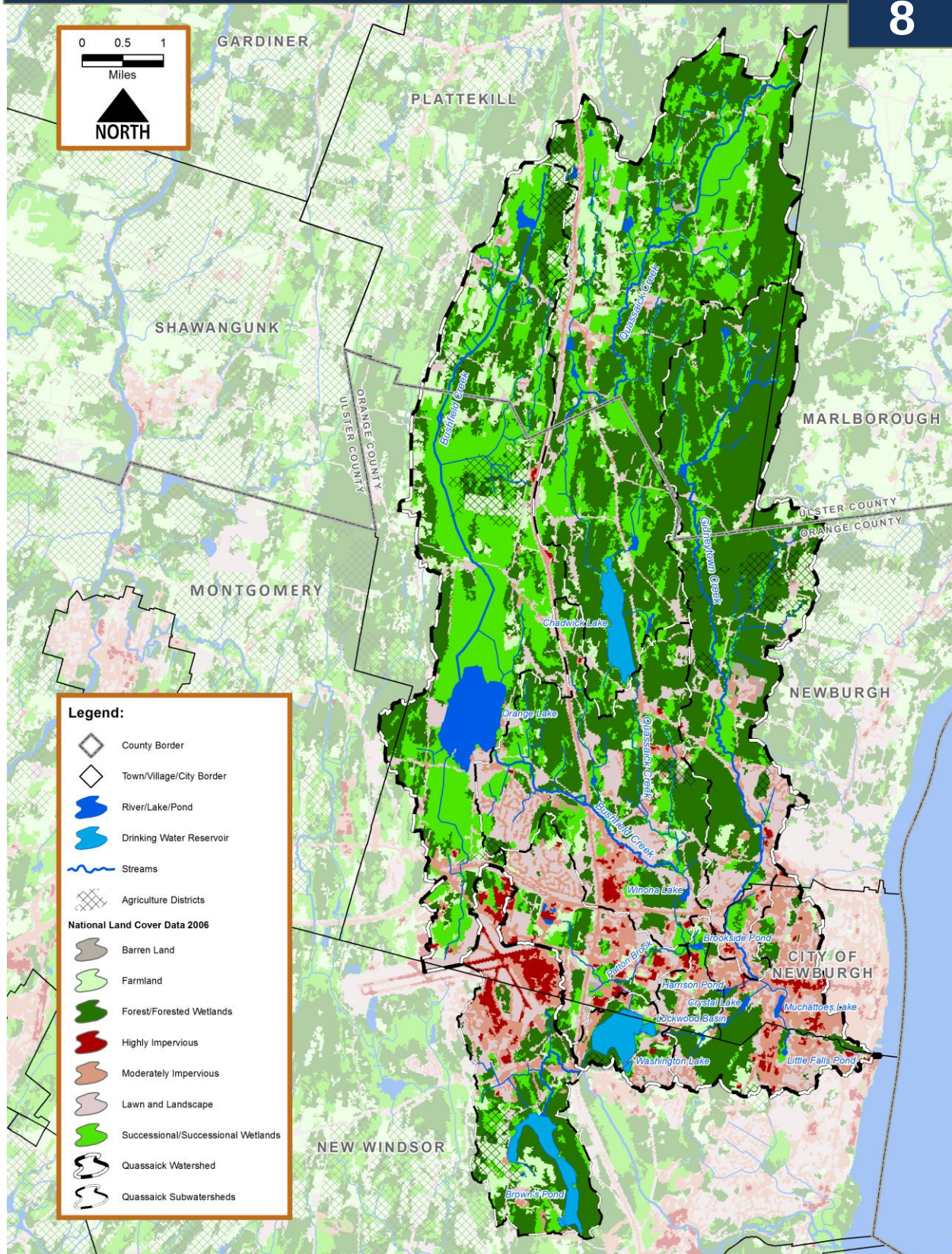


Table 14. Land Cover Use Percentage by Subwatershed

Land Cover Use	Percentage of Subwatershed								
	Bushfield Creek/ Middle Quassaick	Chadwick Lake	Gidneytown Creek	Orange Lake	Patton Brook	Lower Quassaick	Washington Lake	Upper Silver Stream	Percent of Total
Developed, High Intensity	2	0	1	0	12	7	5	2	2
Developed, Medium Intensity	4	0	3	1	10	13	10	1	3
Developed, Low Intensity	14	2	8	3	13	21	15	4	7
Developed, Open Space	1	0	1	0	13	4	12	6	2
Cultivated Crops	5	15	20	10	7	7	3	13	12
Pasture/Hay	0	5	5	9	1	5	1	11	6
Grassland/Herbaceous	2	1	1	1	1	1	1	0	1
Deciduous Forest	26	39	37	28	11	17	27	17	29
Evergreen Forest	2	4	2	1	1	2	1	1	2
Mixed Forest	13	9	12	12	5	9	14	15	11
Scrub Shrub	2	1	1	1	2	1	0	1	1
Palustrine Forested Wetland	20	19	8	32	23	7	11	24	20
Palustrine Scrub/Shrub Wetland	1	3	0	2	0	0	0	3	2
Palustrine Emergent Wetland	2	0	0	0	0	0	0	1	0
Estuarine Emergent Wetland	0	0	0	0	0	0	0	0	0
Bare Land	1	0	1	0	1	1	0	0	0
Open Water	6	2	0	1	0	6	0	1	2
Palustrine Aquatic Bed	0	0	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100	100



2: 5.2 PROTECTED OPEN SPACE

Protected open space is defined as predominantly undeveloped land that is historical, agricultural, recreational, vacant, or any other combination thereof in nature and is protected from development by one of several methods outlined below. Such land can be publically or privately owned and is often, but not always, open to the public. Such areas can range in size and character from a small urban pocket park to large tracts of forests. Protected open space is guaranteed to remain undeveloped because it is owned by a conservation organization (such as a land trust), a government agency, or by any other entity whose mission is to protect land from development or if there is a conservation easement on the property. Examples of permanent protected open space include Federal, State and local parkland and wildlife refuges. **Map 9** shows an inventory of the protected open space within the Quassaick Creek Watershed and its subwatersheds. Protected open space on this map includes Chadwick Lake, Algonquin, and Cronomer Hill Parks located in Newburgh, and Snake Hill Preserve and Little Falls Park located in New Windsor. More information on these lands can be found under Recreation and Tourism **Section 2: 7.3**.

2: 5.3 GENERAL DEVELOPMENT TRENDS

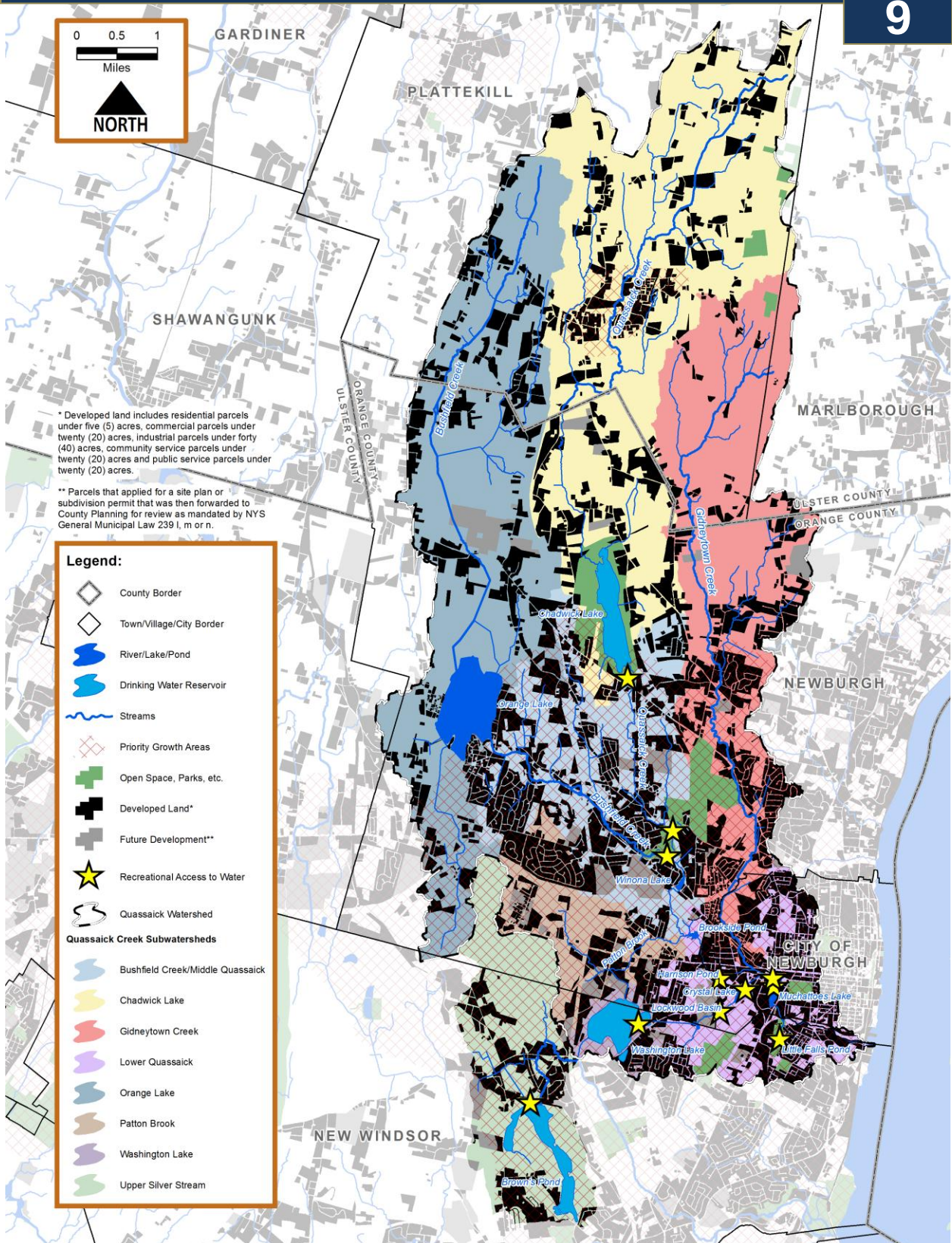
Over the last 20 years, the watershed population and development has expanded in all municipalities. The Town of Newburgh, making up the highest percentage of the watershed, is made up mostly of single family residents located in high density at various places around the town. Industrial and commercial development is most dense along the Town's major corridors, particularly Interstates 84 and 87 and Route 17K. Recreation and entertainment, community and public services, agriculture, vacant lands, and wild and forestlands are mostly located in the northern part of the town and make up small percentages of the land total. The fastest growing land use in the Town of Newburgh is residential. As of 2005, residential land use accounted for 36 percent of all land uses in the Town. An increased pace of growth and development is occurring in parts of the Town where existing zoning permits multi-family residential use adjacent to single family neighborhoods, where water and/or sewer service is readily available, where lands are vacant, and where farmland is becoming increasingly uneconomical. The majority of this development is occurring in the southern part of the Town around Route 17K and Interstates 84 and 87 (Town of Newburgh 2005).

2: 5.4 IMPERVIOUS COVER AND STORMWATER MANAGEMENT

In addition to the pollutants associated with impervious surface and stormwater runoff, there are other concerns with having large areas of impervious surface in a watershed. When it rains, runoff from impervious surface can be swiftly carried to nearby streams, lakes, wetlands and rivers and can cause flooding and erosion. Additionally, runoff is typically a warmer temperature than the stream or lake because rainfall absorbs the heat from surfaces like asphalt as it flows overtop.

PROTECTED OPEN SPACE AND DEVELOPMENT TRENDS

Map:
9



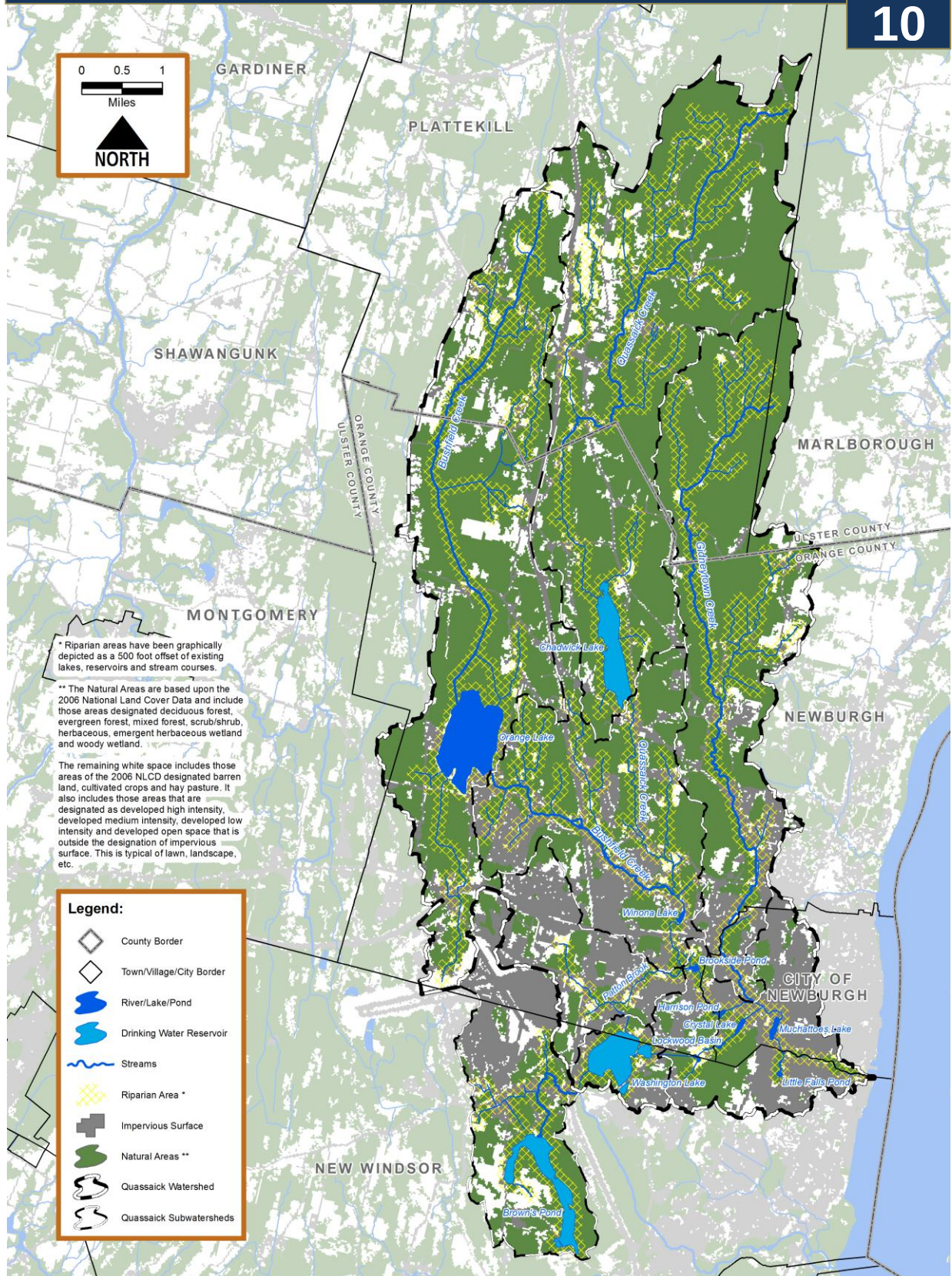
Three subwatersheds stand out as having high impervious cover relative to other subwatersheds: the Lower Quassaick, Patton Brook, and Upper Silver Stream, with approximately 33% impervious cover (**Map 10; Table 15**). These high percentages reflect current land uses in the City of Newburgh, the rapid develop occurring along Route 300, at the interchange of Interstates 87 and 84, and at Stewart Airport and the Air National Guard facilities. A generally accepted finding of stormwater literature predicts that most stream quality may decline when impervious cover in watersheds exceeds 10%, with severe degradation expected beyond 25% impervious cover (CWP 2003). Although this is a good rule of thumb, these estimates represent the potential rather than actual water quality, and we should expect that some streams will depart from these predictions. One instance when departures occur is in watershed with high forest cover, particularly high riparian forest cover (CWP 2003). This means that watersheds with high impervious surface that also have high forest cover may have higher than expected water quality. This scenario may be occurring in Bushfield Creek/Middle Quassaick and Washington Lake subwatersheds.

Table 15. Percent Impervious Surface by Subwatershed

Subwatershed	Impervious Surface	
	Acres	Percent
Bushfield Creek/ Middle Quassaick	983	21.8
Chadwick Lake	816	9.0
Gidneytown Creek	628	10.0
Lower Quassaick	879	33.9
Orange Lake	759	9.8
Patton Brook, Upper Silver Stream, Washington Lake (Combined)	1,739	32.8
Grand Total (from 35,624)	5,804	16.3

These results highlight the importance of having natural, vegetated areas in the Watershed, particularly along waterbodies, to protect water quality as well as to offer key riparian habitat. Vegetated areas allow rain and snowmelt to easily infiltrate into the ground. In the Watershed, natural areas are being replaced by impervious surfaces, which increase the volume and velocity of runoff and the amount of pollutants in stormwater. Excess nutrients in runoff, especially nitrogen and phosphorus, can cause waterbody-impairing algal blooms that are common in highly productive, eutrophic systems. As algae die and decompose, oxygen levels decrease, which can harm or kill fish, plants and other aquatic organisms that are unable to escape to higher habitat quality refuges. **Map 10** portrays that a significant portion of the watershed's streams have adjacent, riparian habitat. However, it should be noted that much of the riparian habitat in the Lower Quassaick and Bushfield Creek/Middle Quassaick subwatersheds represents very narrow bands, dominated by invasive species, and surrounded by development and impervious surface.

IMPERVIOUS SURFACE AND RIPARIAN BUFFERS

Map:
10

The federal [stormwater program](#), operated by the U.S. Environmental Protection Agency and implemented locally by the NYSDEC, requires most municipalities (depending on population size and density) to manage stormwater in their jurisdiction through the formation of Municipal



Figure 11. Rain gardens at the City of Newburgh Water Treatment Plant (Photo courtesy K. Sumner, 2009).

Separate Storm Sewer Systems (MS4s). The

term MS4 does not solely refer to municipally-owned storm sewer systems, but rather is a term with a much broader application that includes, in addition to local jurisdictions: State departments of transportation, public universities, local sewer districts, public hospitals, military bases and prisons. An MS4 is not always just a system of underground pipes; it can include roads with drainage systems, gutters, and ditches. There are three MS4s in the Watershed: Newburgh (city and town), New Windsor, and Plattekill. As an MS4, these municipalities develop and implement a Stormwater Management Program, and must comply with State and Federal regulations requiring proper oversight and management of stormwater during and following construction activities, and to reduce the discharge of stormwater pollutants to the maximum extent practicable (NYSDEC 2004). MS4s must set measurable goals and implement management practices related to Public Education and Outreach, Public Involvement and Participation, Illicit Discharge Detection and Elimination, Construction Site Runoff Control, Post-Construction Runoff Control, and Pollution Prevention and Good Housekeeping. These Stormwater Management Programs provide proactive, enforced protection for surface and groundwater resources in the Watershed.

Surface water resources are also protected from construction activities through the development of [Stormwater Pollution Prevention Plans \(SWPPPs\)](#). SWPPPs are plans for controlling runoff and pollutants from a site during and after construction activities. The principle objective of a SWPPP is to comply with the [NYSDEC State Pollution Discharge Elimination System \(SPDES\)](#) stormwater permit for construction activities by planning and implementing the following practices:

- Reduction or elimination of erosion and sediment loading to waterbodies during construction;
- Control of the impact of stormwater runoff on the water quality of the receiving waters;

- Control of the increased volume and peak rate of runoff during and after construction;
- Maintenance of stormwater controls during and after completion of construction

SWPPPs are required for most construction activities over one acre in size, and describe the site-specific temporary and permanent stormwater control measures that will be undertaken for a construction project. SWPPPs increase municipal oversight of development and incorporate land use controls to manage construction-related stormwater and runoff (NYSDEC 2004).

Recent changes in New York State's stormwater laws now require developers to address changes to the natural hydrology when constructing a project that is one acre or larger in size (regardless of whether it is located within an [MS4](#)). Green Infrastructure practices and principles are often employed to improve stormwater conveyance on new development and in existing urban areas. Green infrastructure practices maintain or restore stormwater's natural flow pattern by allowing the water to slowly permeate into the ground and be used by plants or recharge groundwater. These practices include rain gardens, vegetated swales, green roofs and porous pavements among others. Green infrastructure also includes preserving or restoring natural areas, such as forests, stream buffers and wetlands, and reducing the size of paved surfaces. Green infrastructure generally includes "better site design" or "low impact development" stormwater projects. In addition to managing stormwater, green infrastructure can provide wildlife habitat, beautify neighborhoods, cool urbanized areas, improve air quality and reduce stress on combined sewer systems. Existing developed areas can be 'retrofitted' with storm water management practices to afford significant water quality and groundwater recharge benefits, and also showcase these modern Storm Water Management (SWM) practices. In Orange and Ulster Counties, where a significant portion of the population relies on groundwater sources for their water supply, promoting practices that maintain groundwater recharge can help preserve this resource. Additionally, green infrastructure has the potential to reduce urban runoff that impacts the Watershed' streams and lakes. **Table 16** highlights the green infrastructure projects constructed in the Watershed.

Table 16. Green Infrastructure Projects in the Quassaick Creek Watershed

Subwatershed	Site	Project Description
Upper Silver Stream	Stewart International Airport	Constructed a 6-acre pervious asphalt parking lot with bio-swales, infiltration trenches, a large void sub-base, and rain tanks
Washington Lake	City of Newburgh Water Treatment Plant (Figure 11)	Three rain gardens were installed through a cooperative effort between the OCSWCD and the City of Newburgh's Treatment Plant staff. The main purpose was to catch stormwater runoff from impervious surfaces such as parking areas and prevent it from leaving the site and going into catch basins. Landscape fabric and stone were used to keep maintenance at a minimum.
Bushfield Creek/Lower Quassaick	Orange Lake Fire Department	NYSDEC Trees for Tributaries planting along the Bushfield Creek, which consisted of 19 trees and 104 shrubs.
	Winona Lake	NYSDEC Trees for Tributaries planting at Winona Lake, which consisted of the planting of 13 trees and 50 shrubs.
Lower Quassaick	Muchattoes Lake	Two NYSDEC Trees for Tributaries plantings at the north end of the Lake, consisting of a total of 217 trees and shrubs.

2: 6 Pollutant and Nutrient Loading

Water quality pollutants can take many forms, but the most common is stormwater runoff from impervious surfaces. Impervious surfaces are paved areas, such as parking lots, roads, and driveways, as well as roofs of buildings that prevent water from infiltrating into the soil. Various pollutants are found on paved surfaces such as sediment, nitrogen, phosphorus, bacteria, oil and grease, trash, pesticides and metals, which are picked up by stormwater, and quickly transported overland or through stormdrains into the waterbodies.

A common pollutant in stormwater is phosphorus, a naturally occurring element and a vital nutrient for plants and animals. However, too much phosphorus can cause water quality problems, like algal blooms, through a process called eutrophication, which depletes oxygen from receiving waters under certain conditions, impairing aquatic life. Algal blooms can also be detrimental to leisure activities, tourism, fishing, and other recreational water activities. Phosphorus enters surface waters either attached to sediment particles or free-floating, and sources can include fertilizer, vegetation, road salt, soil and dust, soaps/detergents, and animal waste (livestock, geese, dogs, etc.). Phosphorus concentrations in stormwater are typically higher in areas where soils are disturbed, such as construction sites, or where land surfaces have recently been fertilized. Dense residential properties contribute high phosphorous loads from streets, lawn treatments, and leaf litter (Waschbusch et al. 1999). Refer to **Section 2: 3.6** for descriptions of phosphorous impairments within Orange Lake and the Lower Quassaick Creek.



A pollutant loadings analysis for the Quassaick Creek Watershed was conducted by estimating the phosphorus loading from various land uses in each subwatershed. Loadings were calculated using the “Watershed Treatment Model” (WTM) spreadsheet recommended by the New York State Office of Coastal, Local Government and Community Sustainability in its Watershed Plans Guidebook (NYSDOS 2009). The Watershed Treatment Model (WTM) provides estimates of runoff volume and pollutant loading to waters in each subwatershed based primarily on the land uses found within the drainage area. In general, areas of high residential density, commercial and industrial uses and roadways are ascribed to generate higher rainfall runoff, which depends primarily on impervious surface area, and consequently higher pollutant loading than areas of low residential density, forest and farming.

The results of the WTM can be used to identify the primary sources of pollutants in the six subwatersheds of the Quassaick Creek watershed for water quality management purposes.

A separate model was developed for each of six subwatersheds:

- Bushfield Creek/Middle Quassaick
- Chadwick Lake
- Gidneytown Creek
- Lower Quassaick
- Orange Lake, and
- “Combined Newburgh Water Supply”

The “Combined Newburgh Water Supply Watersheds” is a combination of the Upper Silver Stream, Patton Brook and Lake Washington Lake subwatersheds, three adjacent hydrologic areas that together form a region roughly comparable in size to the other five subwatersheds in the list (**Figure 12**). The three drainage areas share common characteristics: all exhibit high levels of urban development and disturbance, and the waters of all three are predominantly diverted to reservoirs for the City of Newburgh water supply system.

Additional information on the input data used and methodology are included in **Appendix B**.

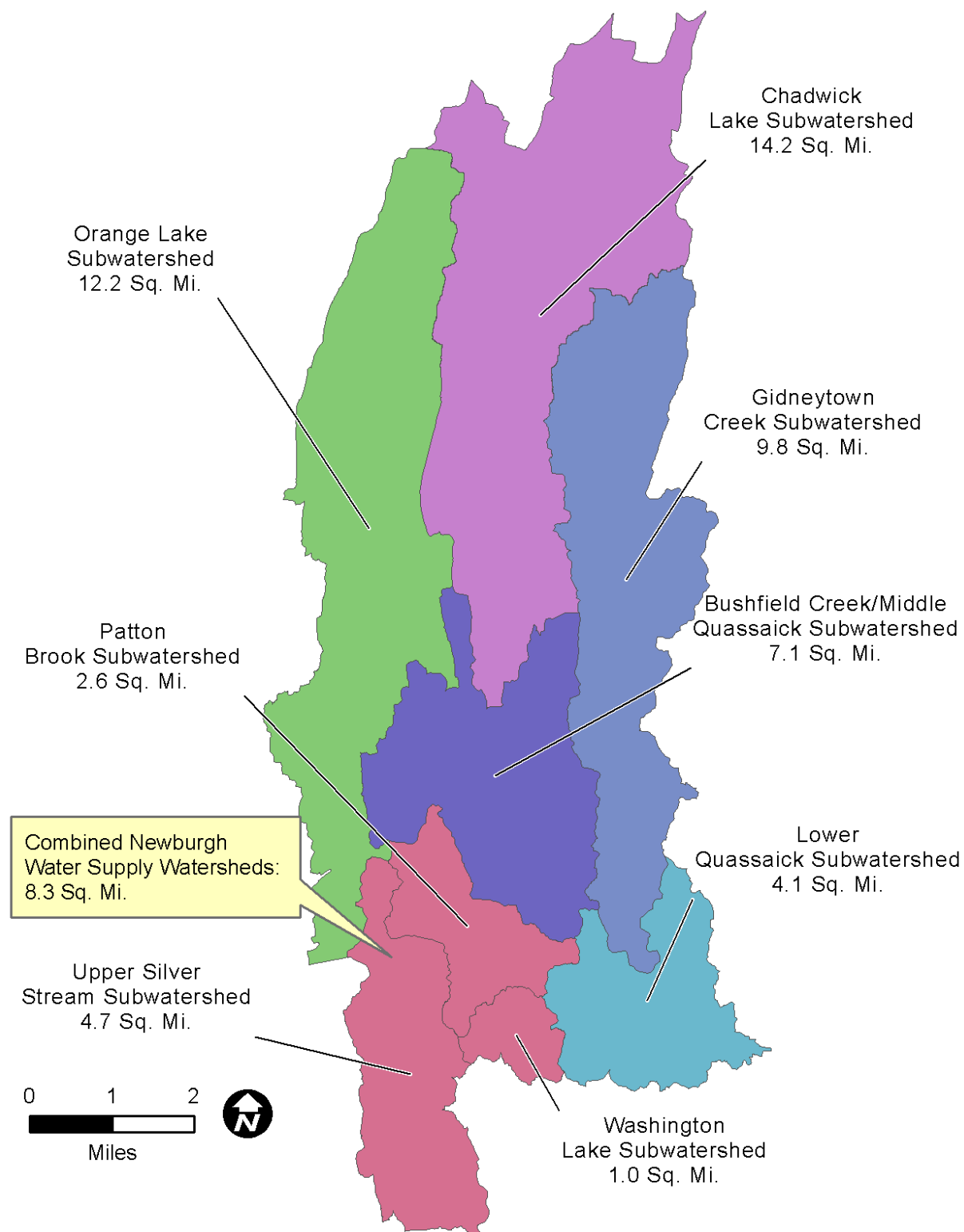


Figure 12. Quassaick Creek Subwatershed Grouping for the Pollutant Loading Analysis

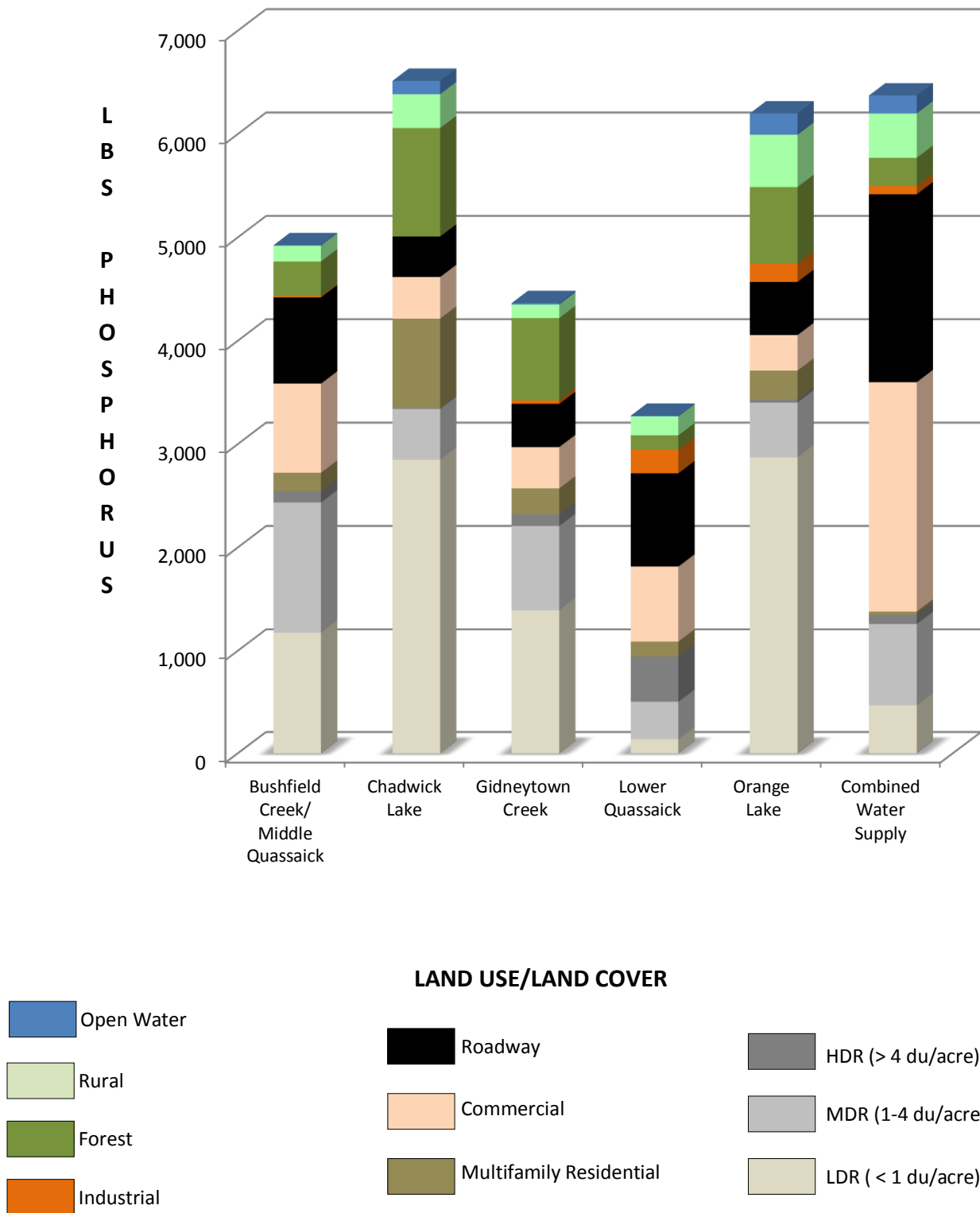


Figure 13. Estimated Pounds of Phosphorous Loading by Land Use and Subwatershed.

Note: High Density Residential (HDR), Mid-Density Residential (MDR), and Low Density Residential (LDR), du (dwelling units)

The WTM results in **Figure 13** graphically depict the estimated pounds of phosphorus loading by land use for each subwatershed. Residential land cover, regardless of the density, was estimated to comprise an especially large contribution to pollutant loading, and accounted for an aggregate of 48% of all total phosphorus loading in the Quassaick Creek Watershed. This effect is most marked in the Chadwick Lake and Orange Lake subwatersheds, where low density residential development alone was estimated to contribute approximately one-third of all total phosphorus loading. The WTM estimated that roadways are also large contributors to phosphorus loading, especially in the more densely developed Lower Quassaick and Combined Water Supply subwatersheds. The Combined Water Supply Subwatershed (grouping) yielded the highest total phosphorus loading of the six subwatersheds. Commercial land use was estimated to account for 36% of the total phosphorus loading in the Combined Water Supply subwatershed.

Because residential land uses were estimated to contribute more phosphorus across the entire Watershed than any other land use, it would be prudent to identify ways of reducing phosphorus runoff from these areas. Having site-specific stormwater quality data can provide a powerful tool for managers to track pollutant loadings and the effect of regulation on managing these non-point sources. For example, recent studies show the main source of phosphorus in residential areas is typically lawn fertilizer (NYSDOS 2009). New York State enacted a ban on fertilizers containing phosphorous that went into effect this year. Although this ban will reduce phosphorus applications it will not eliminate phosphorus because of the exemptions (i.e., gardens; agricultural lands and production; sod farms; phosphorus deficiency; establish new turf). The WTM loading calculation uses a “default” Total Phosphorus concentration of 0.26 mg/l for the runoff from practically all land uses. The WTM can be refined by over-riding this concentration based on site-specific sampling data. Stormwater sampling can then be used to refine the WTM and assess trends in water quality that may result from the recent Statewide phosphorus ban as well as local changes in land use.

2: 7 Community Profile

2: 7.1 DEMOGRAPHICS

The [2010 Census](#) indicates that the current population within municipalities of the Quassaick Creek Watershed rests at around 103,000 (U.S. Census Bureau 2010). Since 1990, the population of these municipalities has been gradually increasing. Following the [2000 Census](#), the population of these municipalities was approximately 97,000 people (U.S. Census Bureau 2002). This was an increase of about 10% in the population size over the course of the previous 10 years. By 2010, the population size increase had slowed to an increase of only 6.6% (**Table 17**).

Table 17. Population change in the Quassaick Creek Watershed Municipalities (Source: U.S. Census Bureau)

Subject	Orange County			Ulster County		Total Population
	New Windsor	Newburgh City	Newburgh Town	Plattekill	Marlborough	
Total population (1990)	20,950	26,454	24,058	8,891	7,430	87,783
Total population (2000)	22,866	28,259	27,568	9,892	8,263	96,848
Total population (2010)	25,244	28,866	29,801	10,499	8,808	103,218

Source: US Census

The majority of the population is older than 18 years of age with the largest age group being the 35-49 (**Table 18**). Population by race is presented in **Table 16**. According to the 2010 Census, the majority of the population in these municipalities identifies as white, at just over 67% (**Table 19**). The next most prevalent race was African American at just under 16%. People who identify as Hispanic or Latino represent a significant portion of the population in the Watershed municipalities, ranging from 48% of the population in the City of Newburgh to roughly 9-19% of the population in the other municipalities.



Table 18. Age/Sex Population Profile of the Quassaick Creek Watershed Municipalities (Source: U.S. Census Bureau 2010)

Population Statistic	Orange County			Ulster County	
	New Windsor	Newburgh City	Newburgh Town	Marlborough	Plattekill
Male	12,326	14,031	14,576	4,340	5,186
Female	12,918	14,835	15,225	4,468	5,313
Under 18	6,141	8,863	6,758	2,026	2,552
18 & over	19,103	20,003	23,043	6,782	7,947
20 - 24	1,460	2,686	1,526	505	638
25 - 34	3,037	4,557	3,097	949	1,099
35 - 49	5,829	5,428	7,018	2,025	2,468
50 - 64	4,995	3,728	6,459	1,879	2,150
65 & over	3,171	2,246	4,209	1,195	1,284
Total	25,244	28,866	29,801	8,808	10,499
Percentage of Total	24.5%	28.0%	28.9%	8.5%	10.2%



Table 19. Race and Ethnicity in Quassaick Creek Watershed Municipalities

Race Category	Orange County			Ulster County	
	New Windsor	Newburgh City	Newburgh Town	Plattekill	Marlborough
White/Caucasian	18,856	11,368	22,811	8,902	7,900
African American	2,901	8,706	3,644	617	363
Asian	871	282	883	86	78
Native American/ Alaska Native	57	478	81	28	18
Native Hawaiian/ Pacific Islander	9	30	11	2	0
Other	1,641	6,510	1,481	571	261
Two or More Races	909	1,492	890	293	188
Total Population	25,244	28,866	29,801	10,499	8,808
<i>Hispanic/Latino**</i>	<i>4,920</i>	<i>13,814</i>	<i>4,664</i>	<i>1,934</i>	<i>769</i>

***Hispanic or Latino is an ethnicity, not a race category. People who identify as Hispanic or Latino are primarily Caucasian, but may be of any race.*

Source: United States Census Bureau, 2010 Decennial Census, Table DP-1, Profile of General Population and Housing Characteristics: 2010

The housing profile of the Quassaick Creek Watershed municipalities is primarily made up of owner occupied houses (61%) holding 67% of the total population, with Newburgh City being the exception with the majority of its housing being renter-occupied (59%). The City of Newburgh also has the highest percentage of vacant housing (14%) with the majority being vacant for rent (**Table 20**).



Table 20. Housing Profile of the Quassaick Creek Watershed (Source: U.S. Census Bureau 2010)

Housing Statistic	Orange County			Ulster County	
	New Windsor	Newburgh City	Newburgh Town	Marlborough	Plattekill
Total	9,862	10,505	11,313	3,644	4,242
Occupied	9,291	9,030	10,762	3,335	3,861
Owner-occupied	6,913	2,867	9,028	2,328	2,808
Population in owner-occupied	19,192	8,807	25,315	6,529	7,875
Renter-occupied	2,378	6,163	1,734	1,007	1,053
Population in renter-occupied	5,775	19,114	4,223	2,258	2,596
Households with Individuals under 18	3,374	4,146	3,825	1,144	1,419
Vacant	571	1,475	551	309	381
Vacant: for rent	180	631	141	70	116
Vacant: for sale	144	176	139	50	50

2: 7.2 POTENTIAL ENVIRONMENTAL JUSTICE AREAS

Environmental justice seeks to address the disproportionate adverse environmental impacts that may exist in minority or low-income communities and focuses on improving the environment in these areas. These areas are generally defined by race, color, national origin, and/or income. New York State has identified potential environmental justice areas based on 2000 census block data. Two potential areas occur within the Watershed, as shown in the red cross-hatch symbol, within the Lower Quassaick subwatershed in the City of Newburgh (**Figure 14**), and within the Chadwick Lake and Gidneytown Creek subwatersheds in the Town of Plattekill (**Figure 15**). Yellow stars indicate public access to water in these two figures.

As the watershed planning process is progressed, specific consideration of environmental justice concerns including race, ethnicity, and the poverty status of communities should be carefully evaluated to ensure there are no negative effects. Negative effects include:

- disruption or division of an existing neighborhood or cohesive community (including the isolation of a portion of a neighborhood or an ethnic group);
- adversely affecting cultural or religious facilities in the community; or
- impacting a minority or low-income population to a disproportionate degree when compared impacts to non-minority and non-low-income populations.

Additionally, these areas represent opportunities to create meaningful improvements within the Watershed, like enhancing natural aesthetics, improving water and habitat quality, or creating



recreational public access locations. These types of projects would directly support national and state initiatives seeking to improve local environmental and public health issues, and for which there are grants and support programs offering assistance.

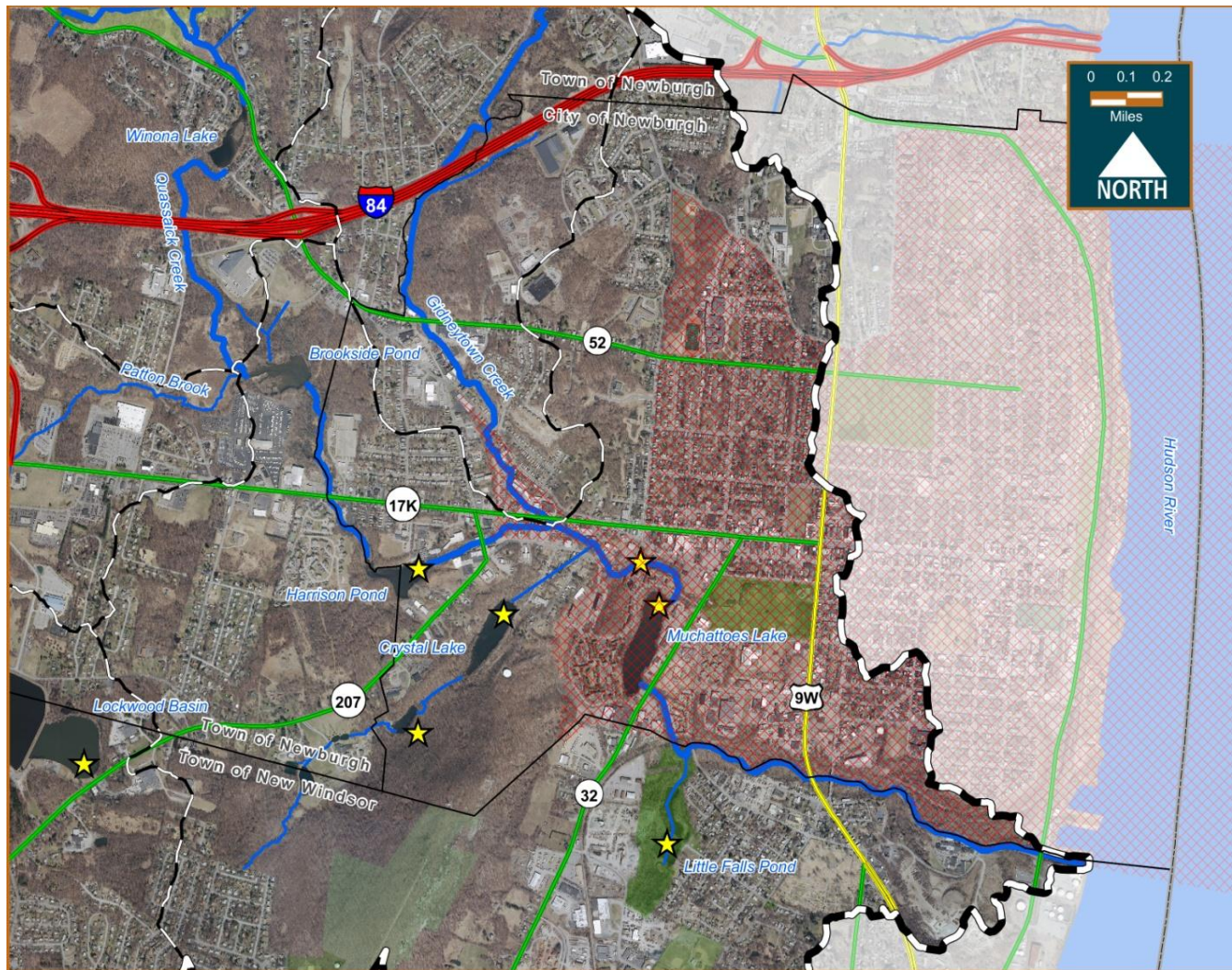


Figure 14. Potential Environmental Justice Area located in the City of Newburgh. Stars indicate recreational opportunities.

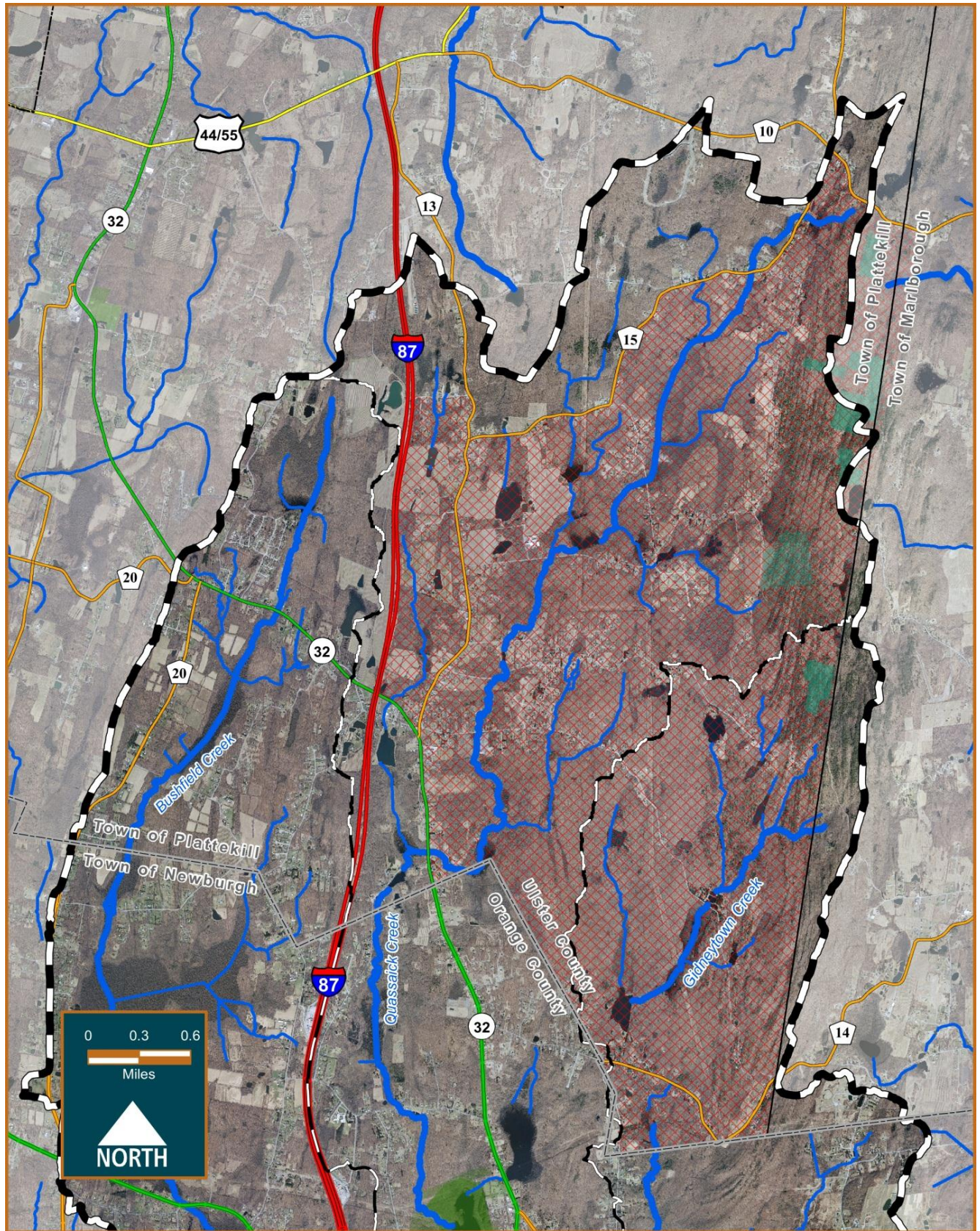


Figure 15. Potential Environmental Justice Area located in the Town of Plattekill.

2: 7.3 RECREATION AND TOURISM

Within the Watershed, many parks and nature preserves provide passive and active recreational activities such as bird watching, fishing, picnicking, and hiking. Algonquin Park is a 41-acre county park located in the Town of Newburgh and is host to a variety of these activities. Chadwick Lake Park, also located in Newburgh, is a popular destination for fishing and boating. Access is typically limited to Town residents for free, with others charged a fee. Cronomer Hill Park is a 70-acre county park that is a popular choice for sporting events and picnic areas (OCDPRC 2012). Downing and Delano-Hitch Parks make up two more parks located in the watershed. Both are City of Newburgh parks that are 35 and 26 acres, respectively and are utilized for sporting, walking, biking, fishing, and garden clubs (City of Newburgh Recreation Department 2012). Snake Hill Preserve is a 95-acre property located in New Windsor, with sweeping views of the Hudson River that will be opened soon as a public park (Orange County Land Trust 2012).

Throughout the watershed, there are also numerous historic sites, scenic views, monuments, and trails that are popular tourist attractions. The City of Newburgh is unique in that it retains much of its architectural past amidst scenic landscapes of the Hudson River. The historic buildings provide a link to the past. For example, the Bay View Terrace Bluff in the City of Newburgh is a favorite venue for artists and photographers, with panoramic river views of the Hudson Highlands. The historic Old Town Cemetery and Robinson Mausoleum are attractions for historians and architects as a rare example of Egyptian Revival Architecture. The East End Historic District of the City comprises roughly 4,500 acres, 2217 buildings, 16 structures and 6 objects according to the National Register of Historic Places and is the second largest historic district in New York State. The [Hudson River Valley Greenway](#) links the City of Newburgh and nearby City of Beacon with trails, known as the Trail of Two Cities, that run along streets with side loops and spurs to parks and historic sites, allowing people the chance to connect with historic, natural and cultural resources. Attractions such as these are dotted all around the Quassaick Creek watershed (City of Newburgh 2008). The Town of Newburgh does not have an extensive tourism industry, however, one recommendation in the Town of Newburgh Comprehensive Plan Update is to capitalize on tourism initiative that are currently ongoing in Ulster and Sullivan Counties such as bed and breakfasts (Town of Newburgh 2005). In the Town of New Windsor, the preservation of historic resources such as the two historic corridors of Knox Headquarters and New Windsor Cantonment, play important roles in spurring tourism's contributions to the Town's economic activity (Town of New Windsor 2009).

Tourism contributes to the local economy of the Towns of Marlborough and Plattekill in Ulster County. The area has high visitation by tourists due in part to its rural attractiveness and also its proximity to the New York Metropolitan Area. Agriculture as well as farms and wineries are tourism themes selling directly to visitors in Marlborough. Plattekill, relies on specialized outdoor recreation, sightseeing and other short term visits and activities whose main focus is the region's wealth of rural scenery, agriculture, and historic preservation (Town of Plattekill 2003).



An inventory of known public accesses to water is provided in **Table 21**.

Table 21. Known Public Access Locations within the Quassaick Creek Watershed

Waterbody	Site Name	Location	Type of Public Access
Chadwick Lake (fed by Quassaick Creek)	Chadwick Lake	Town of Newburgh	boating, fishing, ice skating, hiking/walking, biking, X-skiing, picnicking, bird watching
fed by City of Newburgh Reservoir	Masterston Pond	Town of New Windsor	previously fishing by arrangement for senior citizens and fishing derbies
Muchattoes Lake	Unnamed	City of Newburgh	fishing*
Quassaick Creek	Cronomer Hill Park	Town of Newburgh	hiking, biking, picnicking, sport fields, playground, dog walking
Bushfield Creek	Algonquin Park	Town of Newburgh	picnicking, sport fields, playground
Little Falls Pond	Little Falls Park	Little Falls Park	fishing*, dog walking
Harrison's Pond	Unnamed	City of Newburgh	fishing*
Quassaick Creek	Schleiermacher Park	City of Newburgh	stream access
Crystal Lake	Unnamed	City of Newburgh	fishing*
Miller's Pond	Unnamed	City of Newburgh	fishing*
Brown's Pond, source of Silver Stream	Unnamed	Town of New Windsor	previously fishing by permit

* informal access for fishing

2: 7.4 AGRICULTURE

The land dedicated to agriculture within the Hudson Valley has been slowly declining over the last 40 years as development radiating from nearby metropolitan areas such as Albany and New York City has increased. The towns that make up that Quassaick Creek Watershed are no different. Orange County's acres of farmland have declined 20% since the late 1980's. Despite this decline, Orange County was responsible for \$108 million worth of farming output, the highest in the Hudson Valley region. Orange County's farm economy has transformed from a dairy commodity industry to an industry that produces high-valued agricultural products such as fruits and vegetables. Over the last 15 years, growth in the county's vegetable and nursery/greenhouses have been able to offset the declines experienced in the dairy and feed sectors (ACDS 2004a). In the Town of Newburgh, agricultural lands make up most of the northern portion of the town. As of 2005, 39 active farms contained 1,681 acres of agricultural lands. However, significant obstacles have contributed to the decrease in agricultural yield of the Town of Newburgh, including global competition, high taxes and regulatory costs, increasing expensive labor, equipment, and operations cost, growing conflicts with residential neighbors, and difficulty passing on farms to younger generations (Town of Newburgh 2005). Orchards,



dairy, and livestock/poultry make up the majority of the agricultural output in New Windsor and the Town of Newburgh (ASDS 2004b). In the City of Newburgh, the agricultural industry is virtually nonexistent with only 0.6% of the workforce devoted to agriculture.

Ulster County's agricultural output has been changing shape, as well. Over the course of the last decade, there has been solid growth in output of orchard crops, vegetables and greenhouse/nursery crops. However, there has been little or no corresponding increase in the county's wholesale trade and manufacturing related to these crops. This could limit future growth in the farm sector if not addressed (ACDS 2004a). In the Town of Plattekill and Marlborough, the majority of the agricultural land is devoted to orchard crops. Agricultural land in these municipalities has been steadily decreasing since the 1960s (Town of Plattekill 2003, Town of Marlborough 2002).

2: 8 Summary

The Quassaick Creek Watershed has experienced increasing development that began with the European settlement of the Hudson River Valley and continues to the present. The major factors affecting water quality and habitat quality today are generally the same as those that were initiated with earlier settlement, but have been modified by modern technology and an expanding human population. Land was initially cleared for agriculture, whereas now it is cleared for commercial and residential development. Land clearing has adverse effects on hydrology and water quality, with the magnitude of effects increasing as the cumulative change consumes a greater percentage of the watershed. Dams were initially built to power small mills and are now in place to provide municipal water supply. In both cases natural stream channels are blocked, water quality can be degraded, and water flows altered.

The effects of human development have generally spread upstream over time starting at the Hudson River and now extend into the headwaters of the Watershed to accommodate a growing human population. The summary table for subwatersheds reflects this upstream spread of human induced changes in the Watershed and the actions that may be warranted to manage the important natural resources (**Table 22**). For example, TMDLs should be considered for development within the subwatersheds that supply the drinking water reservoirs to manage pollutant loadings given recent increased development and projected future development in the subwatershed.

Table 22. Summary of Significant Features and Threats for each Subwatershed

Subwatershed	Significant Features	Constraints/Threats to Watershed	Opportunities for Improvement
Bushfield Creek/ Middle Quassaick	Forested wetlands along major stream corridors from Orange and Chadwick Lakes southeast to Lower Quassaick	- Urban development - Slightly to moderately impaired water quality	- Enhanced local planning to minimize impacts of urban development on natural landscapes - Greater applications of stormwater Best Management Practices (BMPs) - Repair of Winona Lake impoundment
Chadwick Lake	Many natural landscapes such as deciduous and mixed forests north of Chadwick Lake	- Experiences elevated levels of algal growth and water quality impairment during the growing season - Residential development of natural landscapes	- Enhanced local planning to minimize impacts of urban development on natural landscapes - Public awareness of climate change impacts on drinking water
Gidneytown Creek	- Third largest subwatershed - Wetlands located along the riparian corridor of Gidneytown Creek - dominated by deciduous forest land	- Urban development in the southern portion of the subwatershed - Non-impacted to slightly impaired water quality along Gidneytown Creek	- Enhanced local planning to minimize impacts of urban development on natural landscapes - Greater applications of stormwater BMPs
Lower Quassaick	- Dominated by urban development - Impoundments that divert stream flows - Scenic vistas at Snake Hill	- Loss of remaining natural habitat, most land has been disturbed - moderately impacted water quality - stormwater runoff contributing impacting water quality	- Barrier removal restoring natural flows or harnessing for micro-hydropower - Greater application of BMPs - Public access along Quassaick Creek and small ponds
Orange Lake	- Largest subwatershed - Upstream of Orange Lake: designated NYSDEC and NWI wetlands	Urban development downstream of Orange Lake and in northern most portions of watershed that contribute to impaired conditions of this 303(d) listed waterbody	- Enhanced local planning to minimize impacts of urban development on natural landscapes - Greater applications of BMPs - Develop TMDLs - Routine septic and catch basin clean-outs



Table 22. Summary of Significant Features and Threats for each Subwatershed

Subwatershed	Significant Features	Constraints/Threats to Watershed	Opportunities for Improvement
Patton Brook	• Fed by small streams and wetlands from Upper Silver Stream • Murphy's Ditch diverts water from Patton Brook to Washington Lake as a supplemental water source	• Urban development along Route 17K and Interstates 87 and 84	• Enhanced local planning to minimize impacts of urban development on natural landscapes • Greater applications of BMPs • Develop TMDLs
Washington Lake	• Most of area is dominated by the lake itself • Relatively little developed land around lake • Drinking water supply reservoir	• Urban development along Route 300 east of Washington Lake	• Enhanced local planning to minimize impacts of urban development around Washington Lake • Greater applications of BMPs • Develop TMDLs • Public awareness of climate change impacts on drinking water
Upper Silver Stream	• Most of area is dominated by the lake itself • Stewart Airport makes up large portion as well • Connected to Washington Lake through constructed surficial diversions	• Experiences elevated levels of algal growth and water quality impairment during the growing season	• Enhanced local planning to minimize impacts of urban development on natural landscapes • Greater applications of BMPs • Develop TMDLs • Public awareness of climate change impacts on drinking water

CHAPTER 3. ASSESSMENT OF LAWS, POLICIES, AND PROGRAMS

AFFECTING WATER QUALITY



Watershed management and watershed conditions reflect the laws, programs, practices, policies in place at multiple levels, together with individual efforts and actions occurring throughout a watershed. In New York, municipal governments arguably have the most profound and direct effect on the health of a watershed due to the strength of local land use authority, and day-to-day interaction with the public. Laws, programs, and incentives at the county, state and federal level have a less direct, but nonetheless meaningful impact on local watershed health. The higher levels of government's impacts often come in the form of incentives that encourage mutually beneficial action implemented at the local level, or the setting of standards or mandates that affect local policies and practices, such as the management of government-owned land and facilities to reduce stormwater pollutant loading to waterways. Intermunicipal watershed planning efforts - such as the Quassaick Creek watershed planning effort – are often initiated or coordinated by County and State agencies. This Chapter is dedicated to identifying and explaining the laws, programs, and governmental agencies that have a hand in watershed management. Sections in this Chapter cover the roles of Local/Municipal, County, State, and Federal agencies, and relevant policies at those levels.

3: 1 Local/Municipal Level

While each of the Watershed's four municipalities have similarities –their climates, their home-rule structure, and the fact that all are governed by the same state and federal laws – they also have their own unique landscapes, natural resources, land-use dynamics, and local leaders. It is this uniqueness that challenges a one-size-fits-all approach to watershed management and necessitates significant community involvement, and customized planning and implementation. There are general principles and myriad methods to address water quality concerns, but management approaches need to reflect the needs, issues, and opportunities of each community in order to be effective.

In order to understand the local tools that are in place in the Quassaick Creek Watershed, an audit of municipal programs, policies, laws and practices that affect water quality was completed. This audit was adapted from the *Code and Ordinance Worksheet for Development Rules in New York State*, prepared by the NYS Department of Environmental Conservation's Hudson River Estuary Program and the NYS Water Resources Institute in cooperation with the Center for Watershed Protection. The *Eight Tools Audit*, prepared by the [Center for Watershed Protection](#), was also utilized. Other elements of the audit resulted from stakeholder and Advisory Committee input, such as the focus on source water protection.



Guided by the above references, the audit hones in on those programs, policies, laws and practices that relate to the following subset of **Goals for the Quassaick Creek Watershed** (as outlined in Section 1.3 of this Report):

- Improve water quality, ensure drinking water sources are protected, and that water quantity is adequately managed
- Improve and enhance natural watershed functions and ecological processes
- Promote watershed awareness and sustainable development practices
- Create a watershed that is resilient to current and future weather conditions

The audit of municipal policies focuses largely on language found within local land use tools such as zoning codes and subdivision and site plan regulations since these directly affect the nature of most land use activities. However, it is important to note that the **municipal comprehensive plan** is the legal backbone for local land use policies – *all zoning codes and land use laws must be in accordance with the municipal comprehensive plan*. It is therefore crucial for watershed management that comprehensive plans acknowledge concerns related to specific waterbodies and establish goals that recognize the need to safeguard water resources and other natural resources. The final subsection of the audit is thus a review of recommendations made in municipal comprehensive plans that are in line with the above noted goals for the Quassaick Creek Watershed, but that are not currently reflected in that municipality's land use regulations.

In addition to describing watershed-friendly practices and the municipalities that espouse them, the audit narrative identifies the **type(s) of landscapes that are most appropriate for each approach or practice**, recognizing that rural, suburban, and urban areas require and can accommodate different management techniques. For example, and generally-speaking, rural areas typically provide opportunities to protect source water and to establish buffers and large-scale Best Management Practices (BMPs) such as land preservation (e.g. conservation easements or land acquisition) and soil conservation practices. Suburban areas are often appropriate for implementation of BMPs that promote infiltration, such as bioretention practices and porous pavement. Within urban areas, where available land is scarce, BMPs are largely geared to reduce stormwater runoff and are typically retrofits to existing developed areas, constructed or installed on a small-scale, including green roofs and stormwater planters. **Figure 16** demonstrates this concept.

Selected Water Quality and Stormwater Management Practices by Landscape Type				
	Rural → Urban			
	Rural Area	Agriculture	Suburban	Neighborhood Center
Porous Pavement				
Reduction of pavement				
Bioretention/Swales				
Conservation Easements				
Soil Conservation				
Stormwater Ordinances				
Repair/Replace Septic Systems				
Educational Outreach				
Detention Basins				
Tree Boxes/Sand Filters				
Green Roofs				

Table Legend:
Most appropriate
Sometimes appropriate
Appropriate but less effective
Not appropriate or applicable

Figure 16. Examples of which landscape types are best suited to various best management practices (BMPs).

The stormwater practices mentioned above, and many of the principles found within this audit, are examples of **green infrastructure stormwater practices (GI)**, which is a term used to describe certain planning and design approaches for managing stormwater runoff. GI utilizes practices that introduce stormwater back into the ground closer to where it would have entered under predevelopment conditions and to maximize the use of vegetation to remove pollutants from and slow the velocity of stormwater. The result is greater infiltration and higher water quality of stormwater runoff. GI practices are in contrast to conventional stormwater treatment methods, which collect and pipe stormwater to retention or detention ponds that typically only provided basic water quality treatment, if any. **Figures 17A-17C** are excerpts from the [Orange County's Design Manual](#) that graphically demonstrate these concepts. The full Manual, which illustrates and explains a wealth of planning and design concepts, is available online at the Planning Department's webpage <http://www.orangecountygov.com/planning>.

Preceding the audit narrative is a subsection containing **Municipal Summaries** (below), which provides a general description of each municipality's landscape within the Quassaick Creek Watershed and a listing of relevant local documents that were reviewed for the audit. This is followed by three subsections that comprise the municipal audit:

- the **Audit of Municipal Codes and Regulations (section 3: 1.2)**

- a review of relevant municipal **Comprehensive Plan Recommendations (section 3: 1.3)**
- a list of **Additional Local Watershed Management Practices** not currently found in the Watershed **(section 3: 1.4)**

3: 1.1 MUNICIPAL SUMMARIES

The **Town of Plattekill** is the most rural municipality within in the Quassaick Creek Watershed. Plattekill contains the headwaters of the Quassaick, Bushfield, and Gidneytown Creeks, which flow from its sparsely populated landscape before flowing into Orange County. Even before crossing County boundaries, the Quassaick Creek runs through a rural landscape that sees many different land uses. Plattekill's portion of the Watershed contains agricultural, civic, commercial and residential land uses. The Quassaick Creek in some stretches takes the form of freshwater-emergent wetlands on residential property. Plattekill is where the Quassaick Creek begins to interface with development. The Quassaick Creek's route through Plattekill calls attention to the complexity of Plattekill's landscape; one can see challenges posed in planning its portion of the Watershed and also the importance of planning efforts that focus on environmental protection.



Municipal land use documents reviewed:

- [Comprehensive Plan, 2003](#)
- [Municipal Code](#), chapters 52 *Freshwater Wetlands*, 65 *Logging*, 89 *Stormwater Management and Erosion and Sediment Control*, 93 *Subdivision of Land* and 110 *Zoning*ⁱ
- [Ulster County Sanitary Code](#)ⁱⁱ

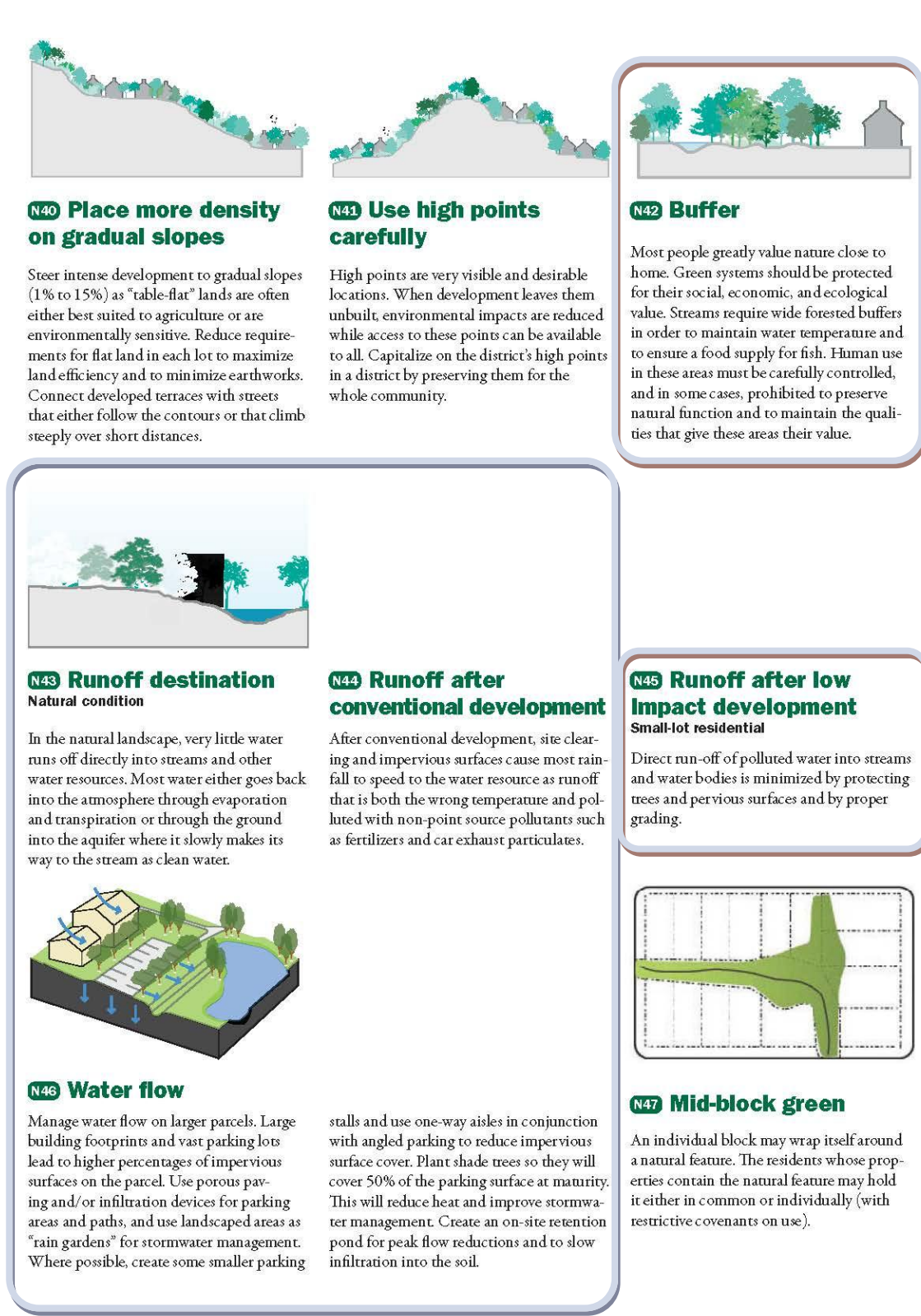
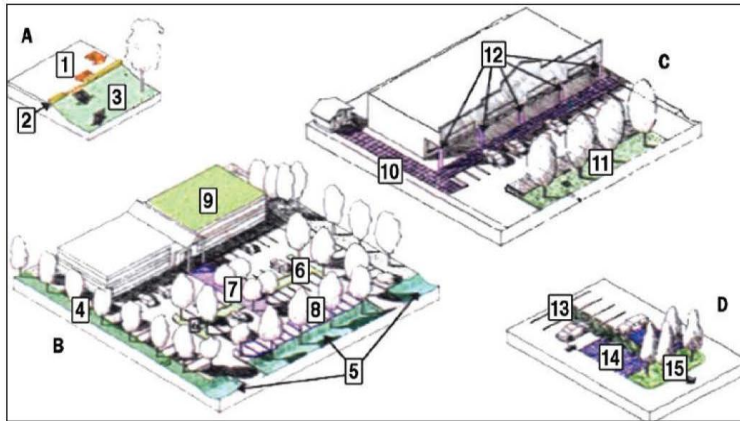
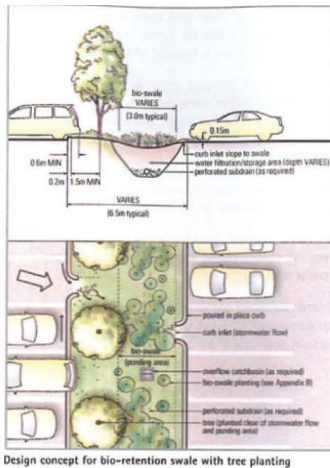


Figure 17A. Orange County Design Manual best management practices (BMPs).



N50 LID applications – commercial

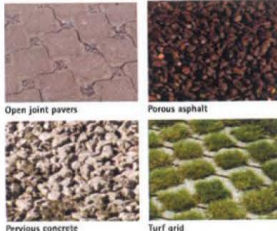


Design concept for bio-retention swale with tree planting

N51 Parking lot bioswales

Large volumes of polluted water run off of commercial parking lots. To the greatest extent possible this water should be captured and cleaned in bio swales with plants before being released into the ground. (photo, top center)

Examples of permeable paving:



N52 Permeable pavings

Permeable paving materials can help reduce run-off as well.



Courtesy of Navue Ngan Associates



Courtesy of Kevin Robert Perry, City of Portland



Courtesy of Tom Lipman, City of Portland

Photos above
Green streets can work in urban conditions.

N50 LID commercial Applications

- A**
1. Bioretention (Grading)
 2. Bioretention (Inlet)
 3. Bioretention
- B**
4. Grass Swale
 5. Bioretention
 6. Bioretention
 7. Permeable Pavers (Walkway)
 8. Permeable Pavers (Overflow parking)
 9. Green Roof
- C**
10. Permeable Pavers
 11. Bioretention (To storm drain system)
 12. Disconnectivity (Disconnect downspouts)
- D**
13. Permeable pavers
 14. Bioretention
 15. Grass swale

Photos below

Curbless details on roads and parking lots allow water to run off into bioswales.



Figure 17B. Orange County Design Manual LID Applications.

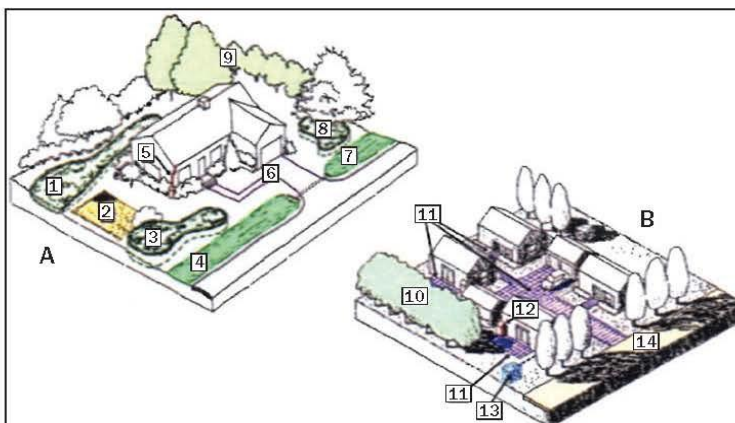
N60 LID residential Applications

A: Low Density Residential

1. Bioretention / Rain Garden
2. Soil Amendments
3. Bioretention / Rain Garden
4. Grassed Swale
5. Disconnectivity (Rain Barrel)
6. Permeable Pavers
7. Grassed Swale
8. Bioretention / Rain Garden
9. Conservation

B: High Density Residential

10. Conservation
11. Permeable Pavers
12. Disconnectivity (Rain Barrel)
13. Disconnectivity (Dry Well)
14. Minimizing Imperviousness (Reduced street width)



From Dawn Miller

DETAILS

Low Impact Design (LID)

N60

Nature



Figure 17C. Orange County Design Manual LID Applications, Cont.

The **Town of Newburgh** contains a diverse gradient of land uses ranging from a rural and suburban matrix to more intense commercial areas, such as the Route 300 corridor. Residential neighborhoods cover much of the Town's landscape. The Town hosts its own drinking water reservoir, Chadwick Lake. Large tracts of land in the Town's portion of the Watershed are used by Stewart Airport and the Air National Guard. The Town has been documented as one of the fastest growing communities in the region in recent years, due in no small part by its convenient access to two major interstates: I-87 and I-84. As stated in the Town's Comprehensive Plan: "similar to many communities to the north, the Town still maintains vestiges of its rural farm traditions that have been prevalent for decades. At the same time however, Newburgh also enjoys a strategic location adjacent to major interstate highways and a regional [Stewart] airport which has resulted in new residential development, and business and commercial growth."ⁱⁱⁱ Another factor that influences the ability of the Town to attract new growth and development is its water and sewer capacity, and the amount of vacant or developable land within the Town's borders.^{iv}



Municipal land use documents reviewed:

- [Comprehensive Plan Update, 2005](#)
- [Municipal Code](#), chapters 157 *Stormwater Management*, 160 *Streets and Sidewalks*, 163 *Subdivision of Land* and 185 *Zoning*

The **Town of New Windsor** contains the southernmost portion of the Quassaick Creek Watershed. It is similar to the Town of Newburgh in that it is comprised of a range of land uses from active farms to commercial and industrial corridors, some of which runs alongside historic railroad lines. The Town hosts widespread residential areas ranging from low to medium densities. A major portion of Stewart Airport is within the Silver Stream subwatershed area of the Town. The Town also supports at least a portion of two drinking water supplies: Silver Stream Reservoir and Washington Lake.



Municipal land use documents reviewed:

- [New Windsor 2009 Comprehensive Plan Update](#)
- [Municipal Code](#), Chapters 249 *Stormwater Management*, 252 *Streets and Sidewalks*, 257 *Subdivision of Land* and 300 *Zoning*

The **City of Newburgh** is the most intensely urban area within the Quassaick Creek Watershed. The prevalence of impervious surfaces - pavement and roofs – necessitates thoughtful stormwater management. Many elements of City's history were shaped by the Quassaick Creek, with much of its past industries utilizing the Creek's water in some form or fashion, as evidenced by the prevalence of dams



along the Creek in the City. While portions of the Quassaick Creek have been channelized and even completely built over to accommodate roads or buildings, increased attention by citizens and municipal officials in recent decades to enhance and open up, or daylight, the Creek and its corridor to make it available to the public for passive recreation. Many streams and reportedly even some lakes have been covered by buildings or roads within the City.

Municipal land use documents reviewed:

- [Plan-It Newburgh: Sustainable Master Plan, 2008](#)
- [Future Land Use Plan, 2011](#)
- [Local Waterfront Revitalization Plan, 2008](#)
- [Municipal Code](#), Chapters 263 *Streets and Sidewalks*, 266 *Subdivision of Land* and 300 *Zoning*

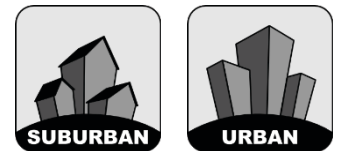
3: 1.2 AUDIT OF MUNICIPAL CODES AND REGULATIONS

The narrative below consists of a list of the watershed management practices that were used as a basis for the municipal audit, accompanied by a general description of the management practice, a symbol indicating which landscape types are often appropriate for the management practice, and information on which municipalities have already incorporated the management practice into their municipal regulations, codes, or standalone local laws. The management practices are divided into four sections, representing the four primary watershed management principles that help to preserve and protect water quality.

3: 1.2.1 PRESERVATION OF NATURAL FEATURES AND CONSERVATION DESIGN

✓ **Redevelopment.**

Redevelopment helps to fulfill the “smart growth” principle of focusing growth in existing centers of development by locating new development on sites that have hosted buildings or other development in the past. This practice can have a lower impact on a watershed than clearing, grading, and making improvements to an undisturbed site. Infill development is redevelopment of a vacant site within an urban area.

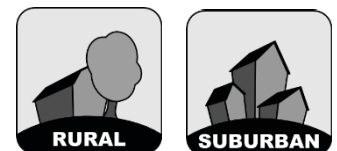


The following municipalities encourage redevelopment/infill development:

- ☐ Town of Newburgh ☒ City of Newburgh^v ☐ Town of New Windsor ☐ Town of Plattekill

✓ **Conservation Subdivisions.**

Conservation/cluster subdivisions are meant to have a lower overall environmental impact than conventional subdivision through open space preservation and the reduction of the overall “footprint” – the



area that is consumed by buildings, impervious surfaces, and other infrastructure. Conservation subdivisions typically seek to preserve environmentally sensitive areas, maintain productive agricultural lands, and encourage cost savings related to infrastructure. Such designs can be encouraged through incentives including density bonuses and by making the development review requirements for conservation subdivisions no greater than those for a conventional subdivision. **Figure 18** elaborates on the concepts behind this type of subdivision and briefly illustrates the design process.

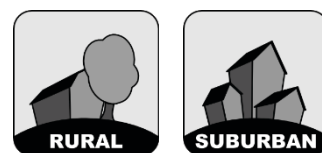
These municipalities allow conservation/cluster subdivisions (those that encourage are in bold):

☒ Town of Newburgh^{vi} ☐ City of Newburgh ☐ Town of New Windsor ☒ **Town of Plattekill**^{vii}

✓ **Tree and Forest Conservation.**

Forested areas are among the most valuable land types in a watershed due to the ability of the forest to soak up stormwater runoff and maintain and enhance water quality in the watershed.

Forested land not only protects water quality but serves to replenish groundwater supplies and sustain stream base flow. Municipal controls, such as codes that require preservation of forested areas over 5 acres during the development review process or that require forestry BMPs for timber harvest and tree-cutting, help to safeguard water quality and watershed hydrology.



The following municipalities have enacted such measures to protect or manage forested land :

☐ Town of Newburgh ☐ City of Newburgh ☐ Town of New Windsor ☒ Town of Plattekill^{viii}

3: 1.2.2 REDUCTION OF IMPERVIOUS SURFACE

✓ **Street Width.**

Although wide streets allow vehicles more room to travel and pull over and also allow for non-motorized transportation methods (e.g. bicycling, walking), they contribute to a watershed's overall impervious surface, can be expensive to install and maintain, and are unnecessary in some instances. Narrower street widths provide safer crossing for pedestrians through less time in a vehicle's path and vehicles typically drive at a slower rate of speed, although roads must be wide enough to allow safe passage of emergency vehicles such as fire trucks and ambulances. As for impervious surface, an eleven (11) or twelve (12) foot travel lane is more than adequate, resulting in a twenty-two (22) to twenty-four (24) foot road, which would reduce the amount of impervious surface by 600 to 800 sq.ft for every 100 feet of road length, compared to a thirty (30) foot road.

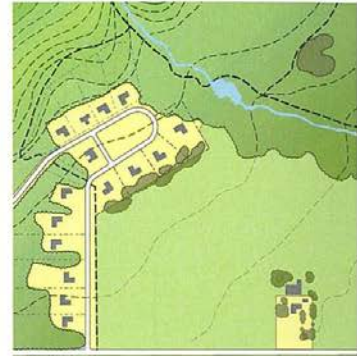
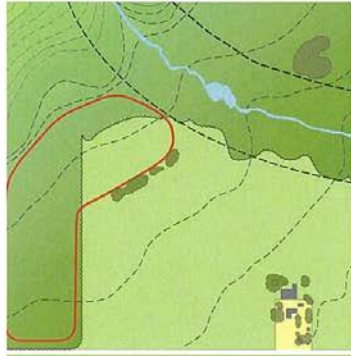


DETAILS

Conservation Subdivisions



How to Create Conservation Subdivisions



N10 Existing landscape

A few houses, many on existing or former farms, but an otherwise unspoiled/intact rural landscape.

Step 1

Require a map of the open space system for the parcel and surrounding area.

A. Locate Appropriate Places for Development

A sketch analysis of the area provides all the basic information to calculate how a development can fit into the landscape – what land should be protected and potential development pockets.

N11 Subdivision sprawl

Individual parcels are developed for stand-alone, large lot houses which spread out across the landscape degrading visual and environmental resources.

Step 2

Conventional sketch layout determines maximum lot count under existing three-acre zoning.

B. Typical Superimposed Subdivision

- Productive farmland lost forever
- Pleasant view from road ruined.
- Stream corridor cut off by backyards.
- Large lots divide up and dominate the landscape.
- Individual roads for each subdivision.
- No chance for residents to enjoy special site features.

N12 Conservation neighborhood

Development is concentrated in more compact neighborhoods, preserving the visual and environmental integrity of most of the landscape.

Step 3

The same number of houses can fit into the landscape while preserving 80 percent of the open space.

C. Conservation Subdivision

- Large farm fields protected.
- Rural view from road retained.
- Trail system allows access to stream.
- Smaller, but substantial individual lot sizes with central green.
- Potential connection to adjacent parcel.
- Less expensive construction costs.
- Residents have views of open field and direct access to woods.

Figure 18. Orange County Design Manual Conservation Subdivisions.

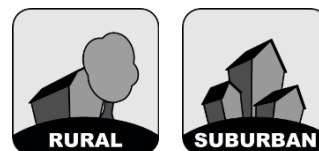


The following municipalities allow narrower street widths in residential neighborhoods:

☒ Town of Newburgh^{ix} ☐ City of Newburgh ☐ Town of New Windsor ☐ Town of Plattekill^x

✓ **Cul-de-sacs and Hammerheads.**

Cul-de-sacs with landscaped islands and hammerheads, sometimes referred to as modified dead ends, have a lower overall footprint than a conventional round cul-de-sac. Additional benefit is realized if stormwater runoff from these practices is directed to an open vegetated area, such as the island within the cul-de-sac if it is capable of acting as a bioretention or infiltration area.



The following municipalities allow modified dead ends:

☒ Town of Newburgh^{xi} ☐ City of Newburgh ☐ Town of New Windsor ☒ Town of Plattekill^{xii}

✓ **Shared Driveways.**

Shared or common driveways aid in the reduction of a watershed's impervious surface. The most common setback in the residential districts is fifty (50) feet, which translates to a driveway that is at least fifty (50) feet in length. The typical width of a residential driveway is twelve (12) feet, which equates to approximately 600 square feet of impervious surface. Although seemingly insignificant, with a development that proposes twenty (20) units, 6,000 sq.ft. of impervious surface can be eliminated overall, significantly reducing the overall impact of the development.



The following municipalities allow shared driveways:

☒ Town of Newburgh^{xiii} ☐ City of Newburgh ☐ Town of New Windsor ☒ Town of Plattekill

✓ **Parking Ratios, Shared Parking and Design Standards.**

Typically, on average in 2009, a family is limited to only 1.92 vehicles per household.^{xiv} Reducing the minimum required number of spaces to 2 or less per household helps to reduce the total amount of impervious surface in a watershed. Suburban or rural areas that lack mass transit may warrant higher minimum parking areas than urban areas with such amenities.



The following municipalities have a minimum requirement of two (2) or less spaces per single family home:

☒ Town of Newburgh^{xv} ☒ City of Newburgh^{xv} ☒ Town of New Windsor^{xv} ☐ Town of Plattekill

Because many local codes are written to accommodate parking volumes needed during peak times, parking requirements can sometimes result in overly abundant parking areas that are only fully utilized once or twice a year. A proposed development would need fewer parking spaces if a nearby property contains parking that is not in use during times of peak need. If a shared parking agreement can be secured between the proposed use and this existing adjacent use during the site plan review process, parking requirements should be minimized or waived for the proposed development. An example of adjacent uses that are likely to have suitably different parking needs is a church and a doctor's office. Land-banked parking is another planning tool that can alleviate the development of overly abundant parking areas. A percentage of the required parking may have the ability of being designed and not constructed; the area would be preserved as open space in the event additional parking is needed in the future. This type of parking could also be developed in a way that can be used seasonally, in the event the height of a development's parking demands are outside the winter months. Therefore, snow maintenance would be unnecessary.

The following municipalities have provisions for shared parking:

☐ Town of Newburgh ☐ City of Newburgh ☒ Town of New Windsor^{xvi} ☐ Town of Plattekill

Typical parking spaces are ten (10) feet by twenty (20) feet, which results in approximately 200 square feet of impervious surface. Minimizing the required parking stall width and length to nine (9) foot by eighteen (18) foot parking space (totaling 162 square feet) is more than sufficient for parking and access to and from the vehicle. This equates to a reduction of thirty-eight (38) square feet of impervious cover per space. Enacting provisions for even smaller stalls for compact cars is another option for reducing impervious cover created by parking spaces.

The following municipalities require smaller parking space dimensions:

☒ Town of Newburgh^{xvii} ☒ City of Newburgh^{xvii} ☒ Town of New Windsor^{xvii} ☒ Town of Plattekill^{xvii}

Setting minimum requirements for landscaped areas within parking lots, when implemented in a coordinated manner, have the ability to promote increased filtration of pollutants and increased groundwater recharge through infiltration. In addition, if planted properly, the vegetative cover has the capability to decrease the heat island effect of solar radiation off the paved surfaces.

The following municipalities require landscaping to soften the impacts of parking areas:

☒ Town of Newburgh^{xviii} ☐ City of Newburgh ☐ Town of New Windsor ☒ Town of Plattekill^{xviii}

3: 1.2.3 CONTROLS FOR STORMWATER MANAGEMENT

✓ **Curbs.**

Although curbs can fulfill a number of beneficial functions in more urbanized areas, roads and parking lots that lack curbs and direct stormwater runoff to a vegetated surface offer benefits such as increased filtration of sediment and pollutants, increased groundwater recharge through infiltration, and decreased incidents of nearby erosion and flooding.



The following municipalities do not typically require curbs:^{ix}

☒ Town of Newburgh^{ix}

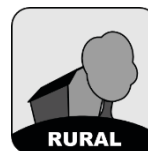
☐ City of Newburgh

☐ Town of New Windsor

☒ Town of Plattekill^{ix}

✓ **Rain gardens, Bioretention Areas and Infiltration.**

Through the creation of impervious surfaces, most land use development results in an overall reduction of the amount of rainfall that infiltrates the ground. Infiltration BMPs, i.e. rain gardens and bio-retention areas, are meant to retain stormwater on a site and, where possible, clean it and even make it available for reuse. Such BMPs are able to achieve the above mentioned objectives through recharging groundwater, reducing flood risks and controlling pollution.



The following municipalities encourage innovative stormwater management facilities such as infiltration practices:

☒ Town of Newburgh^{xx}

☐ City of Newburgh

☒ Town of New Windsor^{xx}

☒ Town of Plattekill^{xx}

3: 1.2.4 SOURCE WATER PROTECTION

✓ **Protection of reservoir shorelines.**

While land conservation is arguably the most reliable approach to source water protection, land purchase can also be the most expensive approach. Protecting a reservoir through local controls such as laws and codes that dictate the allowed uses and activities along its shores is another approach that helps to protect the quality of the drinking water supply by minimizing the opportunities for direct contamination. Prohibiting point and nonpoint source discharges, such as outfall pipes, SPDES discharges septic systems, impervious surfaces, junkyards and other potentially-harmful uses in sensitive areas will contribute to protection of source water.

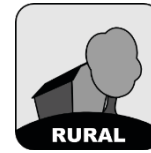


The following municipalities require setbacks from reservoirs:^{xxi}

☒ Town of Newburgh^{xxiii} ☐ City of Newburgh ☒ Town of New Windsor^{xxiv} ☐ Town of Plattekill

✓ **Special zoning district.**

Heightened local regulations for land within the watershed of a reservoir, especially land along streams that feed into reservoirs, helps protect the integrity of the drinking water supply. Examples of such regulations include vegetated stream buffer requirements, heightened review of uses or activities that pose a potential contamination threat, reduced maximum allowable lot coverage, increased incentives for conservation subdivisions, larger minimum lot sizes (where appropriate), and so on.



The following municipalities have created special districts to protect reservoirs:^{xxii}

☒ Town of Newburgh^{xxiii} ☐ City of Newburgh ☒ Town of New Windsor^{xxiv} ☐ Town of Plattekill

3: 1.3 COMPREHENSIVE PLAN RECOMMENDATIONS

The municipal comprehensive plans that have been adopted within the Quassaick Creek Watershed endorse certain watershed-friendly concepts and practices that are not reflected in the respective zoning or other municipal code. But, as noted previously in this section, municipal comprehensive plans are a powerful legal document to which all local land use policies must conform, and therefore the concepts and goals stated within the plans can logically, and often easily, be transitioned from municipal planning policy to land use regulation. The following text highlights ideas and recommendations that are expressed in municipal comprehensive plans that support this Watershed's four primary management principles and help to preserve and protect water quality, but that are not currently found within that municipality's land use regulations.

3: 1.3.1 PRESERVATION OF NATURAL FEATURES AND CONSERVATION DESIGN

The **City of Newburgh** recognized the benefits of open space preservation in the "Natural Environment" section of its Sustainable Master Plan. Under the heading "Greenspace," this section endorses the concept of conservation subdivisions, a trail and greenway along the Quassaick Creek, buffering of protected areas such as Snake Hill, and protection of the Hudson River^{xxv}.

The **Town of New Windsor's** Comprehensive Plan lays out Goals to "protect sensitive environmental areas and incorporate into an open space/natural resource system"^{xxvi} and recommends adoption of "environmental protection laws that protect all streams/creeks, waterbodies, and floodplains in the Town and provide for a minimum required buffer area of 50 to 100 feet between the resource and development of any kind."^{xxvii} The Town's Plan also

recommends encouraging “alternative approaches to development including residential conservation clustering on larger lots” and exploring “creative strategies for the acquisition of open space, particularly open space that contributes to the protection of natural resources and sensitive environments” The Plan lists various methods for open space protection including conservation subdivisions with incentives for additional open space, transfer of development rights, and conservation easements.^{xxviii} Lastly, the Town recommends adoption of “a tree preservation law to help protect the Town’s woodland character. For example, the Town should consider placing limitations on cutting down trees in the public right-of-way and restricting clear cutting during site development.”^{xxix}

The **Town of Newburgh’s** Comprehensive Plan Update recommends enacting steep slope regulations in order to minimize soil erosion and also to protect views along ridgelines.^{xxx}

The **Town of Plattekill’s** most recently adopted comprehensive plan focuses heavily on preserving open space as an important component of broader development goals. Its comprehensive plan has as official town policy for environmentally sensitive areas, where floodplains, wetlands, mountainous terrain, steep slopes, aquifer recharge areas and irreplaceable agricultural lands are not to be intensively developed. Areas in or adjacent to hamlets are cited as “preferred locations” for new development. These policies are part of an overarching goal to promote development patterns that preserve Plattekill’s rural character.^{xxxi}

3: 1.3.2 REDUCTION OF IMPERVIOUS COVER

Goal 6 in the **City of Newburgh’s** Sustainable Master Plan is to “strive to reduce impervious cover and promote best practices of stormwater management.” The Strategies that the City outlines to implement this Goal are to:^{xxxii}

- Implement and enforce the provisions of the MS4 initiative during the site plan review and SEQRA processes.
- Allow the use of permeable surfaces for driveways and parking areas in residential and commercial developments.

3: 1.3.3 CONTROLS FOR STORMWATER MANAGEMENT

The **City of Newburgh** outlined the following strategy in its Sustainable Master Plan in order to promote best practices of stormwater management: “Encourage best management practices by minimizing and treating stormwater at its source including the use of grass swales, rain gardens, and green building techniques.”^{xxxiii}

The City has a Combined Sewer Overflow (CSO) system in which a mixture of stormwater and wastewater can spill into the Quassaick Creek during times of heavy rainfall. In order to remedy

this issue, the City of Newburgh established the following as Goal 3 in the Sustainable Master Plan: “the City’s Wastewater Treatment technology will be state-of-the-art and the effluent being discharged will exceed state and national standards.” The strategies identified by the City to help implement this Goal are to:^{xxxiv}

- Install storm-water treatments systems as part of the CSO project, so that heavy metals, oils, and other contaminants are removed from the storm-water before it is discharged.
- Explore alternative methods of reducing storm-water run-off and discharge to the Hudson River.

The **Town of New Windsor’s** Comprehensive Plan includes a recommendation to “enhance stormwater management within the Town” by amending regulations to “reduce flood damage, soil erosion, and stormwater runoff, maintain groundwater recharge, and minimize pollution of stormwater runoff in order to maintain the integrity of local water resources.”^{xxxv}

3: 1.3.4 SOURCE WATER PROTECTION

Goal 1 in the **City of Newburgh’s** Sustainable Master Plan is to “maintain and improve water quality for all residents and the natural environment.” A strategy that is outlined to implement this goal is to “advocate for a source protection plan for the water supply in the Town of Newburgh and New Windsor, and negotiate the enactment of protective zoning and land use controls to enforce it.”^{xxxvi}

The **Town of New Windsor’s** Comprehensive Plan recommends adoption of aquifer protection regulations and designation of aquifers as [critical environmental areas \(CEAs\)](#).^{xxxvii}

3: 1.4 ADDITIONAL LOCAL WATERSHED MANAGEMENT PRACTICES

The following management practices were included in the Audit of Municipal Codes and Regulations but *were not found in any of the municipal policies currently in place* within the Quassaick Creek Watershed. Adoption of such practices into local laws and codes would serve to enhance watershed management.

3: 1.4.1 PRESERVATION OF NATURAL FEATURES AND CONSERVATION DESIGN.

Natural Resource Inventory. Typically, developers are only required to inventory and preserve particular natural resources within their project site, but in many instances those natural resources are an integral part of a larger natural system. Municipalities have the ability to develop a Natural Resource Inventory (NRI) of their community in order to identify specific areas that are conservation priorities. The NRI can then be utilized when future projects are submitted and guide the location of site plan elements to less sensitive areas, preserving those conservation areas which may have broader significance in the landscape. Examples of features

commonly included in NRIs include reservoir watersheds, rare species habitats, wildlife corridors, vernal pools, aquifer recharge areas, and so on.

Stream buffers. Although the NYSDEC has regulations for activities within 50 feet of protected streams (classes AA, A, B, C[T], and C[TS]), actions taken beyond that distance are not regulated within the Watershed, with the exception of new development within areas governed by New Windsor's Watershed Protection Overlay district. Riparian areas within the remaining majority of the Watershed currently are afforded no local land use protections.

Wetlands: In addition to providing important and unique habitats, wetlands are critically important watershed features due to their role in water purification, flood abatement, and erosion control. Although most wetlands are afforded certain protections by New York State or federal laws, it is common for wetlands to nonetheless be degraded or otherwise impacted by land use activities. Adoption of local wetlands laws can: protect unregulated wetlands (including isolated wetlands, such as biologically-rich vernal pools); restrict clearing of vegetation within wetlands; prevent inadvertent filling and disturbance; safeguard wetland-dependent species through protection of certain adjacent upland habitats; and expand upon protections provided by State and federal regulations in other ways.

Enhanced erosion and sediment control. Currently, the NYSDEC allows up to five (5) acres of land to be disturbed/cleared at any time on a construction site, and no permit is required for disturbing less than one (1) acre. To further prevent soil erosion and protect surface water, local laws can be adopted that provide additional controls at the municipal level. Such laws can impose measures to: limit clearing of trees and other vegetation, with features identified for preservation, limit clearing to preserve mature trees – to be incorporated into the final site plan prevent fragmentation and preserved forest tracts.

3: 1.4.2 REDUCTION OF IMPERVIOUS SURFACE.

Increases in impervious surface caused by development typically raises and concentrate the amount of stormwater that leaves the development. This increased and concentrated flow heightens the amount of water within a receiving waterbody while also amplifying the threat of soil and stream bank erosion. Additional measures that could be encouraged through local laws to reduce impervious surfaces include:

- Strategically utilizing travel lanes for parking (This also acts as a traffic calming feature.)
- Requiring smaller cul-de-sac radii or incorporate landscaped islands on larger radius cul-de-sacs.
- Reducing the required minimum road right-of-way width, thus reducing the potential width of the roadway as well

- Set provisions within parking lots standards to:
 - Incorporate innovative stormwater management techniques in parking lot design; e.g. vegetated islands, biofiltration areas, etc.
 - Allow compact car spaces
 - Allow or encourage pervious pavement, even if only for overflow parking spaces
 - Minimize the required width of the travel lanes within parking lots
 - Set a *maximum* limit for parking spaces/site
 - Reduce the required minimum parking spaces/site

3: 1.4.3 SOURCE CONTROL FOR STORMWATER MANAGEMENT.

Stormwater facilities constructed in accordance with the NYSDEC Stormwater Design Manual are required for certain activities in all municipalities. Although the standards outlined in the Manual are intended to provide water quality and quantity treatment, some are more effective than others. Additional measures that could be encouraged through local laws include:

- Removal of curbing or providing curb cuts in conjunction with the use of roadside swales connected to localized infiltration practices.
- Requiring integrated stormwater management within larger required landscape areas of parking lots
- Collection of roof runoff and sidewalk runoff through temporary ponding in rain barrels or cisterns or within the landscape, rather than collecting the runoff within the traditional stormwater conveyance system.
- Replacement of traditional paving materials with those that are pervious and allow infiltration.
- Ordinances that minimize the use of more traditional management practices and promote use of created wetlands and other localized infiltration practices, which may be better suited for use by local fauna and integration into the natural processes.

3: 1.4.4 OTHER WATERSHED PROTECTION MEASURES.

There are no municipalities or homeowners/civic associations in the Watershed that currently conduct septic system inspections or require regular septic system maintenance. By identifying and resolving septic systems in need of maintenance, nutrient discharges to streams and other waterways would likely be reduced dramatically. Such programs would be especially useful for systems near a stream or the shores of a lake or reservoir or within the watershed of a waterbody known to be impaired by nutrients, such as Orange Lake and the lower Quassaick Creek.

3: 2 County Level

3: 2.1 DEPARTMENTS OF PLANNING

A primary function of County Planning Departments in New York is to fulfill their roles as the regional planning agency as per the requirements of General Municipal Law (GML) §239 (l-n), which dictates that certain types of municipal planning, zoning and subdivision projects be referred to County Planning for review prior to local action being taken. The requirement seeks to promote coordination of land use decision-making and to enhance consideration of potential inter-municipal and county-wide impacts. Both Orange and Ulster Counties perform reviews as per GML §239 (l-n), although their procedures differ; In Orange County, the Planning Department performs all reviews internally, while in Ulster County the Planning Department works with the County Planning Board to develop comments and recommendations on submittals. County Planning also coordinates regional transportation planning efforts, provides technical planning assistance to municipalities, and is involved with regional watershed planning efforts.

Orange County's [Comprehensive Plan](#) and its addendums, the [Open Space Plan \(2004\)](#) and the [Water Master Plan \(2010\)](#), provide a regional blueprint for development patterns, recreation improvements, and natural resource management. Orange County's goals and recommendations relevant to the Quassaick Creek Watershed that are expressed through the County Comprehensive Plan include:

- *Focus development in Priority Growth Areas* – The 2010 Plan differentiates between a range of urban areas, where densities and infrastructure investments are most appropriately focused, and rural areas, where conservation and natural resource management is the focus.
- *Conserve the County's natural land resources* in a sustainable, linked combination of parks, open space, agricultural lands and waterfronts. The Plan states that this can be accomplished by identifying undeveloped areas appropriate for permanent open space, establishing acquisition priorities and conserving farmland.
- *Utilize infill, redevelopment and new development techniques* in built environments to enhance the advancement of quality communities.
- *Encourage an adequate supply of high quality water* in support of the county's residential and business community while balancing the preservation and quality of the County's natural resources
- *Protect source water* through land preservation around reservoirs, public wells and groundwater recharge areas
- *Increase public access to water resources* such as lakes, rivers and streams

- *Promote conservation of important biological areas* through thoughtful land use planning and strategic land conservation. The County's Open Space Plan recognized both the Quassaick Creek corridor and the Red Maple Hardwood Swamps that constitute a substantial portion of the Orange Lake subwatershed as biological "hotspots" due to the presence of rare or otherwise significant species or natural communities.
- *Improve the quality of DEC-designated Priority Water Bodies*, such as the Quassaick Creek, its tributary streams, and Orange Lake

Orange County adopted its [Greenway Compact](#) in the summer of 2013. Although it does not hold the legal standing of a comprehensive plan, the Compact will be used as a guide for regional and local planning efforts. Orange County will become a Greenway Compact County once over 50% of municipalities endorse the Compact, which promotes pedestrian and bicycle trails, natural resource protection, historic preservation, and economic development. All policies that are promoted in the Compact align with those of this watershed planning effort.

Ulster County does not have a standalone comprehensive plan. Rather, it has separate documents that form elements of a comprehensive plan. By far, the document that deals the most with watersheds is [The Ulster County Open Space Plan: Resource Management and Protection](#), and watersheds are addressed in three different sections.

The Ulster County Open Space Plan first discusses watersheds in its section on water resources along with wetlands, aquifers, flood plains and surface waters. Five major drainage basins are identified: the Delaware, Esopus, Rondout, Wallkill and Black Creek & Hudson. The Quassaick Creek Watershed is a sub-watershed of the Black Creek & Hudson. Ulster County supports the EPA's "Watershed Approach Framework" for organizing and coordinating project activities, which the County sees as an approach that can "prevent pollution, achieve and sustain environmental improvements and meet other goals important to the community."

Watersheds, with water resources in general, are next addressed in the section on Resource Actions. One of the goals for water resources focused on watersheds. This is the goal to utilize the EPA's watershed approach framework to prioritize and manage water resources. To achieve this goal, the Ulster County Open Space Plan lists the following four recommended actions:

- Work with all the stakeholders to develop management alternatives that meet resource protection goals.
- Identify, update and coordinate overlapping water and land-use plans, regulations and funding sources.
- Participate in the technical advisory group of New York City West of Hudson watershed for continued management for watershed protection and cooperation among watershed towns in Ulster County.

- Encourage municipalities to protect riparian corridors and natural drainage areas that can be used to establish a buffer along stream/river corridors.

Ecological communities are another environmental feature addressed in the section on Resource Actions. Watersheds are specifically mentioned in this section, along with geographic features referred to as working landscapes, as being part of “interconnected systems that provide protection and corridors for ecological communities.” The goals for ecological communities deal with identifying and protecting them. Recommended actions include promoting biodiversity assessments in land use decisions and policies that sustain agricultural and forestry practices that contribute to biodiversity.

Ulster Tomorrow is the County’s comprehensive economic development plan. It does not deal with watersheds as an individual topic. There is, however, an examination of the [Catskill Watershed Corporation](#) and its role in small business development in the New York City Watershed. Ulster Tomorrow identified it as a partner in the County’s economic development efforts.

3: 2.2 ULSTER COUNTY DEPARTMENT OF THE ENVIRONMENT

The [Ulster County Department of the Environment](#) coordinates environmental policy and resource planning for inter-related County Departments. Key areas of involvement include; implementation of the County’s Open Space Plan, natural resource inventory data management and creation, stormwater regulation compliance, support of county green building & infrastructure initiatives, and involvement in watershed planning issues. The Department recently completed a countywide Green Infrastructure mapping project, which highlighted important natural resources.

3: 2.3 COUNTY HEALTH DEPARTMENTS

3: 2.3.1 ORANGE COUNTY HEALTH DEPARTMENT.

[Orange County Health Departments](#) manage and regulate New York State Sanitary Codes to prevent environmental threats to public health. Health Department administers and enforces State regulations which can be found in [New York Codes, Rules, and Regulations Title 10 \(10NYCRR\)](#). See the list of applicable regulations below. Relative to these, Department engagement is limited to those regulations directly related to public water supply, water quality and development activity. The more common tasks include: engineering review of proposed public water supply improvements; public water supply inspection; engineering review of proposed realty subdivisions; engineering review of proposed public swimming pools.

10NYCRR	Title
Part 5	Drinking Water Supplies - to protect present or future sources of water supply, together with the Watershed Rules and Regulations.
Part 6	Swimming Pools, Bathing Beaches & Recreational Spray Grounds - to assure a sanitary, healthful and safe environment for the public when using swimming pools, bathing beaches or recreational aquatic spray grounds.
Part 74	Approval of Realty Subdivisions. – to protect public health by providing for adequate water and sewer facilities for new homes.
Part 75	Standards for Individual Water Supply & Individual Sewage Treatment Systems - to protect the health and safety of those persons who must use an individual water supply system, an individual sewage treatment system, or both, when a municipal or communal system is not available.
Part 133	Watershed Rules & Regulations - Orange County – to protect reservoir watersheds from contamination.

3: 2.3.2 ULSTER COUNTY HEALTH DEPARTMENT

In Ulster County the agency responsible for granting septic system permits depends on the size of the system and the land use involved, and in some instances, the location. [UCDOH](#) handles permitting for the following septic systems:

- all residential septic systems
- all commercial septic systems that have a daily flow of less than 1,000 gallons/day
- all septic systems with a daily flow up to 10,000 gallons/day for land uses that UCDOH will issue permits at this high a volume. These are land uses listed in the *Ulster County Sanitary Code*. In particular, temporary residences, migrant farm worker housing, children's camps and campgrounds are land uses from the *Ulster County Sanitary Code* that have in the past, are currently or may in the future, locate in the Ulster County portion of the Quassaick Creek Watershed.

As the amount of sewage being handled increases, the role of DEC as a permitting agency increases. DEC issues septic system permits for most land uses starting with systems handling 1,000 gallons/day and more, in particular land uses not listed in the *Ulster County Sanitary Code*. At 10,000 gallons/day and more, DEC becomes the sole permitting authority for non-residential land uses.

UCDOH also coordinates with municipalities on septic system permitting. A developer or landowner must make an application to the UCDOH for review and approval. Once approved



and a final site inspection is completed, building departments can issue a certificate of occupancy.

In the New York City Watershed, the [New York City Department of Environmental Protection \(DEP\)](#) plays some role in permitting septic systems. UCDOH solely handles most septic system permitting in the Watershed. Under certain conditions, UCDOH and DEP conduct a joint review for a UCDOH permit. The most common condition is locating a septic system within 200 feet of a watercourse.

3: 2.4 SOIL AND WATER CONSERVATION DISTRICT (SWCD)

3: 2.4.1 ORANGE COUNTY SOIL AND WATER CONSERVATION DISTRICT.

The [Orange County Soil and Water Conservation District \(OCSWCD\)](#) was established in 1967 through resolution of the County Legislature. A large portion of the SWCDs' work is related to the agricultural community; growth within the County has changed the landscape, adding non-agricultural storm water management and conservation educational programs to their repertoire. OCSWCD recognizes the value of developing and implementing watershed management plans, especially in watersheds with diverse land uses as is common in Orange County. They spearheaded the development of a Wallkill River watershed management plan, one of the first in Orange County. They continue to assist with other watershed plans, often contributing agricultural and storm water management technical topics in particular.

3: 2.4.2 ULSTER COUNTY SOIL AND WATER CONSERVATION DISTRICT.

The Ulster County Soil and Water Conservation District (UCSWDC) administer several programs with direct impacts on water quality. The UCSWDC administers the New York Non-Point Source Abatement and Control Program for Ulster County and offers assistance to municipalities, citizens' groups, agricultural operations and individuals with planning and creating vegetative buffer systems. It also offers assistance in meeting U.S. Environmental Protection Agency Phase II regulations for stormwater management. The UCSWDC has on staff a certified professional in erosion and sediment control (CPESC). Along with the United States Department of Agriculture, the UCSWDC jointly administers the Agricultural Environmental Management Program for the County, which is a watershed-based program with one of its goals to reduce water pollution.

3: 2.5 COUNTY WATER AUTHORITY

The Orange County Water Authority, which was established to manage a countywide water supply system that was never built, performs various research, planning, and infrastructure tasks related to water education, water supply, and source water protection. The OCWA, which is a nonregulatory governmental agency, also oversees an annual stream biomonitoring program to

investigate water quality countywide and maintains eight stream gages that document water levels on an hourly basis. The OCWA has led or participated in various watershed planning projects in Orange County and is a member of the [Moodna Creek Watershed Intermunicipal Council](#). The OCWA also developed the County's Water Master Plan, which was adopted as a component of the County Comprehensive Plan and is described under Orange County Planning Departments (above).

3: 3 State Level

3: 3.1 DEPARTMENT OF STATE

3: 3.1.1 OFFICE OF PLANNING AND DEVELOPMENT.

The [New York State Department of State \(NYDOS\)](#) provides financial assistance to eligible waterfront communities on a competitive basis, through Title 11 of the Environmental Protection Fund, as well as expert guidance and training for the revitalization of communities, protection and improvement of the environment (e.g. watershed planning), strengthening of local economies and improvements to the efficiency and effectiveness of municipal service delivery. Preparing or implementing a watershed management plan is one of the grant categories funded through Title 11 EPF.

3: 3.1.2 LOCAL WATERFRONT REVITALIZATION PROGRAM.

The Waterfront Revitalization of Coastal Areas and Inland Waterways Act allow local governments to voluntarily participate in the State's Coastal Management Program. In order to do so a [Local Waterfront Revitalization Program \(LWRP\)](#) must be prepared and adopted. The LWRP is both a planning document and a program for implementation, which follows a step by step process which advances community planning from a vision to implementation.

3: 3.2 DEPARTMENT OF ENVIRONMENTAL CONSERVATION

3: 3.2.1 STATE POLLUTION DISCHARGE ELIMINATION SYSTEM.

New York State Department of Environmental Conservation (NYSDEC) Division of Water developed the [State Pollution Discharge Elimination System \(SPDES\)](#), modeled after the National Pollution Discharge Elimination System. The SPDES Program has been approved by the Environmental Protection Agency for the control of wastewater and stormwater discharges in accordance with the Clean Water Act. In essence, the State manages the Federal NPDES Program through the SPDES program, which is broader in scope due to the control of point source discharges to groundwater and surface water resources. Under SPDES, NYSDEC reviews permit applications to develop the limits for types and quantities of pollutants in the effluent. The permit also includes the schedules and conditions under which discharges are allowed.

Owners or operators of facilities must treat wastewater in order to meet the limits listed in their SPDES permit.

3: 3.2.2 STATE ENVIRONMENTAL QUALITY REVIEW ACT.

The [State Environmental Quality Review Act \(SEQRA\)](#) was enacted in 1975 and is a preventive measure that requires State and local governments to consider environmental impacts and balance potential impacts with social and economic factors during discretionary decision-making. SEQRA requires investigation into alternative actions and the mitigation of harmful effects of proposed development. Potential nonpoint source pollution can be remediated through revised design or other measures. SEQRA is New York State's substantive component of the National Environmental Policy Act.

3: 3.2.3 WETLANDS PROGRAM.

The [Freshwater Wetlands Act, Article 24](#) of the New York State Environmental Conservation Law, was established by the State Legislature in 1975 with the intent to preserve, protect and conserve freshwater wetlands and their benefits, consistent with the general welfare and beneficial economic, social and agricultural development of the State. Wetlands are classified by their respective function, Class I, II, III, or IV, where Class I wetlands are the most valuable and typically subject to the most rigorous standards. To be protected under the Freshwater Wetlands Act, a wetland must be 12.4 acres or larger, wetlands smaller than this may be protected if they are considered of unusual local importance. Around every wetland is an "adjacent area" of 100 feet that is also regulated to provide protection for the wetland.

[Tidal Wetlands, Article 25](#) of the New York State Environmental Conservation Law, is intent on the preservation and protection of tidal wetlands. Reasonable economic and social development is given due consideration, allowing uses within the tidal wetlands and its adjacent areas that are compatible with the preservation, protection and enhancement of the present and potential values. Around every tidal wetland there is an "adjacent area" of 300 feet that is also regulated to provide protection for the wetland.

Certain activities are exempt from regulation; other activities that could have negative impact on wetlands are regulated. A permit is required to conduct any regulated activity in a protected wetland or its adjacent area. The permit standards in the regulations require that impacts to wetlands be avoided and minimized. Compensatory mitigation often is required for significant impacts to wetlands. This may include creating or restoring wetlands to replace the benefits lost by the proposed project.

3: 3.2.4 PROTECTION OF WATERS PROGRAM.

The [Protection of Waters Program](#) is geared towards the preservation and protection of water resources that are necessary for drinking and bathing; agricultural, commercial and industrial uses; and fish and wildlife habitat. Certain human activities have the ability to adversely affect and impair the uses of water resources. In an effort to prevent undesired activities, NYSDEC enforce regulations based upon the classification of streams.

- (a) Class AA or A streams indicate that the watercourse is used as a source of drinking water.
- (b) Class B streams are watercourses best utilized for swimming and contact recreation.
- (c) Class C streams indicate that a watercourse supports fisheries and are suitable for non-contact activities.
- (d) Class D streams are the lowest classification.

Those watercourses classified as A, B and C may also be indicated with a standard of (T), indicating the potential to support trout population or (TS), indicating the potential to support trout spawning.

Under the Program, streams and waterbodies with a water surface under ten (10) acres within the stream that are designated C(T) or higher are collectively referred to as protected streams and are subject to stream protection provisions.

3: 3.2.5 HUDSON RIVER ESTUARY PROGRAM

The Estuary Program protects and improves the natural and scenic Hudson River watershed for all its residents. The program was created in 1987; its work focuses on the tidal Hudson and its adjacent watershed from the federal dam at Troy to upper New York harbor. Its core mission is to: ensure clean water; protect and restore fish, wildlife and their habitats; provide water recreation and river access; adapt to climate change; and conserve the world-famous scenery.

The program is guided by an Action Agenda - a forward-looking plan, developed through significant community participation up and down the river. The Hudson River Estuary Program achieves real progress through extensive outreach, coordination with state and federal agencies and public-private partnerships. This collaborative approach includes: grants and restoration projects; education, research and training; natural resource conservation and protection; and community planning assistance. In particular, the Hudson River Estuary Program supports watershed-based planning and management to protect and restore clean water.

3: 3.2.6 NATURAL HERITAGE PROGRAM.

The [Natural Heritage Program](#) was established in 1985 through the NYSDEC Division of Fish, Wildlife and marine Resources and is a partnership between the NYSDEC and the State University of New York College of Environmental Science and Forestry. The program is committed to the conservation of rare animals, rare plants and natural ecosystems/communities. The program utilizes field inventories, scientific analysis, expert interpretation, and comprehensive databases on New York's flora and fauna to inform compatible management activities in order to have significant and lasting effects on the Preservation of New York's biodiversity.

3: 3.3 NYS DEPARTMENT OF HEALTH

The [New York State Department of Health \(NYSDOH\)](#) monitors and reports on the impacts of non-point sources of pollution related to the health of the citizens of New York, through water quality monitoring and reporting programs. The New York Public Health Law includes statutes regulating the protection of public water supplies from contaminants due to point and nonpoint source pollution.

3: 3.3.1 SAFE DRINKING WATER ACT.

The 1996 amendments to the SDWA require states to evaluate the quality of sources of public drinking water. It required that beginning in 1998 and continuing through 2001, the NYSDOH administers the [Source Water Assessment Program \(SWAP\)](#) to aid local and State efforts to develop and implement strategies to protect drinking water supplies from both point and nonpoint source pollutants. Under the enabling legislation and the SWAP, the NYSDOH is responsible for overseeing public water supply supervision and wellhead protection among other programs.

3: 3.4 NYS DEPARTMENT OF AGRICULTURE AND MARKETS

3: 3.4.1 AGRICULTURAL ENVIRONMENT MANAGEMENT PROGRAM

The [Agricultural Environment Management \(AEM\) Program](#) was established as a program in 2004. It is a voluntary, incentive-based program for farmers with the primary goal of protecting and enhancing the environment while maintain the viability of agriculture. The AEM program is overseen by the Department of Agriculture and Markets with significant involvement of member agencies and organizations comprising the State Soil and Water Conservation Committee, and each of the county-based Soil and Water Conservation Districts that provide direct technical assistance to farmers.

3: 4 Federal Level

3: 4.1 ENVIRONMENTAL PROTECTION AGENCY

3: 4.1.1 CLEAN WATER ACT.

The [Clean Water Act \(CWA\)](#) was passed in 1972 and signaled the creation of centralized Federal legislation to protect and restore the biological, chemical, and physical properties of the nation's water. This protection was to be achieved through legislation requiring a permit for the discharge of pollutants, the encouragement of best management practices to control pollution, and funding for the construction of sewage and wastewater treatment plants and facilities. The CWA was amended five years later and placed more stringent controls on the discharge of toxic materials and allowed states to assume responsibility over federal clean water programs. The primary focus of the CWA and the 1977 amendments was the prevention of pollution discharges from point sources. In 1987 the act was again amended, this time to focus on nonpoint sources of pollution.

3: 4.1.2 NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM PERMIT.

The [Environmental Protection Agency \(EPA\) Phase I stormwater program](#) was promulgated in 1990 under the CWA. Phase I rely on National Pollution Discharge Elimination System (NPDES) permit coverage to address storm water runoff from:

- "medium" and "large" municipal separate storm water systems (MS4s) generally serving populations of 100,000 or greater,
- construction activity disturbing five (5) acres of land or greater, and
- ten (10) categories of industrial activity.

The Storm Water Phase II Final Rule was published on December 8, 1999. The Phase II program expanded the Phase I program by requiring additional operators of MS4s in urbanized areas and operators of small construction sites, through the use of NPDES Permits, to implement programs and practices to control polluted stormwater runoff. Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of storm water discharges that have the greatest likelihood of causing continued environmental degradation. The program addresses environmental problems associated with discharges from MS4s in urbanized areas and discharges resulting from construction activity disturbing one acre or more. In New York, this policy is administered by the Department of Environmental Conservation through State Pollutant Discharge Elimination System (SPDES) permits.

3: 4.1.3 NATIONAL ENVIRONMENTAL POLICY ACT.

The [National Environmental Policy Act \(NEPA\)](#) was promulgated in 1969 which established a broad National Framework for Protecting the Environment. The basic policy ensures all branches of government consider the natural and human environmental impacts prior to the undertaking of major Federal activities. Any impacts identified as part of NEPA review must be disclosed to interested parties and the general public.

3: 4.1.4 SECTION 404 DREDGE/FILL PERMIT.

[Section 404 of the CWA](#) establishes programs to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. EPA and the [Army Corps of Engineers \(ACOE\)](#) jointly administer the program. In addition, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and State resource agencies have important advisory roles. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects, infrastructure development, and conversion of wetlands to uplands for farming and forestry.

The basic premise of Section 404 is that no discharge of dredged or fill material can be permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. In other words, when you apply for a permit, you must show that you have:

- (a) taken steps to avoid wetland impacts where practicable;
- (b) minimized potential impacts to wetlands; and
- (c) provide compensation for any remaining, unavoidable impacts through activities to restore or create wetlands.

3: 4.1.5 SAFE DRINKING WATER ACT.

The [Safe Drinking Water Act \(SDWA\)](#) was passed in 1974 to protect drinking water supplies from harmful contaminants. The legislation attempts to provide safe drinking water through primary drinking water regulations, underground injection control regulations, and protection of sole source aquifers. In 1986 the act was revised to speed up implementation and included additional provisions for regulating contaminants, filtration systems, distribution systems, and wellhead protection systems. The SDWA establishes both health-related (primary) and nuisance-related (secondary) standards for public drinking water. Under the original legislation, the EPA set primary standards for 25 contaminants. The 1986 amendments required the EPA to include an additional 48 contaminants, raising the total number of chemicals regulated in drinking water to 83. In August 1996, the act was amended to include a program that requires states to monitor and evaluate the quality of sources of drinking water supplies through a state-

driven [Source Water Assessment Program \(SWAP\)](#). In addition, more stringent standards for drinking water and reporting of contaminant levels by water providers to their customers were also included.

3: 4.1.6 CLEAN WATER ACTION PLAN.

In 1997, twenty-five years after the passage of the CWA, the [Clean Water Action Plan \(CWAP\)](#) was launched. The CWAP provides funding for programs developed by the EPA and USDA in conjunction with other federal agencies and state and local governments focusing on restoring and sustaining the quality and health of water resources.

3: 4.2 U.S. DEPARTMENT OF THE INTERIOR

3: 4.2.1 ENDANGERED SPECIES ACT.

The [Endangered Species Act](#) was passed by Congress in 1973 with the purpose of protecting and restoring imperiled species and the ecosystems upon which they depend. Species may be listed as either Endangered; species is in danger of extinction throughout all or a significant portion of its range or Threatened; species are likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened.

3: 4.3 UNITED STATES DEPARTMENT OF AGRICULTURE

3: 4.3.1 ENVIRONMENTAL QUALITY INCENTIVES PROGRAM.

The [Environmental Quality Incentives Program \(EQIP\)](#) is a United States Department of Agriculture (USDA) and Natural Resource Conservation Service (NRCS) initiative authorized by the 1996 Farm Bill that provides farmers with technical, financial, and educational assistance to address soil, water, and natural resource concerns in an environmentally beneficial and cost-effective manner. EQIP addresses natural resource concerns through the implementation of structural, vegetative, and land use practices such as manure management facilities, abandoned well capping, tree planting, filter strips, nutrient, pest, and grazing management, and wildlife habitat protection and enhancement.

3: 4.3.2 AGRICULTURE MANAGEMENT ASSISTANCE.

The [Agricultural Management Assistance \(AMA\)](#) program assists provides financial and technical assistance to farmers who voluntarily want to address issues related to water management, water quality and erosion control through incorporating conservation into the daily farming activities. Farmers have the ability to undertake projects that construct or

improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming.

In addition, the AMA program also addresses Concentrated Animal Feeding Operations (CAFOs). CAFOs are agricultural operations where animals are raised and maintained in confined areas for 45 days or more in any 12- month period and where crops, vegetation, or other forage growths are not sustained over any portion of the lot or facility in a normal growing season. CAFOs contribute to pollution through the carrying of nitrogen, phosphorus, pathogens, sediment, hormones, antibiotics, ammonia, and other harmful substances to water bodies.

CHAPTER 4. WATERSHED MANAGEMENT RECOMMENDATIONS AND IMPLEMENTATION STRATEGY

□□□□□

4: 1 Introduction

4: 1.1 BENEFITS OF MANAGEMENT RECOMMENDATIONS

As described in **Chapter 1**, the Advisory Committee developed a **VISION** statement for the Quassaick Creek Watershed, then established **5 GOALS** and **12** corresponding **OBJECTIVES** to support this vision. The management recommendations, which are described in greater detail in this Chapter, were developed for each objective over the course of a year while the Advisory Committee continued data collection and solicited feedback from the public, municipalities, state organizations, and citizen-based groups (e.g., Orange Lake Civic Association, [Scenic Hudson](#)). The recommendations often echo priorities of municipal plans and studies, which demonstrates the interconnectedness of the Watershed's communities to the environment.

The **54 MANAGEMENT RECOMMENDATIONS** developed for the Quassaick Creek Watershed strongly advocate for water quality improvements and have many overlapping and synergistic benefits. For example, streams that are clean and safe for human interaction add value to a neighborhood or community by serving as an aesthetically-pleasing natural amenity and source of recreation. Healthy streams benefit wildlife living in or near the stream and contribute to a diverse local ecosystem. High quality streams that flow into reservoirs and other lakes help safeguard drinking water and maintain the recreational and aesthetic value of lakes.

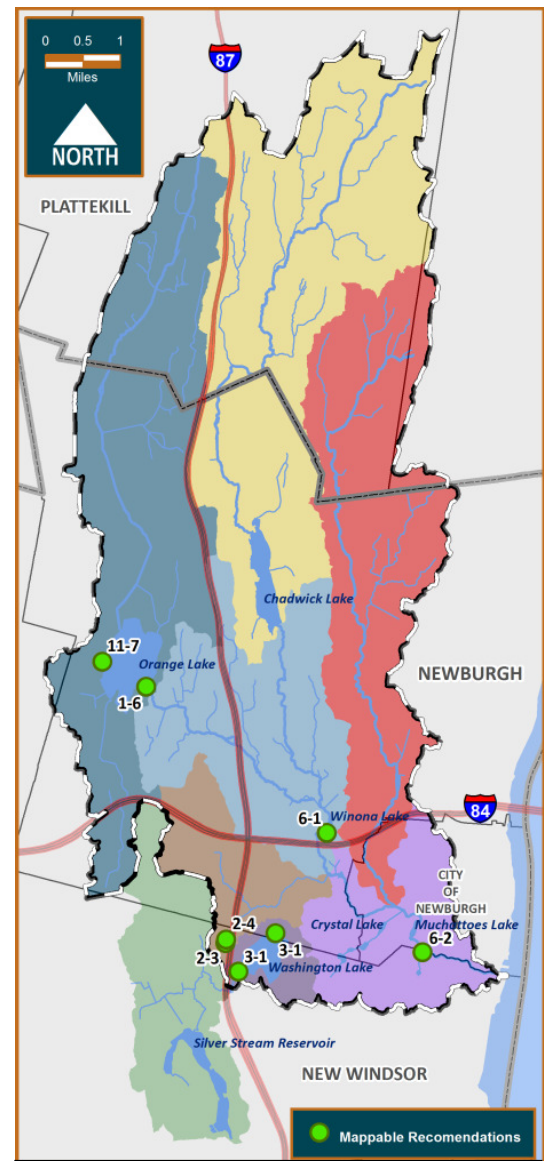


Figure 19. Locations of Management Recommendations that are site-specific. The labels for the points (e.g. 11-7) correspond to the number in this Chapter and in **Appendix E**.

4: 1.2 A COORDINATED IMPLEMENTATION STRATEGY

Based on data needs, stakeholder feedback, and example projects already underway, the Advisory Committee identified potential project partners, cost ranges and funding opportunities for the management recommendations. Recommendations were then prioritized based upon anticipated number of goals met, range of benefits or significance of risk, committed partners and resources, and challenges to implementation. **TEN (10) PRIORITY ACTIONS** were identified, representing key demonstration projects that are being advanced by committed project partners, and often meet multiple management recommendations. Priority Actions Sheets showcase each project's potential for implementation and realized benefits from collaborative watershed planning, and are presented in **Appendix A**. The ★ symbol used in the tables and the narrative headings represents those recommendations that are part of a Priority Action.

4: 1.3 CHAPTER ORGANIZATION

The sub-sections of **Chapter 4** are organized by the 12 Watershed Objectives. A Management Recommendations Table is presented for each of the Objectives, and recommendations in **bold** indicate that an in-depth discussion is included in the narrative. A full table of management recommendations can be found in **Appendix E**. All recommendations have the following information identified within the Management Recommendations Table:

- Watershed **Goals** that the recommendation supports
- **Target Subwatershed** for the recommendation (only found in version of Table in **Appendix B**);
- Anticipated **Project Partners** (see below for key to acronyms)
- **Potential Cost** per site or project: \$ = under \$50,000; \$\$ = \$50,000 to \$250,000; \$\$\$ = more than \$250,000
- Estimated **Implementation Timing**: 1 = implementation will begin within the first year following completion of the Plan, and so forth
- General **Project Considerations**: ● = applicable, ○ = not applicable
 - Site Access is applicable if implementing the management recommendation could require entry onto private property or coordination with landowners.
 - Regulatory considerations pertain to policy recommendations, permitting requirements (e.g., wetlands permit, building/zoning permits), or where regulatory concerns affect restoration, acquisition, species and habitats. Early coordination with regulators and understanding permitting requirements are critical steps for many projects that without which can result in project delays and increased cost.



- Infrastructure improvements or coordination with utilities may be necessary for some projects, like those involving stormwater, water supply, or wastewater treatment.
 - While Social Acceptance is an important aspect for every project, this consideration specifically refers to management recommendations where public support may be challenging due to project cost (those requiring state or municipal funding), location, or other aspects. The fifth project consideration,
 - Ongoing Resources Needs relate to recommendations that require additional investment after implementation, such as operations and maintenance or program oversight. Clearly, there are many additional project considerations not assessed in this Chapter, and it is well understood that proper planning and coordination is an essential step to every project.
- Lastly, and as stated above, the ★ symbol indicates whether the recommendation has been included in a **Priority Action** sheet (located in **Appendix D**).

Note that acronyms are sometimes used for Project Partners in the Recommendations Table, while logos are used in the Priority Action sheets. These include:

OCPD = [Orange County Planning Department](#)



OCDH = [Orange County Department of Health](#)

UCPD = [Ulster County Planning Department](#)



OCWA = [Orange County Water Authority](#)



DEC's HREP = the [New York State Department of Environmental Conservation's Hudson River Estuary Program](#)



QCWA = [The Quassaick Creek Watershed Alliance](#)



OCLT = [Orange County Land Trust](#)



Municipalities are listed in several recommendations, and their individual logos are given in the Priority Action sheets where municipalities are anticipated to be partners. Municipal Conservation Advisory Councils, such as the one set up in 2013 in the City of Newburgh, may be especially well-suited to carrying out Plan recommendations.



SWCD = [Soil and Water Conservation Districts](#)

CCE = [Cornell Cooperative Extension](#)

MS4s = [Municipal Separate Storm Sewer Systems](#), regulated areas exist in each municipality and are tasked too oversee certain aspects of stormwater management and reporting. The Code Enforcement Officer/Building Inspector or municipal Engineer is typically the MS4 officer.

An in-depth discussion of these recommendations within the following Management Recommendations and Implementation Strategy narrative is organized to provide the following:

- Description of how and why the recommendation was selected,
- Benefits demonstrating the effect that implementation will have on the Watershed, and information to guide



- **Implementation** of the recommendation. If specific sites or methods have been identified, these are noted. **Progress** to-date in advancing the recommendations is also noted where applicable.

4: 2 Management Recommendations and Implementation Strategy

Objective 1 DEVELOP A MORE COMPREHENSIVE UNDERSTANDING OF SURFACE WATER AND GROUNDWATER QUALITY, QUANTITY, INCLUDING SOURCES OF IMPAIRMENT

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality and Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
1-1	Establish a program for ongoing monitoring of various stream water quality parameters	X	X		X	X	OCWA, QCWA, NYSDEC, Schools	\$	1+	●	○	○	○	●	★
1-2	Work with existing MS4s to inventory and address illicit discharges	X	X	X	X	X	MS4s, QCWA	\$	1+	●	●	○	●	○	★
1-3	Identify a mechanism to remove Orange Lake from 303d List and/or recognize water quality improvements	X			X		NYSDEC	\$-\$-\$	6+	○	●	○	●	○	★
1-4	Develop system for monitoring and tracking groundwater quality	X			X		OCWA	\$-\$-\$	2-5	●	●	○	○	●	
1-5	Collect and monitor water quality data at reservoirs and lakes	X			X		Municipalities, OCWA, QCWA	\$	1+	●	○	○	○	●	

1-1 ★ Establish a program for ongoing monitoring of various stream parameters

Description: Both the NYSDEC and Orange County have collected a significant amount of stream biomonitoring data within the Watershed, and much of these data indicate that streams continue to be impaired in many areas of the Watershed. Additional biomonitoring in the future will help to both assess stream segments that have not been sampled and monitor historic biomonitoring sites for trends. Biomonitoring, however, while useful as a screening tool to characterize stream health, often falls short of pinpointing specific types of water quality impairments and does not identify specific sources of impairments. Collection of additional field data - including pathogens, water chemistry, riparian condition, etc. - can help determine sources of contamination when used in conjunction with other geographic information such as land use, land cover, infrastructure, soils, topography, etc. Currently, there are no stream gages within the Quassaick Creek watershed. Strategic installation of stream gages would lead to a better understanding of the Watershed's hydrology and enable more informed planning and management decisions.

Benefits: Future biomonitoring will help identify water quality trends and assess the impact of remedial actions. Improving stream water quality is a core goal of this Watershed Plan and, while requiring a comprehensive approach, is dependent upon the identification and remediation of specific sources of contamination. Data collected by stream gages could ultimately lead to a decrease in the Watershed's – and its residents' – vulnerability to wet and dry conditions through decision-making that is based on documented hydrological responses and associated impacts (e.g. flooding, drinking water supplies being stressed from drought, etc.).

Implementation: Stream segments that have not been sampled yet or in the last few years should be prioritized for biomonitoring, including the NYSDEC's [WAVE](#) program. Historic biomonitoring sites should be monitored at least every couple of years to assess change. Investigative monitoring and research should be focused in areas that influence (i.e. drain to) sites with the lowest biological assessment profile (BAP). Other priorities may emerge due to interested landowners or the goals of willing partners. The Quassaick Creek Watershed Alliance should lead implementation of this project, working with Orange County as a primary partner. Training will be required for certain procedures, such as collection of nutrient data during storm events. Funding is needed to analyze biomonitoring samples (with the exception of WAVE samples, which are analyzed by the volunteer collector) and certain other parameters such as pathogens (e.g. *E. coli*, enterococcus), chlorophyll-*a*, and toxic substances.

Stream gages could be installed in each of the subwatersheds, or, minimally, on the Quassaick Creek, Gidneytown Creek, and Bushfield Creek. Ideally a professional hydrologist would be consulted to determine best locations. The OCWA manages eight stream gages in Orange County and could be a partner on installation and management, although municipalities could also take the lead role on ownership and management.

1-4 Develop system for monitoring and tracking groundwater quality

Description: In the Watershed, a groundwater monitoring program could be used to determine long-term trends in groundwater quality. Since a significant portion of the streamflow in the Watershed is derived from groundwater baseflow, it is important to understand the long term groundwater quality trends. By focusing on the non-point sources of potential contamination, which may migrate through the shallow groundwater to surface water resources or the deeper bedrock drinking water aquifer, this monitoring program could track several potential sources of contamination known to exist in the Watershed. Although no groundwater investigations were conducted as part of this Watershed Management Plan, groundwater quality studies conducted within the mid-Hudson valley and Orange and Ulster counties identified potential sources of contamination including pesticides (DDT, lead-arsenates) and pesticide degradates (DDD, DDE) associated with past agricultural practices and from

the use of deicing chemicals on roadways in the winter time (USGS 2006, Kelly et al. 2010). High concentrations of sodium from deicing salts can occur in shallow wells, in wells that are near point sources such as salt storage facilities, and in wells that are downhill from heavily salted roads, such as interstate highways. While safe roads are of utmost importance, recent studies in Dutchess County, New York, have identified sodium accumulations in the ground, possibly in pockets of groundwater that have a legacy effect (Kelly et al. 2010). Generally, there is less concern associated with point sources of groundwater contamination since these sites are typically addressed and monitored under existing regulatory and enforcement programs (e.g. [NYSDEC Chemical & Petroleum Spills Program](#); see **Chapter 2**).

Benefits: Groundwater responds more slowly than surface water to changes in land use and management practices because of the slow rates of groundwater flow and the resulting long residence time (USGS 2006). Therefore, a better understanding of the long-term groundwater quality trends in the watershed would help identify potentially impacted areas and assist with the development of BMPs to reduce the impact and improve the overall water quality both in the groundwater and surface water. From a community benefit perspective, reducing the potential contaminant load to source waters (such as Chadwick Lake, which possesses a large subwatershed) aligns with the goals to protect water quality and promote watershed awareness.

Implementation: A groundwater monitoring program could be implemented using a phased approach. The first phase surface could include collection of water samples on a sub-watershed basis during stream baseflow conditions, preferably during the fall months when much of the streamflow can be directly attributed to groundwater discharge. Although the samples would be surface water under baseflow conditions they can be used as an indicator of the shallow groundwater quality. Based on those results a monitoring program can be designed to focus on those sub-watersheds that show the largest impact. Typically this second phase will require the installation of groundwater monitoring wells at select locations followed by the establishment of a routine sampling and analysis program. The project partners could also produce a GIS-compatible dataset (geodatabase) of groundwater elevations and other site-specific information, which would be a valuable addition to local spatial data clearinghouse (Orange and Ulster Counties). A groundwater database would be beneficial in siting future BMPs or development projects, and to garner local support for watershed planning.

Development and implementation of the groundwater monitoring program is largely constrained by the limited resources and funds available to conduct the program. The initial phase could be conducted largely with volunteers but funding would be required to complete the necessary analytical testing. The second phase would require significant funding but these types of monitoring programs are routinely conducted by environmental consultants and government agencies such as the USGS.



1-5 Collect and monitor water quality data at reservoirs and lakes

Description: Similar to Recommendation 1-1 Stream Monitoring, baseline monitoring of the Watershed's reservoirs and lakes can be used to assess water quality and overall health of these waterbodies over time. A monitoring program could take many formats depending on the program goals, such as identifying impairments to source waters, managing reservoirs to improve "raw" water quality and enhancing recreational use of underutilized lakes.

In drinking water reservoirs, nutrients and algae are impairments that can affect clarity, taste and odor, which then must be treated by water suppliers in order to meet stringent regulatory requirements and basic water quality aesthetics. A recent study of Chadwick Lake, for example, identified heavy algal presence and nutrient concentrations (total organic carbon, ammonia) in both the Lake and its tributaries (GHD 2013). The study recommended multi-season/multi-year monitoring of raw water and intake systems, in addition to other capital and operational improvements, to characterize seasonal variations in water quality, chemical interactions, and the impact on overall water treatment plant performance, particularly identifying the need for further study to determine the source and/or cause of ammonia entering Chadwick Lake. Water quality recommendations include monitoring parameters such as natural organic matter, total organic carbon, dissolved organic carbon, absorbance of light, total dissolved solids, ammonia, and conductivity (GHD 2013). Similar water quality studies could be designed for other source waters, depending on the critical impairments.

Monitoring of recreational lakes often focuses on aesthetics and impacts on recreational uses. Members of the Orange Lake Civic Association and the Orange Lake Fish and Game Association performed monitoring at Orange Lake for several years between 1994 to 2012 through the NYSDEC's Citizen Statewide Lake Assessment Program (CSLAP). This monitoring data reveals insightful information and should continue to be collected in future years to assess trends in total phosphorus, dissolved oxygen, pH, water clarity, Chlorophyll *a*, nitrate + nitrite, ammonia, total nitrogen, specific conductance, calcium, temperature, algae, and plant cover.

Benefits: Implementing one or more targeted monitoring programs would yield a number of water quality, economic, and social benefits. For source waters, programs that successfully characterize and treat the cause of impairments on drinking water quality can lead to significant cost savings with respect to reduced operational costs (maintenance/calibration, water treatment chemicals) and capital costs (improved filtration, treatment techniques, alternative water supplies). Recreational use of lakes in the watershed, such as Crystal and Muchattoes Lakes, could be enhanced simply by demonstrating the lakes have good water quality or, through lake management and annual monitoring, that water quality can be improved. Public perception that urban lakes are impaired can be a significant deterrent for active and passive recreational users. Generally lakes in urban and suburban southeastern New



York are eutrophic, but managing nutrients and aquatic vegetative growth could greatly improve a lake's aesthetics. Lastly, monitoring programs provide an opportunity to obtain baseline data to assess effects from policy changes and land management. For example, New York State passed a law in 2012 that restricted phosphorus fertilizers, and multi-year lake monitoring could be used to assess the efficacy of this law.

Implementation: As with any monitoring, the program must be tailored to specific objectives. The types of monitoring programs described above (source water/feeder streams, recreational use) can be implemented in a number of ways. In addition to monitoring recommended in the GHD (2013) report on Chadwick Lake, a small sampling effort could be undertaken to collect nutrient and flow data of tributary streams and stormwater inputs to reservoirs during storm events. Stormwater runoff can be a significant contributor of nutrients and sediment, particularly with high density residential land and development pressure in water supply watersheds.

Acquisition of seasonal water chemistry data collected using standardized methods over multiple years is ideal. Data collection could be performed by volunteers using rental water quality probes, and analysis of standard parameters is often nominal though this typically requires hiring an analytical laboratory to process the samples. Storm event sampling can yield insightful data on the stream system's response to wet weather events; however the programs are often challenging, not only for staff to be on-call during potential sample events (or use automated samplers) but also to obtain multiple events of varying magnitude to begin to extrapolate the effects of the storm events.

Lakes and reservoirs can also be assessed for the trophic state, which would then lead to the development of appropriate management strategies based on the Carlson Trophic State Index (TSI) protocol. This method involves measuring temperature, pH and dissolved oxygen profiles combined with testing the water for chlorophyll-*a* and total phosphorus.

Monitoring similar to that being undertaken at Orange Lake could be completed at other recreational lakes, although CSLAP funding is limited and typically focuses on community lakes.

Prior to initiating, any monitoring plan should be coordinated with NYSDEC Water Quality to determine if the site-specific plan could be tailored to support other regional or state-wide monitoring/modeling efforts (e.g., PWL, 303d, climate change, etc.).



Objective 2 PROMOTE WATER QUALITY PROTECTION MEASURES AND WATERSHED-FRIENDLY POLICIES THROUGHOUT THE WATERSHED

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
2-1	Identify and protect priority lands, wetlands, riparian buffers and other natural areas within reservoir subwatersheds	X	X	X	X	X	municipalities, OCLT	\$\$-\$\$\$	1+	●	●	○	●	●	★
2-2	Track monitoring results of closed landfills in Washington Lake watershed	X		X			QCWA, Air National Guard, New Windsor	\$	1+	●	○	○	○	●	★
2-3	Develop/maintain intermunicipal agreement on source water protection	X		X	X		OCPD, UCPD, municipalities	\$	2-5	○	●	○	●	●	★
2-4	Develop a watershed protection guide that can be adopted by municipalities	X		X	X	X	OCPD, UCPD, municipalities	\$	2-5	○	●	●	●	●	
2-5	Develop model codes for water resource protection and climate change resilience	X			X	X	OCPD, UCPD, municipalities	\$	2-5	○	●	●	●	○	★
2-6	Recommend standards that incorporate adaptability to climate change for new construction	X		X	X	X	municipalities, OCPD, UCPD	\$	2-5	○	●	●	●	○	★
2-7	Encourage local regulatory measures for water resource protection, especially for drinking water and stormwater reductions	X	X	X	X	X	OCPD, UCPD	\$	2-5	○	●	●	●	○	★
2-8	Encourage planning and zoning in urban reaches of the stream corridor that improves the quality of life for people living near it				X		City of Newburgh+	\$	2-5	○	●	●	●	○	★
2-9	Promote incentive billing for centralized water and sewer services to encourage conservation	X			X	X	Water/Sewer service providers	\$	2-5	○	●	○	●	●	
2-10	Promote water conservation measures for all water users, both municipal customers and those on private wells	X			X	X	municipalities, OCPD, UCPD		2-5	○	○	●	●	●	

2-1 ★ Identify and protect priority lands, wetlands, riparian buffers and other natural areas within reservoir subwatersheds

Description: Watershed protection is widely considered the best way of maintaining the quality of drinking water over the long-term. Some water suppliers benefit from having systems and funding in place to either acquire priority lands within reservoir watersheds, establish conservation easements, or



to otherwise maintain these lands in an unaltered, natural state. Priority lands may include riparian buffer areas, wetlands, steep slopes, forested lands or other areas important for maximizing water quality. As an example, the Town of Newburgh has established priority areas within the Chadwick Lake watershed, and intends to acquire several properties from willing sellers to protect specific lands from future development in late 2013 or early 2014. This land protection program has resulted in the acquisition of over 560 acres adjacent to the Lake or within the Watershed. Another conservation technique that municipalities can employ is the development of a municipal Natural Resource Inventory (NRI), which identifies and maps important natural areas that are worthy of consideration or protection. NRIs are used by the municipal board and planning board during the comprehensive planning, zoning and development review processes in order to ensure that priority natural areas are given appropriate considerations.

Benefits: The benefits of maintaining natural features within a reservoir's subwatershed range from improving natural filtering of pollutants before runoff reaches the reservoirs to decreased likelihood of incompatible land uses or activities encroaching upon the reservoir or its tributary streams. A high percentage of natural cover can make the reservoir more resilient to flooding or storm events due to the low degree of impervious surfaces in the subwatershed. Reduced water treatment costs are ultimately realized by the water supplier because the water quality will be safeguarded and need less treatment on average.

Implementation: Municipalities managing other reservoir subwatersheds could implement a program similar to that followed by the Town of Newburgh, first by prioritizing lands for conservation, then establishing a fund by which these could be purchased or protected under a conservation easement. Due to the extent of development surrounding Lake Washington and Brown's Pond reservoirs, a program such as this would be of smaller scale, commensurate with the availability of undeveloped land.

Another approach to protecting reservoir watershed lands is to establish this as a [Critical Environmental Area \(CEA\)](#). A portion of the Chadwick Lake watershed was designated as a CEA by the Town of Newburgh in 1987. In doing so, proposed projects with the potential impacts are required to assess the effect on the environmental characteristics of the CEA, pursuant to Section 617.7 of SEQRA, which gives the Town greater authority over proposed land use changes that could impair the drinking water supply. It may be possible to designate CEAs for the areas surrounding other source waters, like Washington Lake and Brown's Pond, because these reservoirs meet certain criteria, like being adversely affected by land use changes and adverse changes could threaten human health. For more information on CEAs, visit www.dec.ny.gov.



CASE STUDY:

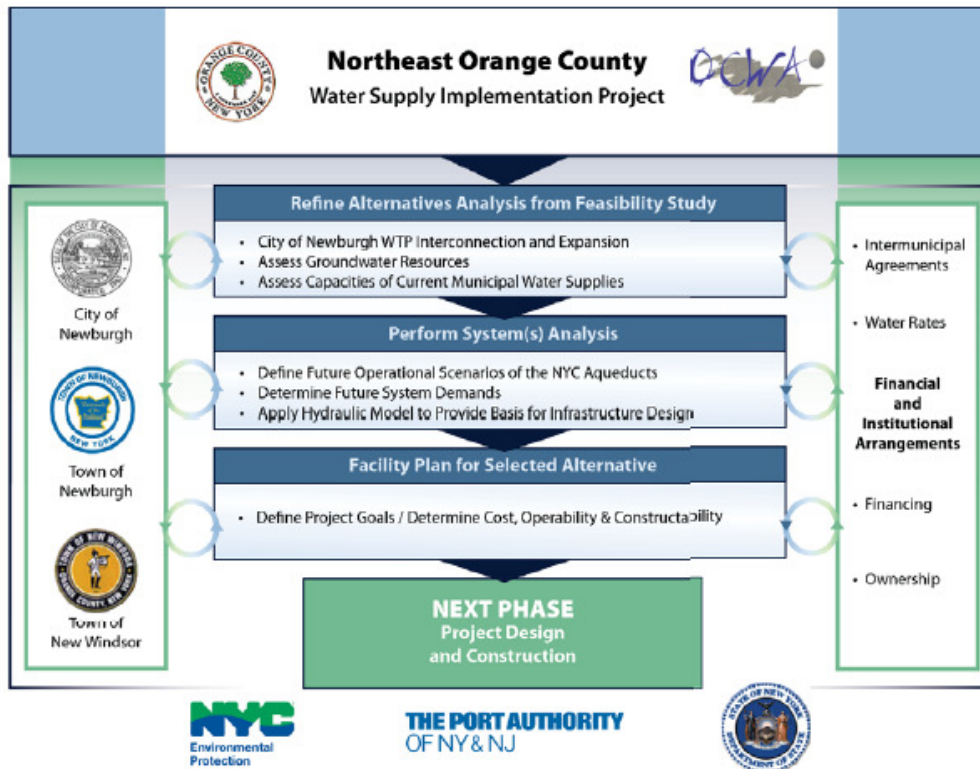
Intermunicipal Collaboration for Drinking Water

Abstract

Northeast Orange County Water Supply Implementation Project

Orange County, N.Y. relies on water from both surface and ground water sources within 11 watershed basins as well as water from the New York City Aqueduct System. The Orange County Water Authority (OCWA) completed the Northeast Orange County (NE OC) Water Supply Feasibility Study in November 2010. This study addressed the future water resource needs of the Towns of Newburgh and New Windsor, the City of Newburgh, AND evaluated the feasibility of constructing a "regional" water treatment facility that would serve each of these municipalities. In 2011, the OCWA filed an application for and was awarded a project implementation grant application under the New York State Department of State Local Government Efficiency (LGE) Grant Program. This grant partially funded the NE OC Water Supply Implementation Project which has two primary objectives: (1) to refine and evaluate the financial and technical details associated with each of the water supply alternatives identified in the feasibility study and (2) to select a preferred regional water supply alternative. Develop a facility plan which meets the requirements of all parties involved and provides the basis for the establishment of a number of inter-municipal agreements. This report presents the results of the work that has been performed since the grant was awarded in July 2012. Tasks undertaken as part of this work include the performance of a safe yield analysis for the City of Newburgh's water supply, an investigation of the options for supplemental water supply to the region, the development of a facility plan (conceptual design) for the optimal water supply interconnections to improve overall system reliability within the region, and the establishment of an institutional framework to facilitate the overall regional water supply plan.

Scope of Work



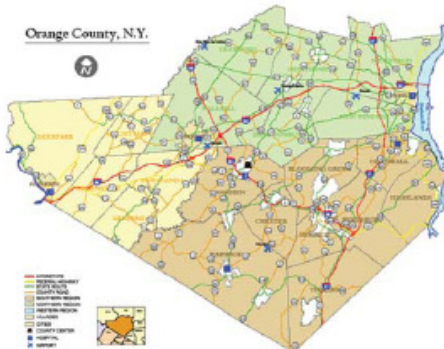
CASE STUDY:

Intermunicipal Collaboration for Drinking Water

Project Background

The Need for Regional Sharing

- The Northeast Section of the County is dependent on the NYC Aqueduct System for which shutdowns are planned.
- Water quality problems result in water shortages and require improved system reliability.



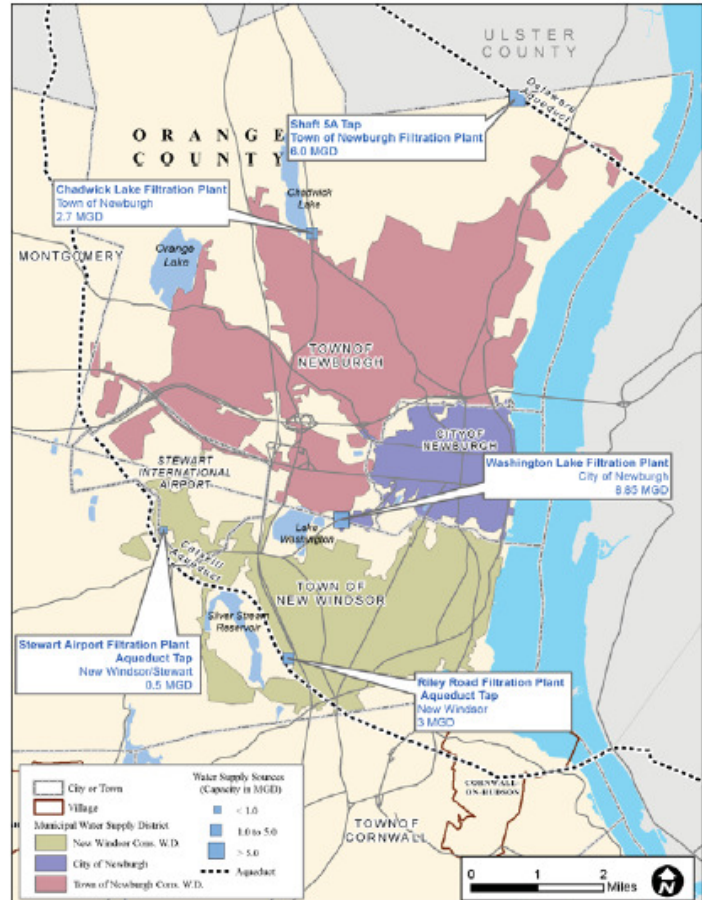
Project Objectives

- Provide for Interconnections between the City of Newburgh and the Towns of Newburgh & New Windsor that will allow for the three systems to operate relatively independent of the NYC Water Supply system.
- Provide for water supply capacity to address times when the NYC aqueduct supply is unavailable (both Catskill and Delaware).
- Provide for improved reliability among all three municipal supplies.
- Provide additional water supply capacity to address future growth projected within the Northeast Orange County area.

Previous Studies

REPORT	DATE	CONCLUSION
	August 2010	Northeast area of the County needs a water sharing plan. Orange County Water Authority Proposed County Comprehensive Plan Amendment Draft Water Master Plan
	November 2010	City of Newburgh Water Supply best option for supplying water regionally. Northeast Orange County Water Supply Feasibility Study
	June 2012	Determined drought and non-drought safe yields. City of Newburgh Water Supply Safe Yield Study Final Report

General Background Orange County, NY



- Population 372,813 (2010 census).
- Located 40 mi. north of NYC in mid-Hudson Valley Region.
- 42 municipalities: 3 cities, 20 towns, and 19 villages.

Current Water Supply Conditions

- **Town of Newburgh** (8.7 MGD capacity): Delaware Aqueduct Shaft 5A (6.0 MGD with new plant in operation in 2014); Chadwick Lake (2.7 MGD/2.1 safe yield)
- **Town of New Windsor** (3.93 MGD): Catskill Aqueduct @ Stewart Airport (0.5 MGD) & @ Riley Road (3.0 MGD), 0.432 MGD wells (Silver Stream Reservoir-Emergency)
- **City of Newburgh** (8.85 MGD): Washington Lake + Silver Stream Reservoir (6.6 MGD/3.7 MGD safe yield), Catskill Aqueduct (4.5 MGD)

2-3 Develop/maintain intermunicipal agreements on source water protection

Description: Land use activities that result in mobilization of nutrients, sediments, and proliferation of algae can affect source water quality within these reservoirs. NYS Department of Health created [Watershed Rules and Regulations \(WRR's\)](#) to enable municipalities whose drinking water supply and/or the water supply's watershed is outside of their jurisdiction to have some level of control over land uses and activities in other municipalities. In recent years, however, the State has enacted an unofficial moratorium on updating or enacting new WRR's, and the WRR's that do exist are outdated and largely unenforced. One action that municipalities can take without State approval is to enter into intermunicipal agreements, which can be formulated to provide a framework for implementing a consistent environmental review process for certain actions being proposed within key source water protection areas that cross municipal boundaries. Key elements contained in the review could include stormwater management, land use planning, NY State SEQRA reviews, and an assessment of pertinent water quality monitoring data. Intermunicipal agreements could be adopted by the following municipalities in order to protect drinking water reservoirs: Towns of Newburgh and Plattekill (Chadwick Lake), Towns of New Windsor and Newburgh with the City of Newburgh (Washington Lake and Silver Stream Reservoir).

Benefits: The benefits of developing intermunicipal agreements for the protection of drinking water sources within the Quassaick Watershed are listed above under section 2-1, i.e., the preservation of natural features, promoting land uses that minimize the introduction of pollutants into the water supply, and shifting development toward areas of less sensitivity. Establishing Intermunicipal agreements will provide a consistent watershed-wide institutional framework based on existing environmental regulations, basic municipal land-use ordinances, and state-of-the-art water treatment\management principles. Ultimately, such agreements would enhance coordination and information-sharing, thereby reducing the likelihood that land use changes or other actions outside of a water supplier's jurisdiction will negatively affect the drinking water supply.

Implementation: The Towns of Newburgh and New Windsor and the City of Newburgh are currently in the process of developing intermunicipal agreements for the purpose of sharing drinking water sources during periods of New York City Aqueduct shutdowns, or periods of water shortages due to either water quality problems or infrastructure failures. Each of these municipalities relies on the New York City water supply either for primary or back-up drinking water. These agreements could be used to include beneficial source water protection initiatives as described above. Or, a similar framework could be used dependent on the schedule and scope of the water source sharing agreement. Implementation requires effort and commitment from each municipality involved, either through formation of a workgroup, task force or sub-committee. Existing platforms that could be used include the Quassaick Creek Watershed Alliance, or the Northeast Orange County Workgroup, which was



developed to implement the Northeast Orange County [Water Master Plan](#). The “Case Study: Intermunicipal Collaboration for Drinking Water,” located on preceding pages, details the Workgroup’s progress as of early 2014.

2-4 ★ Develop a watershed protection guide that can be adopted by municipalities

Description: Watershed plans are often not well-suited to being adopted by a municipality as part of its comprehensive plan due to the fact that they frequently cover multiple jurisdictions. Additionally, watershed plans cover a wide range of topics, some of which may not be directly relevant to the municipality or are otherwise inappropriate to include in a comprehensive plan. Creation of a watershed protection guide that demonstrates how the concepts presented in this Watershed Plan can be implemented at both the site-specific and landscape levels would be educational and useful to many audiences, especially municipal officials and developers. This guide could provide guidance on site development, subdivision design, stormwater management and other topics, and could be written so that it is relevant to all jurisdictions, not solely the Quassaick Creek Watershed.

Benefits: A user-friendly watershed protection guide that includes specific watershed management techniques would increase the likelihood that development activities and planning processes acknowledge and protect water resources, thereby providing a wide range of ecological and social benefits.

Implementation/Progress: In the summer of 2013, the Orange County Planning Department was awarded a grant from the [New England Interstate Water Pollution Control Commission](#)/NYSDEC’s Hudson River Estuary Program to develop a Hudson Watershed Management Guide as an addendum to the [Orange County Design Manual](#), which is a tool kit of best management practices for municipalities to use during comprehensive planning and the development review process. The Hudson Watershed Management Guide will provide techniques, design strategies and implementation policies that will enable communities to better manage their water resources – in terms of both quantity and quality - in the face of a changing climate. The Regional Plan Association will provide technical support for this Guide, which should be completed in late 2014. Model codes will also be included in the Guide, thereby implementing Recommendation 2-5 of this Plan: “Develop model codes for water resource protection and climate change resilience.”

A dialogue about intermunicipal water supply protection

In November 2012, the DEC's Hudson River Estuary Program hosted workshop in the City of Newburgh about source water protection, with the goal of initiating dialogue between municipalities and other stakeholders about the need for an informed watershed approach to water supply management in Orange County, with a focus on the reservoirs within the Quassaick Creek Watershed. Partners on the workshop included several Orange County agencies and the NYS Department of Health. Newburgh City Mayor Judy Kennedy gave opening remarks.

Core messages delivered by the presenters included:

- Formal agreements between municipalities are needed in those instances where the watershed of a municipality's reservoir is either wholly or partially outside of their jurisdictional boundaries.
- Treating contaminated drinking water can be more costly in the long term than watershed management.
- Public outreach and education is key to collaborative watershed management.
- Recognition and visibility of watershed protection success stories creates needed buy-in for watershed management.
- Many reservoirs in Orange County, including Washington Lake and Silver Stream reservoir, may be vulnerable to water quality degradation due to their watersheds have one or a combination of the following: high percentage of unprotected land, high degree of developed land, little or no protections within existing zoning regulations. Land acquisition is one of the most reliable watershed protection methods.
- State-enabled Watershed Rules and Regulations (WRRs), which exist for many of Orange County's reservoirs but are all outdated, could be effective tools for extra-territorial reservoir protection but New York State has not allowed any new or updated WRRs in decades other than for New York City.

The workshop concluded with participants breaking into groups to discuss solutions to source water protection based on what was learned from presentations.



2-6 ★ **Recommend standards that incorporate adaptability to climate change for new construction**

Description: A principle watershed consideration that will become increasingly acute in the future due to our changing climate is storm events. Minor modifications to design and construction standards for infrastructure can reduce vulnerability to future weather conditions, such as flooding, storm surges (along the Hudson River), and sea level rise (downstream of American Felt and Filter Dam). New residential and commercial structures, as well as transportation infrastructure or utilities located within the 100-yr floodplain of the Quassaick Creek and other tributaries, could benefit substantially from implementing upgrades to increase resiliency. The purpose would be to increase the likelihood that new construction would be protected and critical infrastructure (water/wastewater treatment plants, hospitals and other emergency services, etc.) would still be operational in the event of a severe weather event. Resource constraints for capital programs is a real concern and linked to the probability of significant storms occurring. This recommendation was crafted to be mindful of competing resources and differing municipal priorities.

Benefits: Implementing standards that incorporate adaptability or resiliency to climate change will mitigate future losses of critical infrastructure and private property that would otherwise be expected to occur in older structures or those that have not been updated. Hurricane Irene and Tropical Storm Lee caused significant flooding in the Watershed in 2011. More recently, the Newburgh waterfront, although outside of the Watershed, experienced extensive damage from the Hudson River storm surge caused by Hurricane Sandy. This and future storm surges affect the Lower Quassaick Creek.

Implementation: There are a variety of ways in which implementing design standards can promote principles of resiliency and adaptability, and some suggestions are listed below. In each case, the costs and benefits of addressing vulnerable, short-term risk versus investing in long-term protection for future conditions must be assessed. It is understood that standards must be tailored to regional risks and to respond to local programmatic needs, as communities in the Watershed will continue to be faced with many decisions and how best to make use of finite resources.

1. The 100-year floodplain is designated as a base flood elevation (BFE) by the [Federal Emergency Management Agency \(FEMA\)](#), which is a standard design flood elevation not to be encroached upon. Given the frequency and intensity of recent storm events, municipalities can consider buffering the federally-defined BFE, by 1-2.5 feet in elevation, thereby requiring that new development (assumed to last 50-100 years) not encroach in this municipally-defined zone. This requirement would not be tied to flood insurance, but could be used as a way for municipalities to provide additional flood protection for new construction.
2. Implementing recommendations from the local law audit (see **Chapter 3**) to improve construction practices and regulations that affects the erosion, streambank stability during storm events and



water quality overall (e.g., smart growth redevelopment, forest conservation, stormwater controls, etc.).

3. Designs for new construction are currently reviewed by municipal boards and departments. The application review process could include a vulnerability assessment, which would be completed by the applicant and reviewed by the municipality. For example, as part of the assessment, the applicant would address how sanitary systems and new electrical equipment is either protected from or placed above anticipated flood levels. Buildings that are sited near the floodplain or tidally influenced waters (limited to a small reach of the Quassaick in the City of Newburgh), could implement site-specific engineered solutions. These include concepts like raising the building elevation (providing parking or non-essential facilities on the ground floor) or flood-proofing by securing openings or constructing permanent barriers to floodwaters.
4. Upgrades to critical infrastructure (water/wastewater treatment plants, hospitals) should be carefully reviewed, particularly for infrastructure that is deemed vulnerable. Hardening and retrofitting, where possible, can be accomplished by protecting doorways, windows and other openings. Available capital is in short supply. In cases where an investment is not feasible, an alternative strategy of evacuation should be required or transfer/redundancy of service for critical-function facilities should be developed.
5. Natural shoreline protection can be incorporated into waterfront development (along the Quassaick Creek or Hudson River). This should be accomplished by preserving or enhancing existing natural shoreline features. Where natural shorelines do not exist, they can be created in the form of “living shorelines” or waterfront parks, where vegetated features like fringe wetlands and minor armoring are incorporated into the shoreline (**Figure 20**). Ecologically-engineered structures prevent or reduce erosion while emulating the physical and biological conditions of naturally occurring, stable shorelines, have aesthetic value, and can be implemented as part of compensatory mitigation. Environmental permits are required for almost any type of in-water work, even restoration, which require longer design lead-times and could deter developers from proposing these improvements.



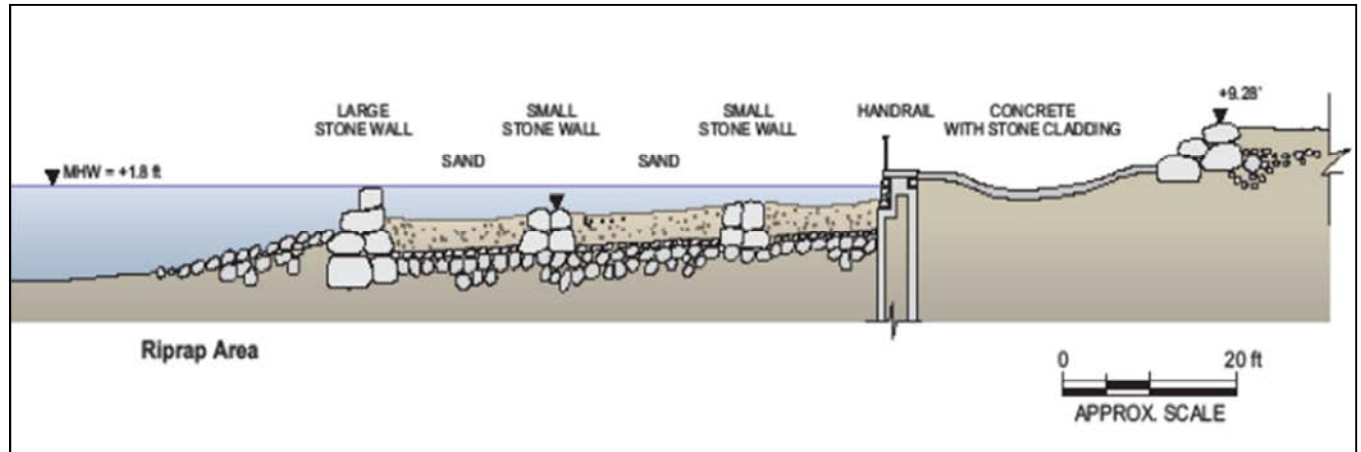


Figure 20. Example of a constructed living shoreline along the tidal Hunts Point Landing, Bronx, NY. Cross section design (top), shoreline under construction (bottom right), and completed living shoreline (bottom left)(Graphics courtesy HDR, Inc. 2012).

Since regulatory revisions are often unpopular when they are viewed as overly restrictive or financially burdensome to adhere to, changes to building standards could be incentivized. The American Institute of Architects identifies three popular incentives to encourage sustainable designs: (1) tax incentives, (2) bonus structure to encourage preferred development patterns (e.g. LID or conservation subdivisions as presented in **Chapter 3**), and (3) expedited approvals for building, planning and site permits (AIA 2012). Incentive programs must be carefully crafted to ensure they work as an incentive and not deterrent, and are also most effective if centralized in one place throughout the entire process and updated across a large geographic range (i.e., intermunicipal agreement) so as to encourage consistent implementation. As with any program, it should be assessed after it is in effect to evaluate and make on-going improvements.

2-7 ★ **Encourage local regulatory measures for water resource protection, especially for drinking water and stormwater reductions**

Description: A review of local regulations was completed by the two County Planning Departments for this Watershed Plan in order to assess the strengths and weaknesses of each municipality's local protection of water resources. This review work, which was detailed in **Chapter 3**, identified a widespread need for local adoption of measures that¹:

- afford a high degree of protection to streams, lakes, and wetlands

¹ See section 3: 1.4 for elaboration.

- ensure that off-site impacts from erosion and sedimentation are avoided during construction
- offer a comprehensive approach to reducing the creation of impervious surfaces
- encourage or require pervious surfaces for new development
- encourage or require detention of stormwater from roofs into cisterns or rain barrels
- encourage or require the creation of wetlands for stormwater treatment
- require septic system inspections in areas that drain to reservoirs and/or waterbodies that are known to be affected by nutrients

Benefits: Maintaining high water quality through such measures as those listed above is generally far less expensive than taking actions, such as enhanced treatment and chemical applications, to correct degraded drinking water. Additional benefits include protection of groundwater and enhancement of wildlife habitat.

Implementation/Progress: Updates to zoning codes could be implemented throughout the Watershed, noting that each municipality would need to tailor regulations to fit within their existing code and to conform to their comprehensive plan. As stated in Recommendation 2-5, the development and dissemination of model codes could facilitate adoption of zoning language that encourages or requires best practices for watershed management. Partners at the local, county and regional level, including the Ulster County Planning Department and the [Orange County Municipal Planning Federation](#), could help to develop model codes and facilitate their adoption.

In 2013, the [Moodna Creek Watershed Intermunicipal Council](#), in partnership with the Orange County Planning Department, developed a model local law for stream corridor management, which could be utilized in the Quassaick Creek Watershed. This model local law includes options, ranging from minimum through maximum protection measures, in attempt to make it easier for a municipality to customize the law to suite the unique needs of and issues within each community. Also, the forthcoming Hudson Watershed Management Guide mentioned under Recommendation 2-4 will include model codes for water resource protection and climate change resilience.

2-8 Encourage planning and zoning in urban reaches of the stream corridor that improves the quality of life for people living near it

Description: Streams have often been afforded little accommodation within historic urban planning and development projects and have also been prone to being targets of illegal dumping. Degraded water quality has been common in urban waterways, further discouraging the enjoyment and enhancement of urban streams. Planning and zoning efforts can revitalize a stream corridor and the land surrounding it if they seek to: increase setbacks from streams, encourage public access, require



best management practices for stormwater and stream corridor management, and allow only appropriate uses that are designed and built in ways that are mindful of the stream.

Benefits: Stream corridors that have been enhanced through the above methods often experience increased water quality and habitat value while also serving as magnets for economic growth and revitalization efforts. This would increase the quality of life of nearby residents, especially if public access to the stream were included in revitalization efforts.

Implementation/Progress: As of the fall of 2013, the City of Newburgh is updating its zoning code and has included a Waterbody Protection Overlay District for stream protection in its draft that proposes to require site plan review for all construction activities within the District. The draft language would require that site plans be approved only if they reduce stormwater runoff and erosion, link natural resource areas with those on adjoining parcels, and provide public access to the creek, stream or waterbody as appropriate. The Town of New Windsor could endorse and adopt similar ideas and techniques in its comprehensive plan and zoning code to ensure that appropriate development is encouraged equally on both sides of the lower Quassaick Creek.

2-10 Promote water conservation measures for all water users, both municipal customers and those on private wells

Description: Water Conservation is a global issue and should be a priority in the Quassaick Creek Watershed to reduce impacts on waterbodies from withdrawal of water that can affect fish and other wildlife and because conservation measures are critical for maintaining adequate water supplies, especially during times of drought. The preferred approach is to encourage all watershed stakeholders to make informed choices by learning about conservation and identifying ways to save water. This approach will have a greater impact on the amount of water conserved than approaches that rely on changing behaviors only during times of water shortages, especially since compliance with temporary water use restrictions can be low. Methods for conserving water can include simple human behavior changes (turning off faucet when not immediately in use), installation of water-conserving appliances and facilities (low-flow toilets and showerheads), repair of leaking water infrastructure (household pipes and faucets, municipal/community pipes), landscaping with drought-tolerant species (also called xeriscaping), and learning to accept that many grass varieties used for lawns and turf become dormant in hot, dry weather and turn brown, but flourish and become green again when rains return, so watering lawns in dry weather is not required to keep it healthy unless the lawn gets heavy use and wear and tear.

Benefits: Widespread water conservation efforts minimize strain on groundwater and surface water supplies, helping to conserve wildlife and biodiversity and leaving them less vulnerable to droughts and to drawdown from additional users. On the other end of the system, reducing the amount of water



that is flushed from a building and leaves as sewage minimizes the volume of wastewater entering sewage treatment plants and septic systems. This results in a cost-savings. Ecosystem benefits are realized as well, mainly through maintenance of more natural hydrologic patterns in surface waterbodies, many of which are directly connected with groundwater levels.

Implementation/Progress: Since 1994, the Orange County Water Authority's (OCWA's) Water Conservation Educators have been teaching school children countywide about the importance and impact of their water use at home. The Educators intend to influence the children's entire family and thereby promote widespread water savings. Adult education is another issue to which OCWA and other partners give sustained attention. Also, in 2010/2011, the OCWA provided full funding for leak detection of municipal water systems to interested municipalities, who cumulatively surveyed 656 miles of water main and found a total of 138 leaks that were causing the loss of 1,337,904 gallons per day. This program cost approximately \$30,000 but resulted in a savings to the municipalities of \$920,835 in lost drinking water. Also at the county level, the Department of Health is authorized to implement water use restrictions under the state's sanitary code. Municipalities can further water conservation efforts by memorializing the importance of such efforts in municipal comprehensive plans and zoning codes and by managing their municipal properties in ways that minimize water use.



Objective 3 IMPROVE STORMWATER MANAGEMENT, WHERE APPROPRIATE, IN ORDER TO REDUCE POINT (E.G., COMBINED SEWER OVERFLOWS) AND NON-POINT SOURCE LOADINGS

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
3-1	Implement stormwater retrofits at identified sites and other appropriate locations	X		X	X	X	SWCD, QCWA	\$\$-\$\$\$	1+	●	●	●	○	●	
3-2	Incentivize stormwater management	X				X	municipalities	\$	2-5	○	○	○	○	●	
3-3	Continue to promote appropriate use of green infrastructure	X	X	X	X	X	municipalities, OCPD, UCPD, SWCD, DEC's HREP, CCE	\$\$	1+	●	○	●	○	●	
3-4	Reduce CSO events	X	X			X	City of Newburgh	\$\$-\$\$\$	2+	○	●	●	○	●	
3-5	Increase maintenance of stormwater infrastructure through education, outreach, and other measures	X			X	X	municipalities	\$\$	6+	●	○	●	●	●	
3-6	Update local codes to require regular inspections and reporting on stormwater infrastructure	X				X	municipalities	\$	2-5	○	●	○	●	●	
3-7	Prioritize catch basins at Orange Lake for cleanout on a regular basis	X	X			X	Town of Newburgh	\$	1+	○	○	○	○	○	★

3-1 Implement stormwater retrofits at identified sites and other appropriate locations

Description: Stormwater retrofits remedy water quality and potentially water quantity problems associated with aging stormwater management systems that are sometimes poorly designed and/or poorly maintained. Retrofits can also be implemented in existing developments that were constructed prior to NYSDEC requirements for water quality and/or quantity controls. In coordination with Orange County Soil and Water Conservation District, the Orange County Department of Planning conducted an inventory of stormwater ponds using aerial images and topography followed by visits to each identified pond. A total of 148 stormwater ponds were found within the Watershed (**Figure 21**, or visit Google Maps at <http://goo.gl/maps/WWvln>). This inventory led to the identification of sites that could benefit from retrofits to enhance stormwater management.



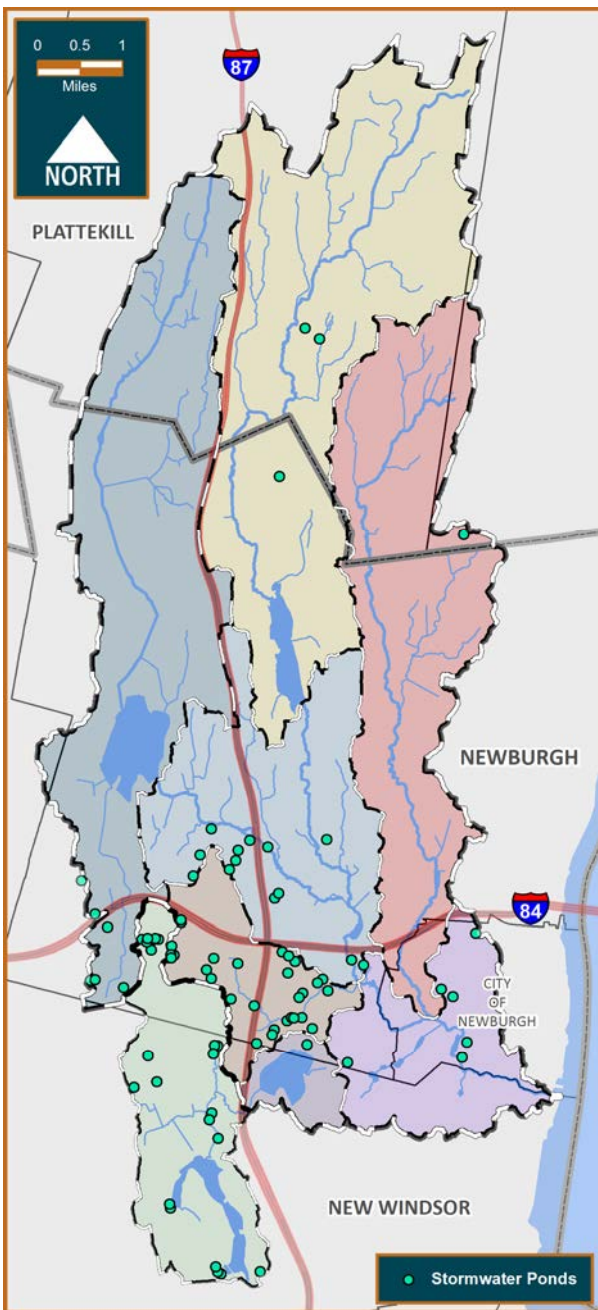


Figure 21. Locations of stormwater ponds, as identified by Orange County Soil and Water Conservation District and Orange County Planning Department in 2012.

Benefits: Stormwater retrofits improve water quality by capturing the “first flush” of a storm event, which is associated with the initial surface runoff of a storm event and typically contains a concentrated amount of pollutants and sediments rinsed from impervious surfaces. Other types of stormwater retrofits, as space allows, can be designed with water quantity in mind. These practices reduce the impacts associated with uncontrolled stormwater runoff by controlling the peak flows and discharging stormwater at a rate that does not burden the receiving water body, thereby avoiding flooding and erosion caused by unmanaged runoff velocities.

Implementation/Progress: To follow up on the stormwater pond inventory, next steps include outreach to identify willing landowners and securing funding to perform construction. Considerations when assessing the suitability of performing a stormwater retrofit include at least the following: landowner permission, physical access to site, need for revised stormwater permit, status of receiving waterbody (e.g. reservoirs and impaired waterways are high priorities in this Watershed), and soil type.

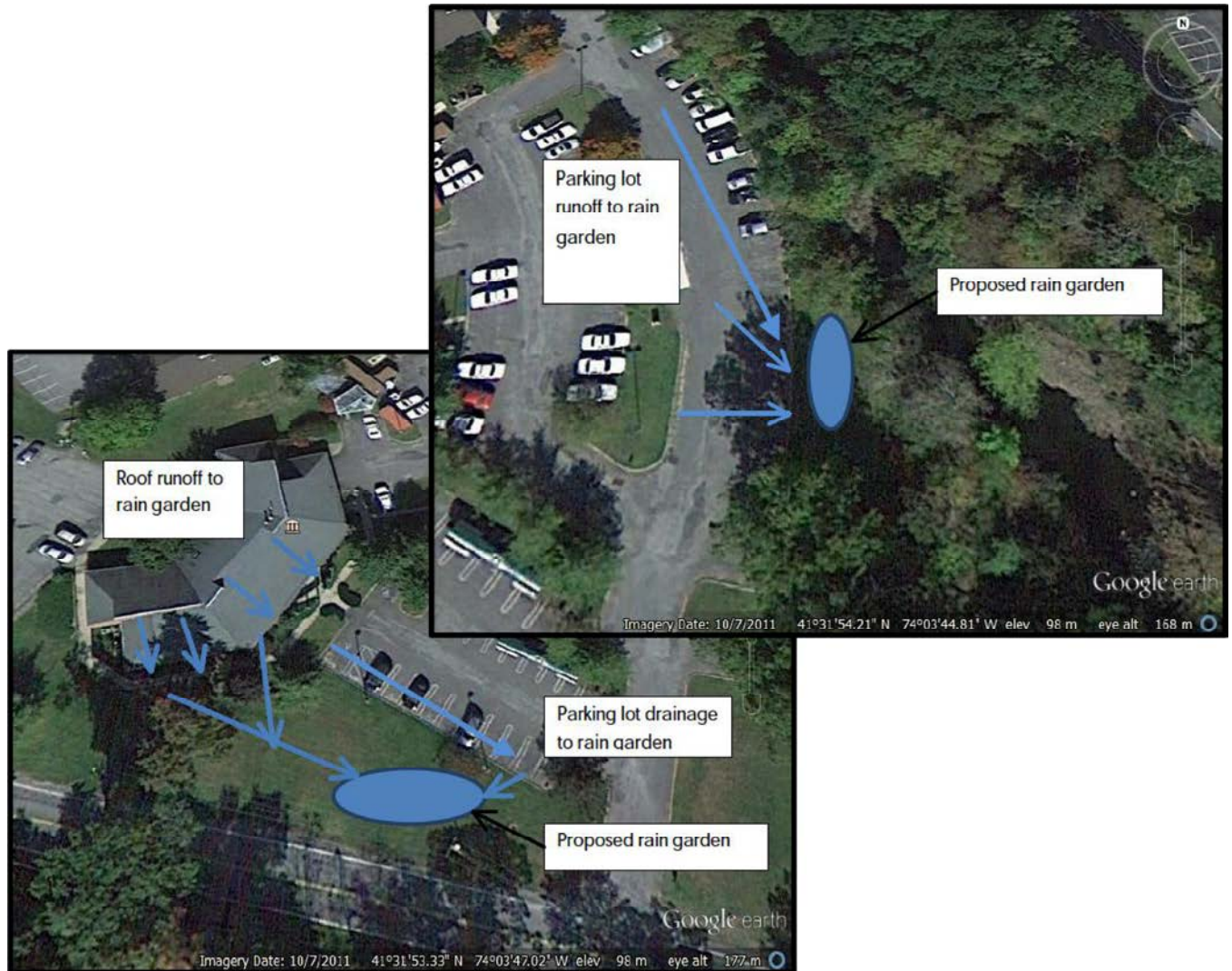


Figure 22: Stormwater retrofit concept proposed for Town of Newburgh Municipal Complex.

In 2013, a grant was awarded to the Lower Hudson Coalition of Conservation Districts to fund two (2) retrofits at the Town of Newburgh Municipal Complex at the intersection of Route 300 and Gardnertown Road (**Figure 22**). Currently the stormwater runoff associated with the roofs and parking areas at the Complex is collected via traditional catch basins and conveyed directly into the Quassaick Creek. The project proposes to convert existing underutilized lawn area into two separate rain gardens that will collect the “first flush.” Orange County Soil and Water Conservation District staff will work with the Town of Newburgh to implement the project, which is expected to begin in 2014.

3-2 Incentivize stormwater management

Description: Incentive programs related to stormwater management allow local governments the flexibility to target priority areas and allow innovative management technologies within new development as well as retrofits in existing development without the creation of mandates. Incentives could take the form of the municipality offering density bonuses, a more efficient review by the municipality, or easing of other code requirements for those projects that provide exemplary stormwater management practices that go above and beyond the minimum requirements.

Benefits: Stormwater management incentive programs have the ability to make exemplary stormwater practices more widespread, at no cost to the municipality in which the project is located.

Implementation: Municipalities can update zoning codes to include incentives. Counties and other partners can provide research into model language and programs then communicate these findings to the municipalities through education and outreach.

3-3 Continue to promote appropriate use of green infrastructure

Description: Green infrastructure (GI) stormwater practices utilize methods that introduce stormwater back into the ground closer to where it would have entered under predevelopment conditions and to maximize the use of vegetation to remove pollutants from and slow the velocity of stormwater. GI practices are in contrast to conventional stormwater treatment methods, which collect and pipe stormwater to retention or detention ponds that typically only provided basic water quality treatment, if any. Section 2: 5.4 elaborates on this concept.

Benefits: Green infrastructure can have lasting effects by potentially reducing energy use, filtering air and water pollutants, limiting the heat island effect, providing wildlife habitat, providing flood control, recharging groundwater, increasing the quality of treated stormwater, and preventing or reducing erosion. One of the biggest benefits related to green infrastructure, especially in the City of Newburgh, is its potential to reduce overflows of the combined sewer and stormwater system. Another benefit to green infrastructure, no matter where it is installed, is the potential for easy and lower-cost maintenance as compared to traditional stormwater systems, which allows problems to be resolved easily and at early stages.

Implementation: Green infrastructure has the ability to take on numerous forms and can be implemented through creative design in almost any development scenario. Project partners can make lists of green infrastructure techniques and best management practices available through the County planning offices, the Soil and Water Conservation Districts, the municipalities, Cornell Cooperative



Extension and the Hudson River Estuary Program, and work with developers and project applicants in early stages of project design to incorporate techniques effectively.

3-4 Reduce CSO events

Description: In the City of Newburgh, as in most urban areas in the United States, stormwater commingles with sanitary waste in what are known as combined sewers before flowing to treatment plants, and ultimately being discharged as treated wastewater to surface waters at permitted locations. During wet weather events, combined sewer overflows (CSOs) occur when the combined flow during wet weather exceeds the capacity of the collection system or treatment plant. One CSO exists in the Watershed (CSO 002), near the mouth of the Quassaick Creek where River Road crosses over the stream. In a typical year, CSO 002 represents roughly 50 percent of the annual volume of CSO discharged from the City's combined sewer system, with an average of 3 to 4 overflow events per month. During 2002, total overflow from CSO 002 was 90.8 million gallons (MG), and with a total of 46 overflow events per year. Predicted increases in the number and severity of storm events in the future will further strain the combined sewer system, resulting in increases in the average annual overflow volume from CSOs.

In January 2013, the City submitted to the NYSDEC a draft of the CSO Long Term Control Plan (LTCP; MP|Arcadis and Stantec 2013). Within this document, the City evaluated several alternatives to achieve compliance with the U.S. Environmental Protection Agency (USEPA) CSO Control Policy, a policy which requires small communities like the City to meet water quality standards of the receiving water body (Hudson River) and achieve 85 percent capture rate (MP|Arcadis and Stantec 2013). Currently, the City's system captures 73.8 percent of wet weather flows for full treatment at the existing Water Pollution Control Plant (WPCP).

Benefits: Reducing CSO events within the Quassaick Creek will directly enhance efforts to improve water quality conditions within the Watershed and the Hudson River, particularly given the magnitude of discharges at this site. CSO events typically result in increased frequency of algae blooms and episodic reductions in dissolved oxygen concentration, which are harmful for aquatic organisms and significantly impair water quality. Reduction of the occurrence of CSO events will also help curtail inputs of sediment, potentially toxic materials and bacterial and viral pathogens present in untreated or partially treated sanitary waste. Implementation of a LTCP will benefit aquatic resources, including fish and invertebrate communities which serve as receptors for these contaminants/pathogens. In addition, the health of people who use the Quassaick Creek and Hudson River for contact recreation, including fishing and boating, will be protected.



Implementation: As part of the CSO LTCP, the City assessed options to control CSOs and selected an alternative that considered social and cultural impacts collectively with technical and economic challenges (MP|Arcadis and Stantec 2013). Additionally, to reduce overall inputs to the sewer system and minimize cost, the City has committed to rigorous source controls, like encouraging redevelopment with green infrastructure, where feasible, by making changes to local building, site plan, and zoning regulations. The selected alternative is a five-phased approach with a 20-year cost projected at \$52,600,000 (MP|Arcadis and Stantec 2013).

As part of Phase I (0-3 years following LTCP approval), the City will institute regulatory changes and incentivize green development and green infrastructure. Additionally, the City will improve performance of a regulator that controls CSO events at CSO 002 to alleviate upstream hydraulic surges. The remaining phases will improve the flow conveyance throughout the sewer system, increase storage capacity, separate a number of combined sewers, and upgrade the existing WPCP for wet weather high rate treatment.

Other stakeholders, such as the QCWA, landowners, and community groups, can also take actions to reduce the amount of stormwater entering the combined system. Such actions serve to detail or retain stormwater from roofs or other impervious surfaces and include installation of rain barrels, cisterns, rain gardens, and other practices. Water conservation efforts would also help alleviate the volume of wastewater in the combined system.

3-5 Increase maintenance of stormwater infrastructure through education, outreach, and other measures

Description: Many traditional stormwater management facilities are reaching a point in their life cycle that requires significant maintenance to be performed in order to allow them to effectively manage water quality and quantity. Compounding this problem is that some systems may not have been regularly or properly maintained. Often this neglect is unintentional and could be a side effect of tough economic times that have reduced municipal monitoring staff, for example, or due to a landowner not being aware of the maintenance responsibilities. The stormwater pond inventory performed by the Orange County Planning Department identified substantial stormwater infrastructure that was in need of maintenance (**Figure 23**); many had been neglected for so long that remedial maintenance action will be expensive.

Most traditional systems are designed to remove sediment and pollutants from stormwater before it leaves the system. The sediment and pollutants settle to the sumps of catch basins and within forebays of stormwater ponds and over time decrease the capacity for quantity and quality control. And trash, debris and other material can block vital structures within the stormwater pond and prevent the system from functioning properly. Maintenance activities are typically comprised of removing

accumulated sediment and other materials from the bed of the stormwater pond, clearing of pipes, and removal of trash and other debris.

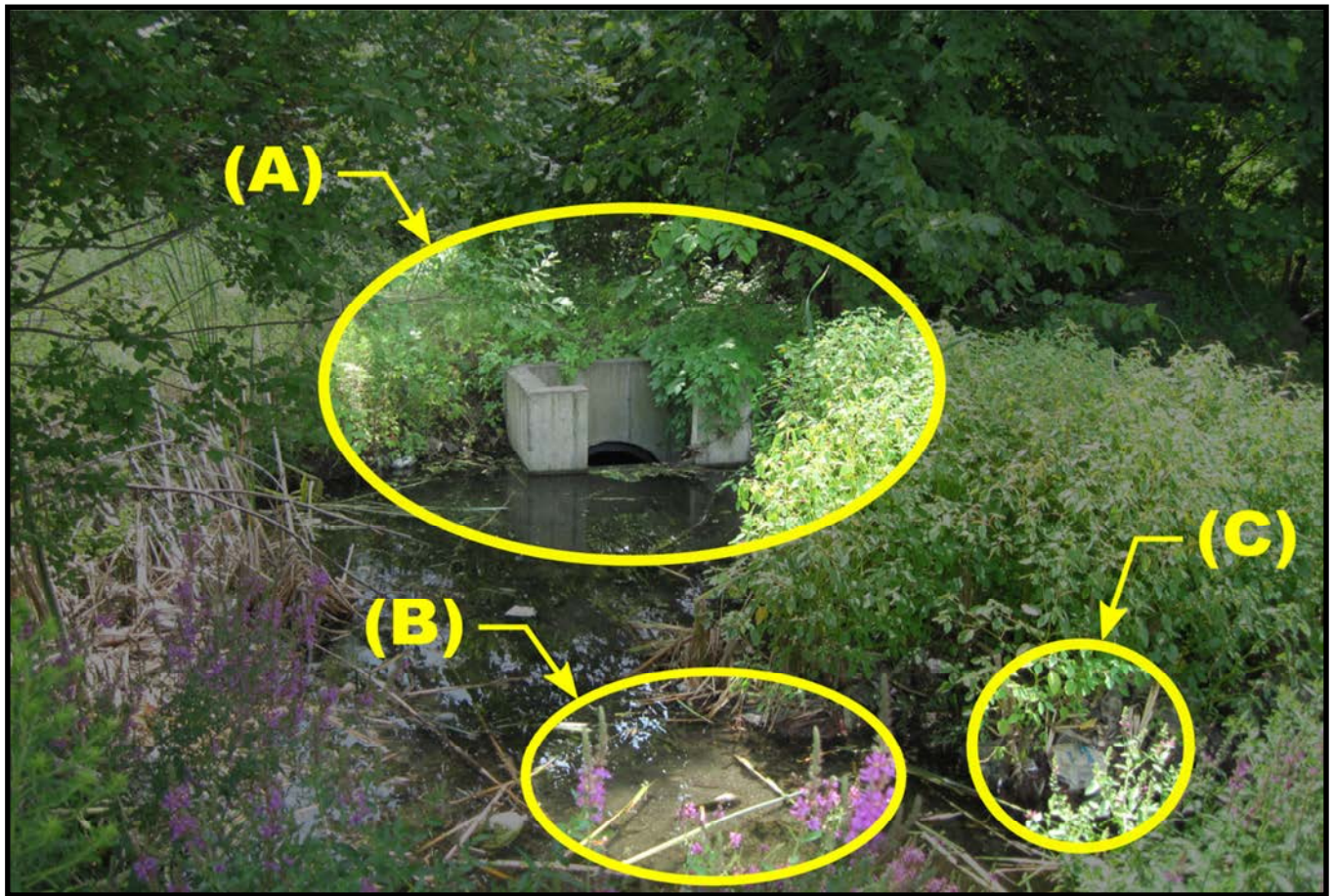


Figure 23. Example of an unmaintained or poorly maintained stormwater management pond in the Quassaick Creek Watershed. (A) The grate is missing from the top of the outlet structure; grate is critical in preventing debris from clogging the outlet structure. Additionally, debris is beginning to build up in front of the low flow inlet. (B) Significant sediment has built up within the pond, resulting in a depth of less than a foot. Typically wet ponds are designed with a permanent pool depth of roughly four feet in depth. (C) Garbage is present, which, if not removed, can clog the outlet structure and affect beneficial plant growth. It is also aesthetically unpleasant.

Benefits: Maintenance not only ensures that the system is properly treating stormwater and thereby protecting surface water quality, but also is fiscally-responsible since repairs prompted by a lack of maintenance can be costly.

Implementation: A key step could involve reaching out the local MS4 officer to coordinate efforts and discuss the history and other details of the onsite stormwater practices. It will also be necessary to reach out to property owners to provide them with useful information about the stormwater facilities within their jurisdiction. Although the required maintenance practices are similar from site to site, project partners should locate the approved plans in the municipal hall to determine the specific

design that was originally approved, and what the required maintenance activities are for that design. Then a flyer or form letter could be provided to the landowner that explains the maintenance requirements and offers resources. And customized training for municipal officials, MS4 officers, contractors, landowners, and others responsible for stormwater systems is imperative in order to increase understanding of maintenance needs.

Outreach to septic service companies to suggest expansion of their line of services to stormwater facility maintenance could result in a new line of professionals who, once trained about the specific maintenance procedures, are capable of performing maintenance.

3-7 ★ **Prioritize regular cleanout of catch basins at Orange Lake**

Description: Orange Lake is listed as Impaired on the [NYSDEC's Priority Waterbodies List](#) due to elevated phosphorus, and leaf litter and other organic waste contribute this nutrient to the Lake as they decompose. Leaf litter accumulating in catch basins that convey stormwater into the Lake are a source of phosphorus that can be readily managed through frequent removal of debris from the basins.

Benefits: Orange Lake's water quality and its recreational and aesthetic values would ultimately improve as phosphorous inputs are reduced. Cleaning out catch basins should be one part of a comprehensive approach to nutrient management in the Lake.

Implementation: Catch basins are currently cleaned out on an as-needed basis by the Town of Newburgh but an agreement could be reached with the Orange Lake Civic Association as to a more aggressive cleaning schedule.

Objective 4 PROTECT, ENHANCE AND RESTORE CRITICAL HABITAT FOR FISH AND WILDLIFE

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
4-1	Restore and protect riparian and wetlands habitats	X	X	X	X	X	municipalities SWCD, QCWA	\$- \$\$\$	1+	●	●	●	●	○	★
4-2	Protect critical open spaces and biological areas		X		X	X	municipalities OCLT	\$- \$\$\$	1+	●	●	○	○	●	★
4-3	Continue monitoring eel and river herring populations in lower Quassaick Creek		X	X	X		DEC, QCWA, schools	\$	1+	●	●	○	○	●	★



4-1 ★ **Restore and protect riparian and wetland habitats**

Description: In addition to providing unique benefits to the Watershed, riparian and wetland habitats are often highly valuable wildlife habitats and ecological resources. This recommendation would provide important ecological linkages between aquatic and terrestrial habitats. Additionally, there are many linkages between this management recommendation and others, such as the source water protection and stormwater quantity and quality improvements. Federal and state governments regulate certain activities within streams, floodplains, stream-side areas, and some wetlands, as described in **Chapter 3**. However, there are many instances of wetlands and waterbodies that are not protected by existing promulgated law, such as wetlands and watercourses that are isolated from traditionally navigable waterways, or vernal pools and adjacent areas of most wetlands less than 12.4 acres in size. In addition, the purpose of some laws governing these areas is not to enhance or maintain critical habitats, but rather to, for example, minimize property damage, prevent water pollution or ensure that uses or activities do not contribute to flooding elsewhere.

Restoration generally refers to returning an area to a close approximation of some natural or known historical condition. Wetland creation is often a component of the restoration process, especially in projects involving the removal of fill and/or re-grading adjacent uplands, and could easily be viewed as restoring lost regional wetland acreage. Restoration and habitat creation projects often include practices such as: revegetation with trees, shrubs, or herbaceous plants; removal of invasive species; streambank stabilization; restoring wetland hydrology; and reconnection of natural floodplains with stream hydrology.

Benefits: Wetland and riparian restoration has wide-ranging benefits to local communities and water quality. They help protect infrastructure such

Guiding principles for restoration, enhancement, and creation

- *Restore ecological integrity*
- *Minimize disturbances during implementation*
- *Restore natural structure and function*
- *Design for self-sustainability*
- *Work within the watershed context*
- *Involve a multidisciplinary team*
- *Plan projects to contribute to the larger mosaic of habitats*
- *Provide a hydrogeomorphic regime similar to wetland type or riparian area being restored*
- *Address ongoing causes of degradation*
- *Use passive restoration, when appropriate*
- *Restore native species; avoid non-native species*
- *Focus on feasibility (ecologically, socially, and financially feasible)*
- *Monitor and adapt where corrective actions are necessary*
- *Provide ongoing maintenance that starts during the implementation stage*

Adapted from USEPA 2013b.

<http://www.epa.gov/region5/agriculture/pdfs/wetlands-in-watershed-planning-supplement-region-5-201302.pdf>



as roads and bridges by restoring floodplains that spread out and slow water from large storms, improve habitat, protect public and private properties by minimizing erosion, reduce re-suspension of sediments that can harm water quality, and contribute to groundwater recharge. Stabilizing stream banks and reducing or eliminating sedimentation throughout the Quassaick Creek watershed will enhance a broad range of ecological attributes and support other ongoing restoration efforts, including provision of fish passage and water quality improvements via elimination of point and non-point sources of pollution. Sedimentation of streambeds is also detrimental to species such as macroinvertebrates that live atop or within the stream bottom and/or depend on rock substrate for shelter or habitat. Additionally, planting trees and shrubs in a riparian area provides shade to the stream and reduces water temperature, thereby also increasing dissolved oxygen levels and habitat value to aquatic species.

Wetlands and riparian areas also maintain local and regional biodiversity and provide valuable foraging, breeding, and refuge habitat for a variety of species. These include warm-water fish communities, wading birds, migratory waterfowl, mammals, reptiles (notably turtles) and amphibians.

Wetlands and riparian areas can provide important areas for recreation and education. Ecological studies and programs within wetlands and riparian areas within the Quassaick Creek watershed may include participation by local school children, college students, and scientists from nearby research institutions. The aesthetic qualities of wetlands, enjoyed through passive recreation such as hiking or wildlife viewing, are valued by many who choose to reside in or visit the Hudson Valley region.

Implementation: This management recommendation could be implemented in one or more ways, as follows:

1. Seek to preserve existing wetlands and vernal pools within the Watershed: Through GIS mapping and field verification, a database of wetlands could be generated. The field data collection effort could begin with priority areas, such as in the vicinity of Orange Lake (which is on the [303d list](#)), areas where important biological resources have been documented, and within source watersheds (e.g., wetlands are known to exist near the closed landfills in Washington Lake watershed, and should be mapped and protected).
2. Preservation of significant natural communities: Two state-designated significant natural communities, Hemlock Northern Hardwood forest and Red Maple Hardwood Swamp, occur in the Chadwick Lake and Orange Lake subwatersheds, respectively. Habitat preservation and enhancement could occur for habitat within municipally-owned lands. Alternatively, swamp habitat may be partially protected from development by state and federal wetlands regulations.



3. Municipal wetlands and watercourse regulations: Regulations could be promulgated to protect important wetland and riparian habitats that would not otherwise be protected under existing state or federal laws.
4. Seek to restore impaired habitat: Areas in need of riparian restoration have been identified along the lower Quassaick Creek corridor and are shown in the map of the [Lower Quassaick Priority Action sheet](#). Also, a GIS analysis was completed to identify potential wetland and stream restoration areas in the Watershed, by identifying existing NYSDEC and NWI mapped wetlands and NYSDEC watercourse classifications that were identified as impaired, hydric soils not associated with mapped wetlands, identifying areas of potential wetland loss by comparing the latest NYSDEC wetland layer (wetlands greater than 12.4 acres) to a NYSDEC historic wetland layer from the 1990's. The results of the analysis are shown in (**Figure 24**), and tabulated below (**Table 23**) . A review of property ownership for the identified locations and conducting site visits are recommended as next steps to confirm the results of the desktop assessment. Opportunities for restoration or enhancement of smaller stream segments and wetland sites should be explored.

Table 23. Results of GIS analysis to identify large (> 2.5 acre) wetland restoration opportunities.

Site	Description	Source	Estimated Area	Mitigation Type
1	Along the Quassaick Creek, near Brookside Pond. Existing wetlands surrounded by development.	Impaired wetlands/ streams	8.1 acres	Wetland Preservation
2	Along the Quassaick Creek, in Algonquin Park. Mapped impaired NWI wetland surrounded by NYSDEC wetland. Access may be limited.	Impaired wetlands/ streams	12.2 acres	Wetland Restoration/ Stream Restoration

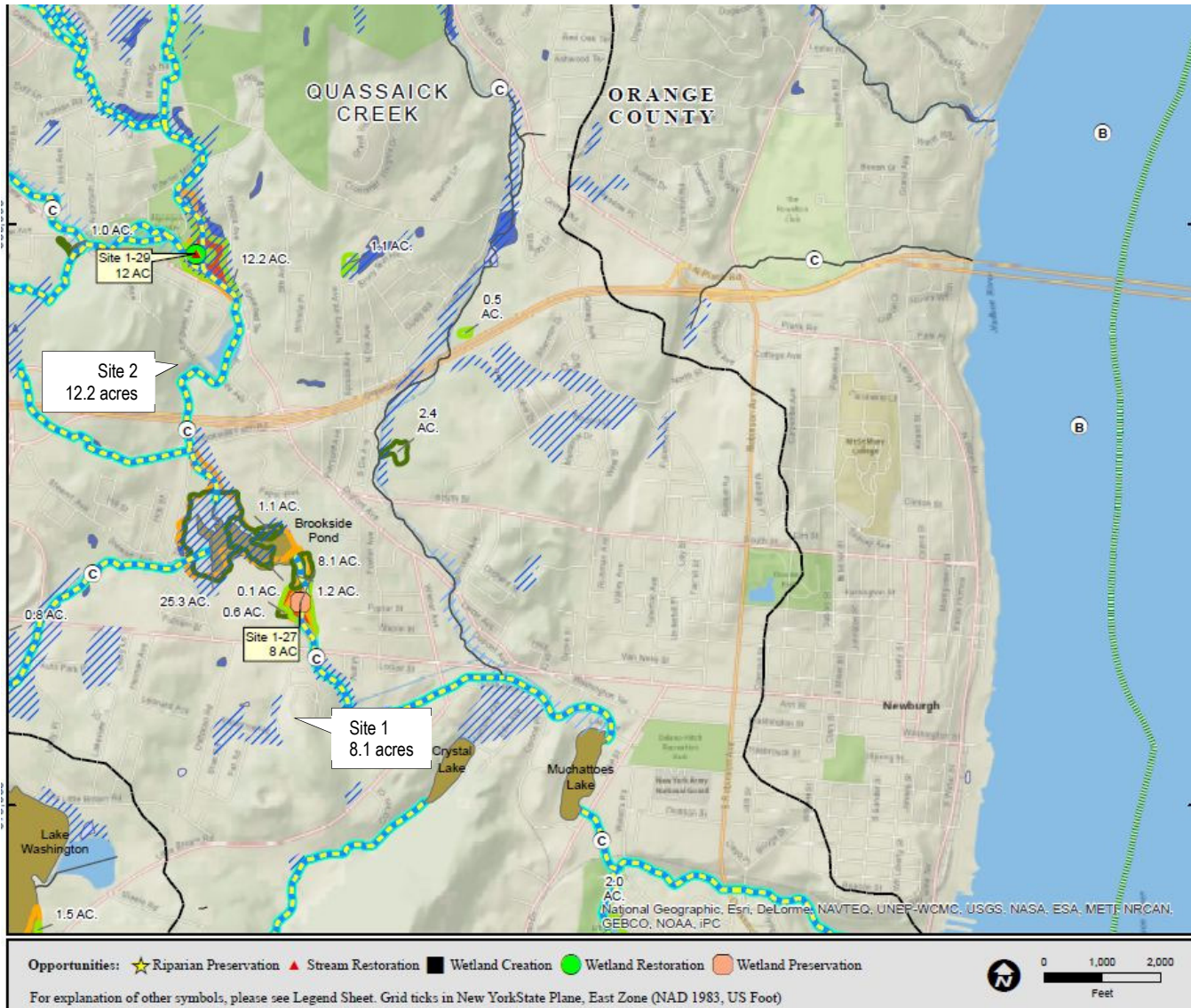


Figure 24. Results of GIS analysis to identify potential large (> 2.5 acre) wetland restoration opportunities.

5. [Trees for Tribs](#) plantings: This NYSDEC program provides native trees and shrubs, at no cost, for volunteer-selected sites. In the Quassaick Creek Watershed, the Quassaick Creek Watershed Alliance (QCWA) has coordinated a Trees for Tribs planting each year for the past four years (2010-2013), for a total of approximately 580 native tree saplings, willow and red osier spikes and shrubs planted across 4 stream bank locations. The QCWA plans to continue coordinating with the NYSDEC in the Watershed, and will seek out additional volunteer groups with which to partner.
6. Manage invasive species: The NYSDEC often includes invasive species removal as a component of the Trees for Tribs planting program. Combined, these programs have synergistic results. For

example, at the Muchattoes Lake Trees for Tribes planting in May 2013, NYSDEC identified invasive plants that could be removed prior to planting native trees and shrubs, and QCWA volunteers followed behind to clear the plants. Once the native plants and shrubs are in place, the NYSDEC involvement is typically limited to an annual site visit to assess the plants. Management of the invasives, such as additional cutting or removing, often becomes the responsibility of the landowner. For this example site, QCWA volunteers have committed to continue trimming and some limited maintenance into the future.

4-2 ★ **Protect critical open spaces and biological areas**

Description: Open space planning focuses on the conservation or enhancement of natural/ecological, scenic, and cultural resources of local or regional significance. Within the Quassaick Watershed, the two areas have been identified as having the greatest potential for preserving open space in the near term (see also **Appendix A**).

1. Crystal Lake and Snake Hill: Snake Hill is a local landmark that offers sweeping views of the Hudson River and surrounding landscape from its summit. The Hill is flanked on its northwestern slope by Crystal Lake, an 8-acre pond that was once the centerpiece of a public park, and the smaller Miller's Pond. Ownership of these three resources is predominantly municipal. If improved and opened to the public, best uses for this area include bird watching, fishing, picnicking, nature study, hiking, and paddling. A rare butterfly called the Appalachian blue was found on the east slope of Snake Hill.
2. Lower Quassaick Creek Corridor: The lower reach of the Quassaick Creek, which forms the boundary between the City of Newburgh and the Town of New Windsor, is flanked by a well-vegetated corridor, much of which is municipally-owned. Although past efforts to develop an estuary preserve in this corridor were unsuccessful, recent work performed due to a sewer blow-out have created new opportunities for public access, stream restoration, and corridor improvements. This area serves as a nursery for a variety of aquatic species such as striped bass, American eel, and river herring, and warmwater fishes, like bass, sunfishes and pickerel. A plant listed as Threatened in New York, the Woodland agrimony, was found in this Corridor, as was the Wood turtle, listed as of Special Concern in New York. An inventory of potential improvements to the corridor was developed during a field visit by Advisory Committee members and HDR, Inc staff in 2013; this inventory is displayed on the map on the associated Priority Action sheet.

Additional opportunities to create publically-accessible open spaces within the Watershed should be explored. Other areas with known occurrences of rare species, such as other reaches of the Quassaick Creek and Little Falls Park, or with suitable habitat for rare species should be prioritized for conservation and management efforts.



Benefits: Humans benefit from open space resources in their communities, as they are able to enjoy passive and active recreational pursuits not generally available in urban areas. There are less obvious, but no less important, benefits to terrestrial organisms (including mammals, birds and reptiles/amphibians) by providing sufficiently large “home range” areas for foraging, reproduction and avoidance of predators, and migration corridors. This promotes and maintains regional biodiversity. Open spaces which include wetlands and other aquatic habitats perform additional functions, including maintenance of water quality and provision of groundwater recharge areas.

Implementation: For these two projects, the lands described are predominantly owned by public entities (e.g., [Scenic Hudson](#), City of Newburgh, Town of New Windsor), but closed for public use. Agreements to open the land to the public will need to be established, as well as commitments for maintenance of trailways, and fishing and parking areas. Often trails can be maintained by partnering with nearby communities or trail organizations to offset municipal costs associated with maintaining the properties. Overall, efforts to encourage the public to view and recreate in these areas would serve to increase public appreciation of the Creek and Watershed, increase tourism and foot traffic in the area, and reduce crime in the immediate vicinity. Regulatory requirements should be explored, such as the need for a SEQRA environmental review, federal/state wetlands permitting, as well as municipal building/zoning permits.

Selecting additional land for conservation or enhancement should align with the vision for this Watershed Plan. There are a number of ways to preserve open space without an undue burden on taxpayers. These may or may not involve actual purchase of the land. Some of these approaches include:

1. Conservation Easements
2. Purchase of Development Rights
3. Outright Purchase
4. Transfer of Development Rights
5. Amended Zoning

4-3 ★ Continue monitoring eel and river herring populations in lower Quassaick Creek

Description: Historically (as recently as the mid-1990s), Quassaick Creek hosted a significant river herring run, and currently provides critical habitat for migrating American eels. In recent years, the [NYSDEC's spring "glass eel" trapping count](#) in the Quassaick Creek, by the QCWA and other local volunteers, has had an annual glass eel catch in the range of 8,000 to 23,000, validating that the Quassaick Creek provides critical habitat for migrating American eels. Dedicated volunteers from the QCWA and other organizations participate in these NYSDEC-coordinated monitoring programs.



Benefits: Citizen-based volunteer programs, like the eel and river herring programs, engender a deeper connection to the Watershed, an understanding of intrinsic value to maintaining a healthy watershed, and an appreciation for the species and their complex life histories. The long-term monitoring and extensive geographic range of data collection efforts could not easily be obtained without volunteers. Moreover, these data on migratory eel and river herring populations in lower Quassaick Creek can be used to inform resource managers of the response of herring and eel populations (along with other non-migratory species) to proposed improvements within the Creek and Hudson River watersheds, including water quality enhancement, riparian and stream-bed habitat enhancement, and fish passage projects. This is especially important in promoting the benefits of fish run restoration to funding agencies, potential partners/sponsors for future restoration projects, and the general public.

Implementation: The QCWA is a committed project partner that will continue coordinating with NYSDEC for as long as these citizen-based programs are operated, and will seek opportunities to encourage participate by other stakeholder groups in the Watershed.

Objective 5 REDUCE NEGATIVE EFFECTS OF HYDRAULIC CONSTRICTIONS, INCLUDING THOSE CREATED BY BRIDGES AND CULVERTS

This objective was identified to address hydraulic constrictions that can result in localized flooding and/or streambank failure. Two management recommendations have been identified to advance this objective, as shown in the table below.

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality and Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
5-1	Inventory hydraulic constrictions and document impacts, both positive and negative		X			X	QCWA, DEC's HREP	\$	6+	●	○	●	●	○	
5-2	Resolve hydraulic constrictions, where appropriate, to reduce ponding and flooding		X			X	municipalities	\$\$	6+	●	●	●	●	●	



Objective 6 ADDRESS IMPACTS OF PROBLEMATIC DAMS THROUGH REPAIR, REMOVAL OR OTHER MITIGATION

Recommendation	Goals						Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
	Protect Water Quality and Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
6-1	Address streambank erosion and other downstream impacts of breached spillway at Winona Lake		X			X	Winona Lake Homeowners Assoc.	\$\$\$	2-5	●	●	●	●	●	★
6-2	Address concerns at Holden Dam section of the Lower Quassaick Creek		X				City of Newburgh	\$\$\$	6+	●	●	●	●	●	
6-3	Inventory dams; Identify candidates for removal, repair, etc.		X			X	QCWA, DEC's HREP, OCPD, NOAA	\$	2-5	●	○	○	●	○	
6-4	Remove/repair dams, where appropriate		X			X	QCWA, DEC's HREP, OCPD	\$\$\$	6+	●	●	●	●	●	
6-5	Maintain adequate stream flows below impoundments (dams)		X				municipalities	\$	6+	●	●	●	●	●	

6-1 ★ Address streambank erosion and other downstream impacts of the breached spillway of Winona Lake

Description: The Winona Lake Dam impounds the Quassaick Creek in the Town of Newburgh. A breach in the spillway has effectively drained Winona Lake down from nine (9) acres to 5.5 acres in size and created a flow pattern immediately after the spillway that has resulted in significant streambank erosion, incision of the stream channel, and undercutting of the dam. For elaboration on the conditions at the site and discussion of remedial actions, see the Priority Action sheet in **Appendix A**.

Benefits: The Winona Lake community would greatly benefit from implementing a permanent solution at this site. This would provide peace of mind after more than six years of concerns over property damage from erosion immediately downstream of the breached spillway. This solution would also correct the severe erosion that exists on the downstream side of the dam and affects its integrity. There are also a variety of ecological benefits that could be achieved regardless of the design solution. Reducing streambank erosion and stabilizing sediment transport will have secondary benefits to aquatic fish, invertebrates, and downstream riparian habitats. This could serve as a demonstration project for small dam removal or breach in southeastern New York.



Implementation: Project partners, including the Orange County Planning Department, Orange County Soil Water Conservation District, QCWA, and the Winona Lake Homeowners Association, have been investigating options for obtaining funding to address the issues at this site. At least two project phases are anticipated: an assessment study to evaluate options and recommend the most feasible and cost effective alternative for the community, followed by design and construction of restoration measures, dam removal or other repairs. As of the fall of 2013, preliminary site evaluations indicate that the most sustainable and cost-effective solution is to both breach the dam to reroute the outflow of the Lake and perform stream restoration and streambank stabilization in the affected areas. Since such actions would further reduce the Lake's water level, additional grading or restoration work may be needed along the rear portions of some residential lots that border the Lake.

There are many project considerations associated with such a large endeavor that must be addressed as part of the planning process:

1. Social acceptance, because dam removal and stream reclamation can be an unpopular option given that the Lake is an aesthetic focal point of the neighborhood and used for recreation;
2. Accumulated contaminated sediments in the Lake;
3. Undesired changes in sedimentation rates or turbidity, and channel scour which may induce erosion of stream banks;

Planning Considerations for Dam Removal/Repair

- *Land and barrier ownership*
- *Bridges/utilities possibly affected*
- *Community interest/willingness*
- *Sediment contamination*
- *Presence of cultural resources (often the dam itself)*
- *Hydraulics, stream channel morphology*
- *Sediment load/transport*
- *Biological impacts (e.g., sedimentation of mussels beds downstream, or spread of invasive species via barrier removal)*
- *Water quality upstream and downstream of the barrier*
- *Presence of historic fish runs*
- *Current fish presence below the barrier*
- *Identification of non-target species likely to be affected, upstream and downstream*
- *Environmental permits for work in regulated waters, disposal of contaminated wastes*
- *Project longevity (fish passage structures require long-term considerations for maintenance and logistic support)*
- *Project prioritization, which refers to the concept of strategically targeting a dam for removal with the goal of opening up a section of critical habitat to migratory species.*
- *Sequencing with other restoration projects, such as removing the barrier before restoration of the other downstream or upstream components occurs.*



4. Archeological or significant cultural resources are not anticipated because the impoundment was constructed in 1932;
5. Environmental permitting during design, including addressing habitat tradeoff issues if dam removal is proposed. This entails assessing impacts from replacing wetland and still-water habitat upstream of the barrier with running-water habitats;
6. Post-construction permittee-responsible monitoring requirements that may be imposed by resource agencies.

6-2 Address concerns at Holden Dam



Figure 25. Looking downstream from Holden Dam at confined stream channel of Lower Quassaick Creek.

Description: The Holden Dam is located on the Quassaick Creek just west of the Route 9W bridge and precedes a segment of the Creek that is confined by concrete and stone walls on both sides (**Figure 25**). City of Newburgh engineers from Barton & Loguidice, P.C. point to the partial breach in the dam along with the downstream stream channel confinement as the root cause of the collapse of the sewer line in July 2012 and again in October 2012; the confined channel causes an accelerated stream flow velocity of the Creek, which is continually eroding the

toe of the slope and ultimately undermining the streambank that houses the sewer line. Each of these collapses released approximately 5 million gallons of untreated wastewater and stormwater into the Creek and cost the City \$1.7 million in emergency repairs, including lining sections of the West Trunkline sewer to compensate for its compromised structural integrity following the break. An additional \$7.2 million project is planned by the City including additional lining, and stream stabilization to protect the sewer structural and hydraulic integrity following the breaks. This additional construction work is needed to create safe and sustainable conditions in this section of the Creek.

As of the fall of 2013, the City is proceeding with an additional measure that will mitigate future impacts to the streambank that contains the West Trunkline sewer line. Referred to as Alternative #2 by City engineers, a partial breach of the Holden Dam is being designed. This alternative includes

realigning the Creek to construct an unconfined stable channel away from the sewer line, and amending the existing Creek channel in order for it to serve as a floodplain. Estimates for this project range from approximately \$685,000 to just under \$1million and will be included in the overall project budget already contemplated by the City. Another project idea, Alternative #3, is to breach the dam entirely and perform the same channel realignment and floodplain work mentioned above. This project is estimated to cost over \$3 million and would likely provide the same benefits as Alternative #2. Alternative #1 does not include breaching the dam or stream realignment. Neither Alternative #1 nor #3 is being pursued by the City. Both alternatives #2 and #3 would restore fish passage.

Benefits: Addressing the issues in this stream section through the construction projects mentioned above would protect the sewer line from future damages, reduce downstream streambank erosion, increase riparian habitat, allow for fish passage (now prevented by Dam), avoid future risk of dam failure and associated impacts, and potentially enhance the suitability of this section for a pedestrian trail in the Creek's corridor. Just as importantly, protective measures would ultimately be less expensive than reactive repairs.

Implementation/Progress: City engineers have developed conceptual designs for the preferred alternative noted above (#2), and the City has authorized the design to proceed. Construction is anticipated in 2014. The project will require soil borings, sediment tests, agreements with affected landowners, coordination with the Town of New Windsor, additional survey and engineering, and additional permits from the NYS DEC and the [Army Corps of Engineers](#).

6-4 Remove/repair dams, where appropriate

Description: As identified in **Chapter 2**, the Quassaick Creek Watershed contains 32 documented dams. In many cases, the conditions of these dams are unknown and site access is limited due to land ownership. The primary purpose for undertaking dam repair would be to address safety concerns or issues with the dam not meeting its functional use. Habitat or recreational enhancement should be considered for dam repair projects, where feasible. Dam removal could be considered when the costs (safety, environmental societal, cultural) of maintaining or preserving the dam outweigh its useful purpose. Often a cost effective alternative to dam removal is notching or lowering a dam, which can provide similar benefits as complete dam removal.

A number of studies have been completed on the Lower Quassaick to assess the feasibility of dam removal and the potential benefits to restoring historic migratory runs of river herring in the Watershed. A study from 2003, identified that removal of the American Felt and Filter dam (most downstream) on the Quassaick Creek was more cost effective than install a fish ladder, primarily due to the dam's relatively small size and existing degradation (Allen and Cook 2003).



Benefits: Similar to the benefits stated in recommendation 6-1 (Winona Lake) and outlined in recommendation 6-2 (Holden Dam), dam repair and/or removal provides societal, physical, and ecological benefits to the Watershed. Repairs have the clear benefit of improving the impoundment's structural stability and returning the facility's functionality, whether it be recreational, hydropower, or flood control. Depending on the project, dam repairs that include a fish passage component could have the added benefit of re-establishing connectivity between upstream and downstream habitats, which provides resident fish and invertebrate populations greater access to feeding, spawning, and refuge habitats. Repairs are also typically less costly than dam removal.

Dam removal provides a number of benefits that often would not be realized by repairing the dam: reinstating natural sediment transport and hydrology, moderating stream temperatures, restoring connectivity of river reaches both upstream and downstream and laterally to floodplains, as well as creating diverse habitats that could encourage colonization by fish and wildlife.

Implementation: Where possible, projects should attempt to include multiple components (i.e., in-stream habitat, riparian habitat, barrier repair/removal) to increase the number of functional benefits and the ecological contribution to the Watershed. This Plan also promotes focused projects that aim to repair the physical structure, as this also provides meaningful benefits. Dam removal project in the lower Quassaick Creek will advance Policy 10 of the City of Newburgh's Local Waterfront Revitalization Plan by increasing the spawning habitat for Hudson River fish species.

Considerations listed in recommendation 6-1, and the sidebar alongside that narrative, will in many cases apply to other dam repair or removal projects in the Watershed. A primary concern is that studies in the Watershed have identified sediments impounded by dams in the lower Quassaick are contaminated with metals beyond acceptable levels (e.g., cadmium, antimony, copper, lead, nickel, zinc; Allen and Cook 2003).

6-5 Maintain adequate stream flows below impoundments (dams)

Description: Maintenance of water quality conditions downstream of impoundments requires adequate flow, typically over the spillway. A reduction in stream flow can lead to stagnant conditions, characterized by an increase in water temperatures, and reduced water clarity as a result of algae blooms. Minimum stream flows are essential for the maintenance and persistence of many biological assemblages in flowing waters, such as fish, freshwater mussels and a variety of insect larvae, many of which represent essential prey resources.

Benefits: The benefits associated with maintenance of adequate stream flow include ensuring sufficient water quality and appropriate temperature regimes for aquatic organisms, and ensuring against interruption of stream flow during drought or seasonal drawdown conditions. Characteristic



biological assemblages, including submerged aquatic vegetation, fish and invertebrate communities, aquatic reptiles and amphibians, and birds and mammals which rely on the foraging and refuge opportunities provided by streams will benefit from the maintenance of adequate flow throughout the Quassaick Creek Watershed.

Implementation: One notable example is the Silver Stream, which rarely spills over a dam to a small unnamed impoundment (downstream of Silver Stream Reservoir Dam) because its flow is instead diverted through a man-made ditch into Washington Lake (as described in **Chapter 2**). The City of Newburgh manages the diversion gates to this ditch, which regulate flows in this reach of Silver Stream. In doing so, Silver Stream does not follow its natural path to the Moodna Watershed, and instead, there is a dry streambed for some distance. If an operations plan were developed for this ditch, maintenance of flows within Silver Stream should be addressed.

There may be other dams in the Watershed with downstream areas that are routinely dewatered. Maintenance of downstream flows should be noted for each dam, when the inventory of watershed barriers is undertaken (recommendation 6-3).

Objective 7 DEVELOP A MECHANISM FOR ONGOING COLLABORATION AND MAXIMIZE FUNDING OPPORTUNITIES TO ADVANCE PLAN IMPLEMENTATION

Recommendation	Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
	Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
7-1	Establish intermunicipal watershed group to implement plan		X			all partners	\$	1+	○	○	○	●	●	★
7-2	Develop work plans and progress memos to track implementation of the Plan		X			all partners	\$	1+	○	○	○	●	●	★
7-3	Identify funding opportunities to implement this Plan		X			all partners	\$	1+	○	○	○	○	●	★
7-4	Implement stormwater drainage districts		X			municipalities	\$	2-5	○	●	○	●	●	★

7-1 ★ Establish intermunicipal watershed group to implement plan

Description: Watershed plans such as this one are typically not designed to be adopted by a municipality in the same way that a comprehensive plan is, and therefore municipal planning, zoning, and development activities may not adhere to the principles and recommendations set forth within the Plan unless the municipality actively seeks to undertake the recommendations. Watershed plans are



often implemented through collaborative partnerships, which often take the form of a watershed group. These groups can also be responsible for updating the plan, as needed, so that it remains relevant to current conditions. Membership could be comprised of municipal representatives or non-municipal members, or both. Similar efforts are underway in other watersheds, such as the neighboring Moodna Creek; the Moodna Creek Watershed Intermunicipal Council was formed in 2010, just months after the Moodna Creek Watershed Conservation and Management Plan was completed.

Benefits: Establishment of a watershed group whose mission is implementation of this Plan greatly increases the chances that the Plan's recommendations will be undertaken and that watershed functions and values will be maintained and/or enhanced. The group could also educate stakeholders about issues and concerns affecting the Watershed, and could coordinate planning and management efforts across municipal boundaries.

Implementation: The Quassaick Creek Watershed Alliance is a group of concerned citizens, public sector representatives, and professionals that was formed in 2008 and has been a major force behind the creation of this Plan. This group should solicit additional members in order to expand its capacity and influence. Alliance members should seek enhanced involvement from the Watershed's municipalities in an attempt to create an intermunicipal group, such as the Intermunicipal Watershed Council that exists for the Moodna Creek. The many partners who have been involved in activities in the Quassaick Creek Watershed should also be invited to become formal members of the group.

7-2 ★ **Implement stormwater drainage districts**

Description: Stormwater drainage, or maintenance, districts are created and managed by municipalities. A district levies a tax on residences and businesses within the district in order to accrue revenue that is then used to pay for stormwater infrastructure maintenance and improvements. Although they are an uncommon type of taxing district in the Hudson Valley – none currently exist in the Watershed – stormwater drainage districts could be an equitable and effective solution to the widespread problem of underperforming stormwater facilities.

Currently, maintenance of stormwater infrastructure is typically financed by municipalities or, more likely, by landowners. Unfortunately, municipal budgets are often spread thin and landowners are not always aware that facilities such as stormwater ponds require regular maintenance; some landowners may actually be aware of maintenance needs but lack the funds or the motivation to perform the maintenance. The result is that many of the stormwater ponds in the Quassaick Creek Watershed are not performing properly due to lack of maintenance, as detailed in Recommendation 3-5.

Benefits: Districts ensure that stormwater infrastructure maintenance is performed in a routine manner by identifying a clear responsible party and by providing a dedicated source of funding. Regular inspections of stormwater facilities allow for issues to be identified early and potentially remedied at a much lower cost than would likely be incurred if the issue were to linger and be exacerbated. Unmaintained stormwater facilities have the ability to effect the larger community via degraded water quality, degradation of aesthetic appeal, and increased ponding and flooding. Because drainage districts only collect revenue from those users that directly benefit from the stormwater facilities, they are typically viewed as a more equitable method of funding maintenance than utilization of the municipality's general fund.

In some instances, especially with commercial development, a future owner who was not involved with the site plan process may be unaware of the maintenance responsibilities associated with stormwater infrastructure; allowing the maintenance to be overseen by the local municipality ensures continuity and that facilities continue to serve their intended purpose.

Implementation: Although drainage districts can be formed at any time, they are typically created when an applicant is before the planning board with a proposed subdivision or site plan. They are created through an agreement between a landowner and a municipal board. In the case of a subdivision, the district includes all new lots that utilize the stormwater infrastructure; with a site plan, the property would be included in an existing district along with other properties or would be the first property in a new district. These scenarios are a better option than attempting to form a district once a development is already in place and functioning; for example, it would be onerous to get all residents of a subdivision to agree to an additional tax to fund stormwater maintenance through a district.

Although the formation of the districts increases the workload of the municipal public works or highway department, the funding collected from the tax would offer some reprieve to the municipality and potentially allow the hiring of additional maintenance staff or purchasing of equipment. The municipality could also choose to hire a contractor for the maintenance work.

One of the hurdles that can cause a local municipality to be hesitant in developing such districts is the concern of liability. In many instances, however, the liability insurance held by a municipality may already include adequate coverage. And it is preferable for municipalities to be proactive rather than be forced to intervene in a situation where unmaintained stormwater infrastructure is burdening the community because it has been neglected by its owner.



Objective 8 ENHANCE AWARENESS OF AND ACCESS TO THE CREEK AND OTHER WATERBODIES OF THE WATERSHED

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
8-1	Promote community involvement and education on changes in water resources and protecting water supply	X		X	X	X	all partners	\$	2-5	●	○	○	●	●	★
8-2	Conduct regular stream and lake clean-ups	X	X	X	X	X	QCWA	\$	1+	●	○	○	●	●	★
8-3	Develop outreach and education program that is revisited on an annual basis	X		X	X		all partners	\$	1+	○	○	○	●	●	★
8-4	Increase public access to waterbodies, particularly in under-served areas				X		municipalities, Counties, OCLT, QCWA	\$\$	1	●	●	○	●	●	★

8-4 ★ **Increase public access to waterbodies, particularly in under-served areas**

Description: There are only a handful of opportunities that exist for the general public to come into contact with or otherwise enjoy the lakes and streams within the Watershed. Specific opportunities for new public access points that have been identified during this watershed planning process include: Muchattoes Lake, Miller's Pond, Crystal Lake, and the Lower Quassaick Creek. These water resources are either owned by a municipality or have been the subject of public access discussions (or both). Other opportunities were identified along the Quassaick, Gidneytown, and Bushfield Creeks and their tributaries, but the owners of potentially-appropriate land have not been contacted and therefore those parcels are not being identified in this Plan.

Benefits: Establishment of formal recreational access to streams and lakes engages the public with their local water resources and encourages public steward of water resources, thereby ultimately increasing public respect and protection of the resource. Increased public access will also improve quality of life for nearby residents and help to revitalize the immediate area. Public health benefits are also realized from outdoor recreation.

Implementation/Progress: Given that many of the waterbodies listed above are in municipal ownership, public access would need to come about through development of appropriate signage, lighting, parking area designations, safety amenities, and other improvements. Garbage that has been dumped at the sites would also need to be removed. Public access to Muchattoes Lake is expected to be established in 2014-2015 using assistance from an [Environmental Justice Community Impact Grant](#)



received by the Quassaick Creek Watershed Alliance in collaboration with Clearwater, who is serving as the financial partner. This grant award will to support the design and establishment of public open space along Quassaick Creek that would include a fitness trail, habitat restoration and green infrastructure.

Objective 9 ENCOURAGE ALL WATERSHED STAKEHOLDERS TO ACT IN WAYS THAT ARE CONDUCTIVE TO WATERSHED PROTECTION

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
9-1	Promote municipal board awareness of existing regulations	X		X	X		OCPD, UCPD, municipal planning federations, municipalities	\$	1+	○	●	○	●	○	★
9-2	Create checklist and/or maps of sensitive areas for municipal boards	X		X	X	X	OCPD, UCPD, municipal planning federations, municipalities	\$	2-5	●	○	○	●	○	
9-3	Inform and engage public on pollution-reducing behaviors (including tips for homeowners, impact of pet waste)	X	X		X		OCPD, UCPD, municipal planning federations, municipalities	\$	2-5	○	●	○	●	●	★
9-4	Highlight stormwater retrofits and other BMP demonstration sites, as well as their impacts (e.g. before/after, cost/benefit)	X	X		X		SWCD, CCE	\$	2-5	●	●	●	○	●	★
9-5	Increase public awareness of potential climate change impacts on drinking water supplies	X			X	X	OCDOH, DEC's HREP, OCWA	\$	6+	○	○	○	●	●	★
9-6	Develop program to encourage septic maintenance	X			X		Municipalities, OCDOH	\$	2-5	●	○	○	●	●	★
9-7	Develop a septic pump-out program for Orange Lake	X			X		Orange Lake Civic Assoc.	\$	2-5	●	○	○	●	●	★

9-1 ★ Promote municipal board awareness of existing regulations

Description: Regulations affecting the Watershed exist at the local, county, state, and federal levels. Given the frequency and/or depth of changes in relations at these four levels of government, it is beneficial for decision-makers to receive regular education on laws and policies that impact their community and the Watershed.

Benefits: Increased awareness can strengthen the consistency of local decisions with adopted environmental policies and would theoretically result in higher levels of environmental protection than what has been attained to date.

Implementation: Several entities, including County Planning Departments and the Orange County Municipal Planning Federation, currently offer education and/or perform outreach to municipal board members. These entities should continue to target their outreach on regulation changes that affect the Watershed and on policies or laws that warrant greater attention, or on regulations that may not be receiving full compliance. One example of the latter is the requirement for regular maintenance of certain stormwater management facilities.

9-3 ★ ***Inform and engage public on pollution-reducing behaviors (including tips for homeowners, impact of pet waste)***

Description: Nonpoint source pollution is the most detrimental water quality issue in the Watershed, and it is generated throughout the Watershed. Polluted runoff generated by household activities may impact streams in a variety of ways. Nutrients such as phosphorus and nitrogen coming from unmaintained or failing septic systems, yard waste, or fertilizers can promote the overgrowth of algae, deplete oxygen and stress aquatic organisms. Toxic chemicals from poorly maintained or leaking automobiles and other machinery, sediment derived from construction activities and excess or careless application of pesticides/herbicides threaten the health of nearby receiving waters and can kill fish and other aquatic life. Bacteria from pet and other animal wastes can render waterways unsafe for wading, swimming and fish/shellfish consumption. As well, roadways and other paved surfaces contribute salt, sediment, phosphorus, oils, debris, and other chemicals to streams via stormwater runoff.

Benefits: Public education regarding best management practices for activities such as lawn care, automobile maintenance, and disposal of animal waste can lead to improvement of water and habitat quality within the Quassaick Creek Watershed by substantially curtailing inputs of nutrients, toxic materials, and potentially harmful microbes. These efforts compliment the entire suite of restoration and improvement activities described in the Plan, cumulatively resulting in improvements to stream ecosystems and potentially increasing regional aquatic biodiversity.

Implementation: The most important component of outreach is ensuring a properly crafted message reaches the target audience. This requires identifying a target audience, and understanding how to physically connect with them and how to convey a meaningful, lasting message.

Ideas include:

- Continued participation in festivals/fairs, hosting stream clean-ups

- Develop outreach materials with positive messages (Illustrated posters, bill inserts, magnets or calendars), in English and Spanish, many of which can be found on USEPA's Nonpoint Source Outreach Toolbox (www.epa.gov/nps/toolbox)
- Encourage proper disposal of yard waste, especially for properties along waterbodies. This idea is especially relevant to the properties surrounding Orange Lake since it has elevated phosphorous levels.
- Encouraging low impact development practices for residential and commercial properties
- Install stream signs or Hudson River Estuary signs at key road crossing
- Stencil storm drains to deter dumping
- Installing receptacles and signage in high-traffic parks to collect pet waste
- Pool resources among municipalities to launch regional campaigns
- Outreach efforts should strive to develop a stronger connection between the yard, the street, the storm and the stream
- Host field trips or open houses to completed projects in the watershed (see recommendation 10-4), and invite the new media for free press
- Use social media for event invitations and reminders, to call attention to press releases or news articles, or to share breaking news
- Reach out to agricultural community to share information on best management practices for fertilizers, manure, livestock, and water resources.

9-4 ★ Highlight stormwater retrofits and their impacts (e.g. before/after, cost/benefit) and other BMP demonstration sites

Description: Increasing awareness and understanding of stormwater best management practices (BMPs) through site visits, publications/literature, and presentations can be an inspiring and effective technique for educating stakeholders on the value and benefits of BMPs. Explanation of details such as site conditions before and after the BMP, and the cost/benefit of BMPs is especially helpful for gaining support.

Benefits: Public and private “buy-in” for stormwater retrofits and other BMPs will ultimately lead to enhanced stormwater management by increasing demand for such practices.

Implementation/Progress: Several agencies have been involved with developing stormwater BMPs that are later used as demonstration sites. Such agencies include NYSDEC's Hudson River Estuary Program (HREP), Orange County Soil & Water Conservation District, Cornell Cooperative Extension, and various municipalities in both Counties. These and other entities, such as the County Planning Departments, should collaborate to highlight model stormwater facilities within the Quassaick Creek Watershed as they are developed.



9-5 ★ **Increase public awareness of potential climate change impacts on drinking water supplies**

Description: Climate change represents an important challenge for drinking water utilities. The climate system puts an upper limit on the circulation rate of available renewable freshwater resources. Climate change is expected to disrupt the balance of water cycles and thereby change the available rate of renewable freshwater resources. Annual precipitation trends are expected to increase, as are temperatures. A recent review of climate change literature and hydrologic analysis related to the water supplies in Orange County suggest that the region may not be especially vulnerable to climate change impacts on water supplies over annual cycles, as compared with many regions where dramatic water scarcity is projected. Nevertheless, it is possible that climate change will result in more frequent short-term droughts. Runoff and groundwater recharge are not projected to change substantially over annual cycles (Stone Environmental 2009). Adaptation options include institutional arrangements, changes in infrastructure, operational changes of existing infrastructure, development of additional water supply sources, and demand management through water conservation and leak repair (Stone Environmental 2009). Groundwater management will also be an important component of mitigating the risk of droughts largely by promoting measures consistent with other recommendations in this Plan, such as low-impact development and stormwater management practices that are consistent with the goal of sustaining reliable groundwater supplies. Reducing the water supply's vulnerability to climate change will be the first step to prepare for such anticipated changes, and doing so will require widespread public support and political will.

Benefits: Promoting greater awareness of issues affecting drinking water supplies is necessary to gain support for research/studies and address projected vulnerabilities. Having this public support enables other source water protection initiatives to advance.

Implementation: Similar to recommendation 9-3 for promoting pollution-reducing behaviors, the key to effective messaging is understanding the target audience and delivering the action-oriented message. It may be necessary to target the "low-hanging fruit", like demographics that fully acknowledge climate change as a pressing threat, to build momentum for the campaign.

9-6 ★ **Develop program to encourage septic maintenance**

Description: For homeowners, routine septic maintenance can easily take a back-seat to other pressing maintenance items, especially if the system appears to be operating correctly with no evidence of odors or seeps. Large regions of the Quassaick Creek Watershed are unsewered, and have on-site septic systems or community septic systems. While this Plan does not pinpoint specific or documented septic failures, it is likely that many systems within the Watershed are not operating effectively given

that there are concentrations of old or inadequate septic systems and given the economic status of certain unsewered neighborhoods. Anecdotal information regarding sewage odors also suggests infrequent septic maintenance in some areas. Public education about septic maintenance would help promote individual actions to decrease nutrient runoff from failing systems. Incentive systems could also be developed by the municipalities, Health Departments, or other entities to increase compliance with standard maintenance procedures. In Ulster County, there are several incentive programs for properties within the New York City (NYC) Watershed, including:

- Septic System Rehabilitation and Replacement Program (West of Hudson)
- Cluster Septic System Program (West of Hudson)
- Small Business Septic System Program (West of Hudson)
- Septic System Maintenance Program (West of Hudson)

These programs are funded by [NYC Department of Environmental Protection \(NYCDEP\)](#) and administered by the [Catskill Watershed Corporation](#). Funding for each of these programs is in the millions of dollars.

Benefits: The primary benefit of implementing a public education program to encourage septic system maintenance among private homeowners is the avoidance of system failures that result in costly repairs and pose a threat to the environment. Such programs have been proven to be cost-effective for both property owners and municipalities and can result in substantial reduction of untreated or partially treated wastewater to streams, lakes/reservoirs, and groundwater aquifers. In concert with the Plan's suite of proposed restoration and watershed protection activities, implementation of a septic maintenance program could ensure continued protection and enhancement of water and habitat quality within the Quassaick Creek watershed.

Implementation: Potential options for implementation could include:

1. Education: Educate homeowners on the importance of maintenance every 2-3 years, what to expect (so there are no surprises), how they can reduce the need for maintenance through water conservation and not using the garbage disposal. Educational materials could be distributed through mail inserts from municipalities, County agencies, or homeowners associations.
2. Reimbursement: Reimbursement programs require a steady funding stream, which may be challenging for municipalities to implement in the Watershed. For an alternative funding stream, the Advisory Committee should determine whether any homeowners in the Watershed pay sewer taxes, but have septic system. If there are significant numbers of residences in this situation, a program similar to NYCDEP's or Westchester County's could be established to reimburse homeowners' costs for septic pump-out or inspection.
3. Mandates:



- a. Require that septic inspectors send copies of maintenance report detailing gallons pumped, the date, and any pertinent results, to a central government agency or party that could act on the information. This would most likely entail promulgating a law, which could be politically unappealing.
 - b. Enforce maintenance of failing systems.
4. Incentives: Offer a discounted pump-out rate, with a free inspection at the time of pump out, and provide educational materials on septic system function and maintenance. The discounted rate could either be negotiated with septic inspectors by homeowners, or could be offered to homeowners for a nominal cost to the municipality (\$50-\$100 per household). Homeowners associations or civic associations should be targeted because they represent existing, coordinated groups of residents within a localized area.

9-7 ★ ***Develop a septic pump-out program for Orange Lake***

Description: The Advisory Council has been in discussions with the Orange Lake Civic Association in attempts to determine if an incentivized septic pump-out program for the western side of the Orange Lake, which is the only area along that lake where the residences are unsewered, is feasible. As described in the Priority Action sheet for Orange Lake (see Attachment B), the Lake is on New York's 303(d) List of Impaired Waterbodies due to nutrients from habitat modifications and wastewater/stormwater, and the primarily pollutant of concern is phosphorus.

Benefits: As described in recommendation 9-6, implementing this program is a pro-active approach that would result in a reduction in the volume of untreated or partially treated wastewater entering Orange Lake.

Implementation: The Civic Association can work with project partners to disseminate educational materials and gauge interest in a program, then proceed to discuss options with septic service companies to determine if a discount could be realized through bulk pumps-outs in close proximity.

Objective 10 APPROPRIATELY MANAGE WATER-RELATED CULTURAL RESOURCES, INCLUDING HISTORIC AND ARCHAEOLOGICAL SITES

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
10-1	Develop Cultural Resource Management Plan for Watershed				X		municipalities	\$\$	6+	●	●	●	●	○	
10-2	Develop interpretive and educational plan for significant cultural resource sites, where appropriate				X		municipalities	\$	2-5	●	○	○	●	●	
10-3	Perform focused archaeological survey of Lower Quassaick Creek				X		City of Newburgh, Town of New Windsor, SHPO	\$\$	6+	●	●	●	●	○	

10-1 Develop Cultural Resource Management Plan for Watershed

Description: The Watershed's rich history has imparted the area with significant historical and archaeological assets. Streams were utilized in many ways by the Watershed's early inhabitants and many were dammed to power adjacent industrial uses. Existing documentation could be supplemented with a watershed-wide cultural resource survey to create a comprehensive assessment of the Watershed's cultural resources. This cultural resource management plan would also include recommendations for how the resources could best be preserved and possibly restored while also being made known to the public (when appropriate). Given the watershed approach to the cultural resource management plan, the plan would likely have a strong focus on dams, dam-associated industrial ruins, streamside Native American artifacts, and other stream- or lake-related cultural resources.

Benefits: The plan would provide a comprehensive view of how the water resources in the Watershed affected human settlement, commerce, and industry in the area and would be a powerful educational tool for many audiences, including students. The plan would also be a resource when plans are being made near a stream or lake to develop land or create a park or trail with interpretive signage.

Implementation: Given the intermunicipal approach to this type of plan, all municipalities in the Watershed should partner on the effort to ensure comprehensive coverage.

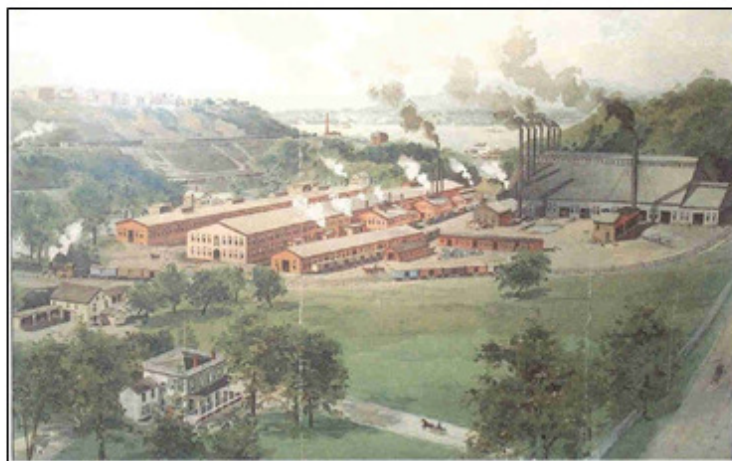


A brief history of the lower Quassaick Creek

Adapted from text provided by Russell Lange, local historian

The waters of the Quassaick Creek have witnessed the flow of time from its prehistoric occupation by the Waranawankong Indians who gave the Creek and Chadwick Lake that it flows through their name of Qussuk (believed to be a translation of Stony Lake), to the earliest settlement by the German Lutheran Palatines in the Parish on the then-named Quassy in 1709, through its role in the American Revolution, powering what may be one of America's earliest weapons forge, through its powering of 19th century industrial mills, to today where it has largely returned to a natural state - a beautiful estuary of the Hudson River, punctuated periodically with the remains of its mill ponds, dams and smoke stacks. History happened along the Quassaick in every century since the settlement of Newburgh. Its story is the story of America in a single 2 mile valley.

The history of the Creek is both fascinating and important. Early settlers, mostly farmers, required the Creek to supply water power for grist mills and saw mills. It is the site of Boyd's Forge, established in 1775 to supply the American forces with a domestic source of weaponry. New York's first cannon foundry was established in 1816 by Peter Townsend, pre-dating the better known West Point Foundry at Cold Spring. The Quassaick mills were first built to serve the local inhabitants starting in 1753 with Jonathan Hasbrouck's grist mill, the earliest in the area. Over 18 different mills have been powered by the Quassaick Creek and have manufactured and processed a broad variety of products including lumber, nails, gun powder, plaster, Daguerreotype cameras, candles, pins, coins, bleaching, paper, wire fencing, and woolens. Today, felt products are still manufactured at American Felt and Filter, a 19th century factory along the Creek on the site of 18th century grist mills. The remains of over 260 years of industry lie along the Creek and its valley and are an as yet an undiscovered and undocumented trove and repository of artifacts and historic sites



recounting its story of industry and reflecting the beauty of the natural landscape. **Above** is a lithograph showing Kilmer Wire Works in the northeastern-most corner of the Town of New Windsor during the late 1800s (provided courtesy of Historical Society of Newburgh Bay and the Highlands).

The Quassaick Creek has constantly been at the focal point of the conflicting forces of the industry and natural beauty. A canal feeding one of the early mills passed through such a beautiful area overlooking the Hudson that it was named the Vale of the Avoca. Asher B. Durand, one of the best known Hudson River School painters, came to live in the Vale, overlooking the Creek. The valley of the Quassaick creek has served as the home of artists, shippers and industrialists. It is the hope of many stakeholders that the lower Quassaick Creek will be restored and opened to the public for interpretive historical trail.

Objective 11 IDENTIFY OPPORTUNITIES FOR CREATIVE PARTNERSHIPS, RENEWABLE ENERGY SOURCES, AND PAIRING WATERSHED MANAGEMENT WITH ECONOMIC DEVELOPMENT

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
11-1	Explore potential for Micro-hydro power on existing dams				X		QCWA, dam owners	\$- \$\$	2-5	●	●	●	●	●	
11-2	Utilize and revitalize watershed resources as focal areas for compatible commercial, residential, and/or community service uses.				X		municipalities, developers	\$	1+		●	●			

11-1 Explore potential for Micro-hydro power on existing dams

Description: A total of 32 dams have been documented within the Watershed, and some of these may have appropriate features and dimensions to be retrofitted and used for micro-hydropower that could provide a source of renewable energy that could either be reverse metered into the electrical supply grid (recommended as having highest value) or used locally for a specific project or area.

Benefits: Micro-hydro facilities have low maintenance needs and provide a renewable energy source.

Implementation/Progress: Representatives from [Hudson Hydro](#) have visited several dams in the Watershed. Based on their initial calculations, three dams are suitable candidates for further study: Chadwick Lake Dam, Muchattoes Lake Dam and Harrison's Pond Dam. Two are municipally owned. The next step would be to undertake a detailed cost/benefit feasibility study for each location. If the outcome proves favorable then engineering plans would be prepared, permits would be obtained; funding sources would be identified and a long term management/maintenance plan would be developed.

11-2 Utilize and revitalize watershed resources as focal areas for compatible commercial, residential, and/or community service uses.

Description: Across the country and beyond, many neighborhood and community revitalization efforts have centered around a notable natural resource such as a river, stream or lake. Prominent national examples include the River Walk mixed use area alongside the San Antonio River in San Antonio, Texas and San Francisco's "Golden Gateway." Locally, the City of Newburgh's Waterfront on the Hudson River is a vibrant commercial and pedestrian area that draws thousands of visitors to the River's shore



every weekend. Waterbodies in the Watershed have the potential to serve as focal points of natural beauty and engines for economic development.

Benefits: Drawing public attention to a natural resource that is an attractive focal point creates a sense of appreciation and respect for the resource, thereby supporting public stewardship for the local environment. Resources benefit from proper management and enhancements when they are valued by the community.

Implementation: An essential factor in revitalization is the condition of the resource; the stream or lake should have acceptable water quality and aesthetic values, and should otherwise not pose any threat to the public. Getting to an acceptable condition may require remedial action such as garbage and debris removal, habitat restoration, and landscaping work.

The Lower Quassaick Creek presents an ideal option for this type of revitalization if a trail is developed through the stream corridor since it will likely become a destination for residents and tourists alike. This foot-traffic and appeal can lead to investment in adjacent properties because people value living near green spaces, especially those that are publicly-accessible, and retail businesses prefer to locate in areas with high foot-traffic.

Objective 12 IDENTIFY AREAS, FACILITIES, AND INFRASTRUCTURE THAT ARE VULNERABLE TO FLOODING AND SEA LEVEL RISE

Recommendation		Goals					Project Partners	Potential Cost	Year Implemented	Project Considerations					Priority Action
		Protect Water Quality, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed				Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
12-1	Assess vulnerability of transportation systems to the combination of increased flows and rising sea levels (e.g. River Road bridge and adjacent RR bridge and tracks)				X	X	City of Newburgh, NYSDOT	\$	2-5	●	○	●	○	○	
12-2	Assess vulnerability of wastewater systems to storm surges and flooding	X			X	X	municipalities	\$	2-5	●	○	●	○	○	

12-2 Assess vulnerability of wastewater systems to storm surges and flooding

Description: Wastewater treatment plants (WWTPs) are placed at low elevations respective to their surroundings due to the reliance on gravity to move wastewater to the plant and are often located on a stream or river in order to enable the discharge of treated effluent into a waterbody. Such a location can make a WWTP susceptible to inundation if the floodwaters of the adjacent waterbody penetrate



the facility. WWTPs can also suffer physical damage by debris that is being carried by floodwaters or by high velocity surges. The sewer pipes can also be stressed or filled to capacity during storm events when stormwater enters the system either through storm drains (as occurs in the City of Newburgh's CSO) or due to inflow and infiltration (I&I). A vulnerability assessment of the WWTPs and related wastewater infrastructure would identify potential issues and determine appropriate management solutions.

Benefits: An assessment would help wastewater system managers develop and prioritize management actions to take before an incident occurs, thereby avoiding a disruption in service, facility damage, and/or potential water pollution issues brought about by an overflow of untreated wastewater.

Implementation: A licensed engineer working on behalf of a wastewater system owner should perform the assessment, which should include an inventory of vulnerabilities as well as recommendations for managing or resolving these issues.

4: 3 Compensatory Mitigation

Agencies and private entities are often required to mitigate for unavoidable project impacts to wetlands and waters. It may be possible to obtain mitigation funding to support restoration or preservation projects in the Quassaick Creek Watershed.

The federally-mandated 2008 [Final Compensatory Mitigation Rule \("2008 rule"\)](#) emphasizes that the process of selecting mitigation sites should be driven by a watershed approach and address watershed needs (USACE and USEPA 2008). The 2008 rule establishes a hierarchy for the types of compensatory mitigation projects that may earn "credits" including: mitigation banks, in-lieu fee programs, and permittee-responsible mitigation under a watershed approach. Although the Watershed does not fall within the service area of an active mitigation bank or in-lieu fee program, either of these programs could be created to provide opportunities for wetland mitigation to project sponsors within the Watershed as well as the larger Hudson River Watershed. Without a mitigation bank or in-lieu fee program, the search for potential mitigation sites should follow requirements for permittee-responsible mitigation under a watershed approach.

Mitigation actions could be selected based on recommendations within this Plan to ensure that the projects benefit the Quassaick Creek Watershed, while also meeting mitigation requirements. The Plan is rich with site-specific opportunities for enhancement and restoration that simply require a project sponsor. There are also general recommendations that could be implemented in various locations in the Watershed but require a site search as part of the project planning to determine suitable locations.



Project sponsors that are seeking mitigation sites are encouraged to review Objectives 4, 5 and 6, and for more information may contact:

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CITATIONS FOR MUNICIPAL LEVEL ASSESSMENT IN CHAPTER 3

- ⁱ Town of Plattekill Municipal Code - Chapter 52: Freshwater Wetlands (adopted August 30, 1976) ; Town of Plattkeill Municipal Code - Chapter 65: Logging (adopted May 19, 1999) ; Town of Plattekill Municipal Code - Chapter 89: Stormwater Management and Erosion and Sediment Control (adopted December 19, 2007) ; Town of Plattekill Municipal Code - Chapter 93: Subdivision of Land (June 28, 1977) ; Town of Plattekill Municipal Code - Chapter 110: Zoning (adopted August 7, 1973; amended in its entirety October 19, 2005)
- ⁱⁱ Ulster County Health District Sanitary Code, Ulster County Department of Health (last updated May 7, 2012)
- ⁱⁱⁱ Saccardi & Schiff, Inc., *Comprehensive Plan Update, Town of Newburgh, New York* (Town Board, Town of Newburgh, New York, 2005), I-1
- ^{iv} Ibid.
- ^v Article IV, Section 300-21 of the City of Newburgh *Zoning Code* established standards for the redevelopment of vacant properties.
- ^{vi} Article VI, Section 185-26 *Cluster Subdivisions* of the Town of Newburgh *Zoning Code* allows cluster subdivisions which allow for flexibility in the design and development of a parcel which, among others, promotes the preservation of natural and scenic of open space and protects resources of the Town.
- ^{vii} §Section 110-48 Zoning | Conservation subdivisions contain Plattekill's regulations for subdivisions and includes density bonuses. These regulations allow for reduction in street widths, lot widths, lot sizes and other development standards. A mix of lot sizes is encouraged.
- ^{viii} Section 65-4 Logging | Standards and limitations for commercial forestry operations stipulates that “[a]ll commercial forestry operations shall be managed and conducted in accordance with the New York Timber Harvesting Guidelines, which shall be enforceable by the Town of Plattekill Zoning Officer hereunder as standards for commercial forestry operations in the Town of Plattekill.” This chapter of Plattekill’s code also prohibits clear-cutting as a method of harvesting forest products “unless approved by the Town Board and where clearly justified by the requirements of sound forest management.” The Town of Plattekill Master Plan recommends protecting open space along the mountainous area along Plattekill's eastern border (Page 45).
- ^{ix} Article II *Town Roads*, Section 161-37 *Classification of Roads* | Allow not every street described results in a potential decrease in street width, the Town of Newburgh classifies its roadways of which many result in a pavement width of twenty-four (24) feet. Most of these are related to those roadways that proposed no curbs. Plattekill’s rural areas, as with others, do not typically see curb installation, as rural roads see high speed traffic, and at high speeds, vehicles hitting a curb have an increased chance



of flipping over. When curbs are installed in rural areas, it is for stormwater management efforts in mountainous areas, as part of culvert construction, and other concerns as identified by engineers. As reflected in Section 93-38 Subdivision of Land | Curbs, circumstances as identified by the municipal planning board whether or not curb installation takes place, and under the specifications of the town engineer and/or highway superintendent. In addition, Section 110-22 Zoning | Multifamily dwellings requires landscaping parking areas and driveways to be protected by curbs or other barriers.

^x Plattekill offers density bonuses for conservation/cluster subdivisions. Section 110-48 *Zoning | Conservation subdivisions* has language on density bonuses. At 30% to 34% proposed open space, density bonuses start at a 9% increase in the housing density allowed by zoning. Density bonuses go up to a 25% increase in the number of houses allowed on a site when 50% or more in open space is proposed.

^{xi} Article I, Section 163-15 *Street Layout* | Circular turnarounds, cul-de-sacs, with or without planting areas are encouraged. T-type turnarounds, hammerheads, are allowed where temporary or extraordinary hardship exists.

^{xii} No regulations in Plattekill require cul-de-sacs or hammerheads. Town policy discourages, but does not prohibit, cul-de-sacs and hammerheads. The Town of Plattekill Master Plan explicitly encourages road network connectivity (page 50). The Ulster County Referral Guide recommends avoiding "the use of cul-de-sacs and where possible require interconnections to adjoining properties, subdivisions, etc." (page 17). Given the prevailing planning and development policy concerning cul-de-sacs and hammerheads, they still are built, but with access easements to neighboring parcels in anticipation of extending the local road network. Hammerheads have been particularly popular because they cost less to maintain. § 110-26 Zoning - Commercial design standards for Streets and Sidewalks says "[r]oads and drives that connect to existing streets on both ends are generally preferable to cul-de-sac and dead-end streets and shall ordinarily be used unless traffic safety issues will be mitigated by the use of a cul-de-sac or dead-end street."

^{xiii} Article I, Section 161-4(A) *Common Driveways* | Common driveways are allowed to serve no more than two (2) dwelling units. Article I, Section 161-4(B) *Private Road* of the Town of Newburgh *Zoning Code* allows and requires delineation of a right-of-way. Although the right-of-way is required, in the event the private road would need to be dedicated as a public road in accordance with the roadway specifications, a narrower pavement width is allowed than what would be typical for a public roadway.

^{xiv} Fact #618: April 12, 2010 Vehicles per Household and Other Demographic Statistics. "Vehicle Technologies Program: Fact #618: April 12, 2010 Vehicles per Household and Other Demographic Statistics. N.p., n.d. Web. 23 Oct. 2012.

<http://www1.eere.energy.gov/vehiclesandfuels/facts/2010_fotw618.html>.

^{xv} Article IV, Section 185-13(C)(1)(a) of the Town of Newburgh *Zoning Code* requires only two (2) parking spaces per dwelling units, this applies to both single family and multi-family dwellings. Article



IX, Section 300-60(D)(1) requires only (2) parking spaces per dwelling unit for single family and two-family dwellings, adequate garage space counts towards the requirement.. Article VIII, Section 300-45(A)(1) of the City of Newburgh *Zoning Code* requires only (2) parking spaces per dwelling unit for single family, two-family and three-family dwellings.

^{xvi} Article IX, Section 300-60(G) *Shared Parking* of the Town of New Windsor *Zoning Code* allows for the implementation of shared parking at the discretion of the Planning Board, upon the Applicant providing proof the shared parking shall meet the needs without adversely affecting public health safety or welfare. Section 300-60(H) *Land-banked Parking* allows upwards of twenty-five (25) percent of the required parking to be preserved as undeveloped open space upon proof by the Applicant that the reduced parking still meet the needs of the development.

^{xvii} Article IV, Section 185-13(D)(5) *Parking Space Standards* of the Town of Newburgh *Zoning Code*, parking spaces can be designed to reduced dimensions of nine (9) feet by eighteen (18) feet. Plattekill has regulations addressing parking space dimensions for multifamily housing. Section 110-16 Zoning | Multifamily dwellings requires parking spaces to be 9 feet by 18 feet in size. For other land uses, the municipal planning board has considerable latitude over parking space dimensions. Often parking areas in a largely, rural community such as Plattekill are often not paved with asphalt or concrete, but often with gravel or some other pervious surface cover. Such surfaces make pavement markings impractical. In the case of parking spaces for compact cars, they are impractical in Plattekill. Parking spaces for compact cars are popular in urban and suburban areas in order to incorporate more spaces into a parking area.

^{xviii} Article IV, Section 185-13(D)(9) *Landscaping* of the Town of Newburgh *Zoning Code* requires parking areas are to be suitable landscaped. Parking lots containing twenty (20) or more spaces, a minimum of five (5) percent of the parking lot area shall be devoted to landscaping within the interior of the parking lot. Section 110-16 of the Town of Plattekill Zoning Code | Off-street parking and loading addresses landscaping in parking areas. It states that “[a]ll parking areas that are designed to accommodate 12 or more vehicles shall be landscaped using materials of sufficient growth and height to aesthetically balance the impact of the open paved area and provide effective stormwater control.” It also says that “[n]o more than 12 parking spaces should be allowed in a continuous row uninterrupted by landscaping.”

^{xix} These municipalities only require curbing when NYS DOT requires it along State highways.

^{xx} Article I, Section 157-6(B) *Design Standards* of the Town of Newburgh *Zoning Code* and Article I, Section 249-7(B) of the Town of New Windsor *Zoning Code* allows for innovative stormwater management facilities to be proposed as part of Site Plan Applications, which may include infiltration systems. Section 89-7 *Stormwater pollution Prevention Plans* of the Town of Plattekill Zoning Code stipulates that “[n]o application for approval of a land development activity shall be reviewed until the



appropriate board has received a stormwater pollution prevention plan (SWPPP) prepared in accordance with the specifications in this chapter.” This chapter of the Plattekill code, as part of its specifications, has separate sections on pond, infiltration and bioretention practices.

^{xxi} The shores of the Town of Newburgh’s Chadwick Lake Reservoir are protected through ownership by the Town and management as a passive park. New Windsor’s Watershed Protection Overlay (WPO) District requires 100’ setbacks from the shores of Silver Stream Reservoir, Lake Washington, and streams feeding those reservoirs.

^{xxii} The Town of Newburgh’s Reservoir Residential zone has 2-acre min. lot size, 10% max. lot coverage, and only allows single family dwellings and municipal buildings as permitted uses; a limited number of additional uses are permitted but require site plan review. New Windsor’s Watershed Protection Overlay (WPO) District: prohibits 19 potentially-polluting uses; requires a special use permit for uses that are not prohibited and are permitted in underlying zoning; sets reporting and approval requirements for application of fertilizers, pesticides, and herbicides; establishes provisions for continuance of existing development; establishes 100’ setbacks from streams (deemed a buffer area) that regulates tree removal, impervious cover, structures, septic tanks, and other uses – this buffer area applies to new development in the watersheds of both Silver Stream Reservoir and Lake Washington.

^{xxiii} Article III, Section 185-4 *Establishment of Zoning Districts* of the Town of Newburgh Zoning Code established one of the eight zoning districts in the Town of Newburgh as a Reservoir Residence District.

^{xxiv} Article VI, Section 300-21 *Watershed Protection Overlay District* of the Town of New Windsor Zoning Code | The District encompasses the area near Silver Stream Reservoir and Washington Lake and outlines controls in an effort to provide adequate buffers, limit impervious surface cover and define prohibited uses in order to control nonpoint source discharge and pollution.

^{xxv} City of Newburgh, New York, Department of Planning and Development, *Plan-It Newburgh: Sustainable Master Plan* (City Council, City of Newburgh, New York, 2008), 65-66

^{xxvi} Turner Miller Group, *New Windsor 2009 Comprehensive Plan Update: Town of New Windsor, Orange County, New York* (Town Board, Town of New Windsor, New York, 2009), 23

^{xxvii} Turner Miller Group, *New Windsor Plan*, 26

^{xxviii} Turner Miller Group, *New Windsor Plan*, 28

^{xxix} Turner Miller Group, *New Windsor Plan*, 28-29

^{xxx} Saccardi & Schiff, *Comprehensive Plan, Newburgh*, IV-4

^{xxxi} Town of Plattekill Master Plan - Town of Plattekill, Ulster County, New York (Town Board, update adopted May 2003)

^{xxxii} City of Newburgh, *Plan-It Newburgh*, 105-106



xxxiii City of Newburgh, *Plan-It Newburgh*, 106

xxxiv City of Newburgh, *Plan-It Newburgh*, 104

xxxv Turner Miller Group, *New Windsor Plan*, 26

xxxvi City of Newburgh, *Plan-It Newburgh*, 104

xxxvii Turner Miller Group, *New Windsor Plan*, 26



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APPENDIX A: COMMON AVIAN AND FISH SPECIES OF THE QUASSAICK CREEK

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Appendix A

Common Avian and Fish Species of the Quassaick Creek

Table A1. List of Most Common Bird Species Observed in the Quassaick Creek Watershed (from Barbour 2004).

Common Name	Scientific Name
wood duck	<i>Aix sponsa</i>
common grackle	<i>Quiscalus quiscula</i>
American crow	<i>Corvus brachyrhynchos</i>
red-winged blackbird	<i>Agelaius phoeniceus</i>
northern flicker	<i>Colaptes auratus</i>
mute swan	<i>Cygnus olor</i>
baltimore oriole	<i>Icterus galbula</i>
red-bellied woodpecker	<i>Melanerpes carolinus</i>
American robin	<i>Turdus migratorius</i>
green heron	<i>Butorides striatus</i>
great blue heron	<i>Ardia herodias</i>
wood thrush	<i>Hylocichla mustelina</i>
red-eyed vireo	<i>Vireo olivaceus</i>
eastern wood pewee	<i>Contopus virens</i>
mallard	<i>Anas platyrhynchos</i>
blue jay	<i>Cyanocitta cristata</i>
northern cardinal	<i>Cardinalis cardinalis</i>
Canada goose	<i>Branta canadensis</i>
rock dove (pigeon)	<i>Columbia livia</i>
hairy woodpecker	<i>Picoooides villosus</i>
eastern kingbird	<i>Tyrannus tyrannus</i>
black-capped chickadee	<i>Parus atricapillus</i>
tufted titmouse	<i>Parus bicolor</i>
gray catbird	<i>Dumetella carolinensis</i>
yellow warbler	<i>Dendroica petechia</i>
yellow-rumped warbler	<i>Dendroica coronata</i>
worm-eating warbler	<i>Helmitheris vermivora</i>
double crested cormorant	<i>Phalacrocorax auritus</i>
red-tailed hawk	<i>Buteo jamaicensis</i>
killdeer	<i>Charadrius vociferous</i>
American woodcock	<i>Philohela minor</i>
herring gull	<i>Larus argentatus</i>
ring-billed gull	<i>Larus delawarensis</i>
mourning dove	<i>Zenaidura macroura</i>
belted kingfisher	<i>Megasceryle alcyon</i>



Appendix A. Common Avian and Fish Species of the Quassaick Creek

Table A1. List of Most Common Bird Species Observed in the Quassaick Creek Watershed (from Barbour 2004).

Common Name	Scientific Name
downy woodpecker	<i>Picoides pubescens</i>
great crested flycatcher	<i>Myiarchus crinitus</i>
American crow	<i>Corvus brachyrhynchos</i>
Carolina wren	<i>Thyrothorus ludovicianus</i>
northern mockingbird	<i>Mimus polyglottos</i>
field sparrow	<i>Spizella pusilla</i>
chipping sparrow	<i>Spizella passerina</i>

Table A2. Common fish species found in the Quassaick Creek Watershed

Common Name	Scientific Name	Source
blueback herring	<i>Alosa aestivalis</i>	Lake and Schmidt 1998
alewife	<i>Alosa pseudoharengus</i>	Lake and Schmidt 1998
American shad	<i>Alosa sapidissima</i>	Lake and Schmidt 1998
rock bass	<i>Ambloplites rupestris</i>	Lake and Schmidt 1998
white catfish	<i>Ameiurus catus</i>	Lake and Schmidt 1998
yellow bullhead	<i>Ameiurus natalis</i>	Lake and Schmidt 1998
brown bullhead	<i>Ameiurus nebulosus</i>	Lake and Schmidt 1998
bay anchovy	<i>Anchoa mitchilli</i>	Lake and Schmidt 1998
American eel	<i>Anguilla rostrata</i>	Lake and Schmidt 1998
fourspine stickleback	<i>Apeltes quadracus</i>	ASA Analysis and Communication 2010
freshwater drum	<i>Aplodinotus grunniens</i>	Lake and Schmidt 1998
Atlantic menhaden	<i>Brevoortia tyrannus</i>	ASA Analysis and Communication 2010
goldfish	<i>Carassius auratus</i>	Lake and Schmidt 1998
white sucker	<i>Catostomus commersoni</i>	Lake and Schmidt 1998
common carp	<i>Cyprinus carpio</i>	Lake and Schmidt 1998
gizzard shad	<i>Dorosoma cepedianum</i>	Lake and Schmidt 1998
redfin pickerel	<i>Esox americanus americanus</i>	Lake and Schmidt 1998
chain pickerel	<i>Esox niger</i>	Lake and Schmidt 1998
tessellated darter	<i>Etheostoma olmstedii</i>	Lake and Schmidt 1998
eastern banded killifish	<i>Fundulus diaphanus diaphanus</i>	Lake and Schmidt 1998
mummichog	<i>Fundulus heteroclitus</i>	Lake and Schmidt 1998
striped killifish	<i>Fundulus majalis</i>	ASA Analysis and Communication 2010
threespine stickleback	<i>Gasterosteus aculeatus</i>	ASA Analysis and Communication 2010
channel catfish	<i>Ictalurus punctatus</i>	Lake and Schmidt 1998
redbreast sunfish	<i>Lepomis auritus</i>	Lake and Schmidt 1998
pumpkinseed	<i>Lepomis gibbosus</i>	Lake and Schmidt 1998
bluegill	<i>Lepomis macrochirus</i>	Lake and Schmidt 1998
Atlantic tomcod	<i>Microgadus tomcod</i>	ASA Analysis and Communication 2010
smallmouth bass	<i>Micropterus dolomieu</i>	Lake and Schmidt 1998



Appendix A. Common Avian and Fish Species of the Quassaick Creek

Table A2. Common fish species found in the Quassaick Creek Watershed

Common Name	Scientific Name	Source
largemouth bass	<i>Micropterus salmoides</i>	Lake and Schmidt 1998
white perch	<i>Morone americana</i>	Lake and Schmidt 1998
striped bass	<i>Morone saxatilis</i>	Lake and Schmidt 1998
golden shiner	<i>Notemigonus crysoleucas</i>	Lake and Schmidt 1998
spottail shiner	<i>Notropis hudsonius</i>	Lake and Schmidt 1998
summer flounder	<i>Paralichthys dentatus</i>	ASA Analysis and Communication 2010
yellow perch	<i>Perca flavescens</i>	Lake and Schmidt 1998
bluefish	<i>Pomatomus saltatrix</i>	Lake and Schmidt 1998
black crappie	<i>Pomoxis nigromaculatus</i>	Lake and Schmidt 1998
brown trout	<i>Salmo trutta</i>	Lake and Schmidt 1998
brook trout	<i>Salvelinus fontinalis</i>	Lake and Schmidt 1998
fallfish	<i>Semotilus corporalis</i>	Lake and Schmidt 1998
hogchoker	<i>Trinectes maculatus</i>	Lake and Schmidt 1998
central mudminnow	<i>Umbra limi</i>	ASA Analysis and Communication 2010



Appendix A. Common Avian and Fish Species of the Quassaick Creek

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APPENDIX B: POLLUTANT LOADING ANALYSIS

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Appendix B

Pollutant Loading Analysis

Methodology

- HDR, as primary consultant for the Watershed Plan, developed a pollutant loadings analysis for the Quassaick Creek Watershed using the “Watershed Treatment Model” spreadsheet recommended by the New York State Office of Coastal, Local Government and Community Sustainability in its *Watershed Plans Guidebook*.
- A separate model was developed for each of six subwatersheds:
 - Bushfield Creek/Middle Quassaick Watershed
 - Chadwick Lake Watershed
 - Gidneytown Creek Watershed
 - Lower Quassaick Watershed
 - Orange Lake Watershed, and
 - The “Combined Newburgh Water Supply Watersheds,” a combination of the Upper Silver Stream, Patton Brook and Washington Lake subwatersheds, three adjacent hydrologic areas that together form a region roughly comparable in size to the other five subwatersheds in the list (See Table B-1). The three drainage areas share common characteristics: all exhibit high levels of urban development and disturbance, and the waters of all three are predominantly diverted to reservoirs for the City of Newburgh water supply system.



Appendix B. Pollutant Loading Analysis

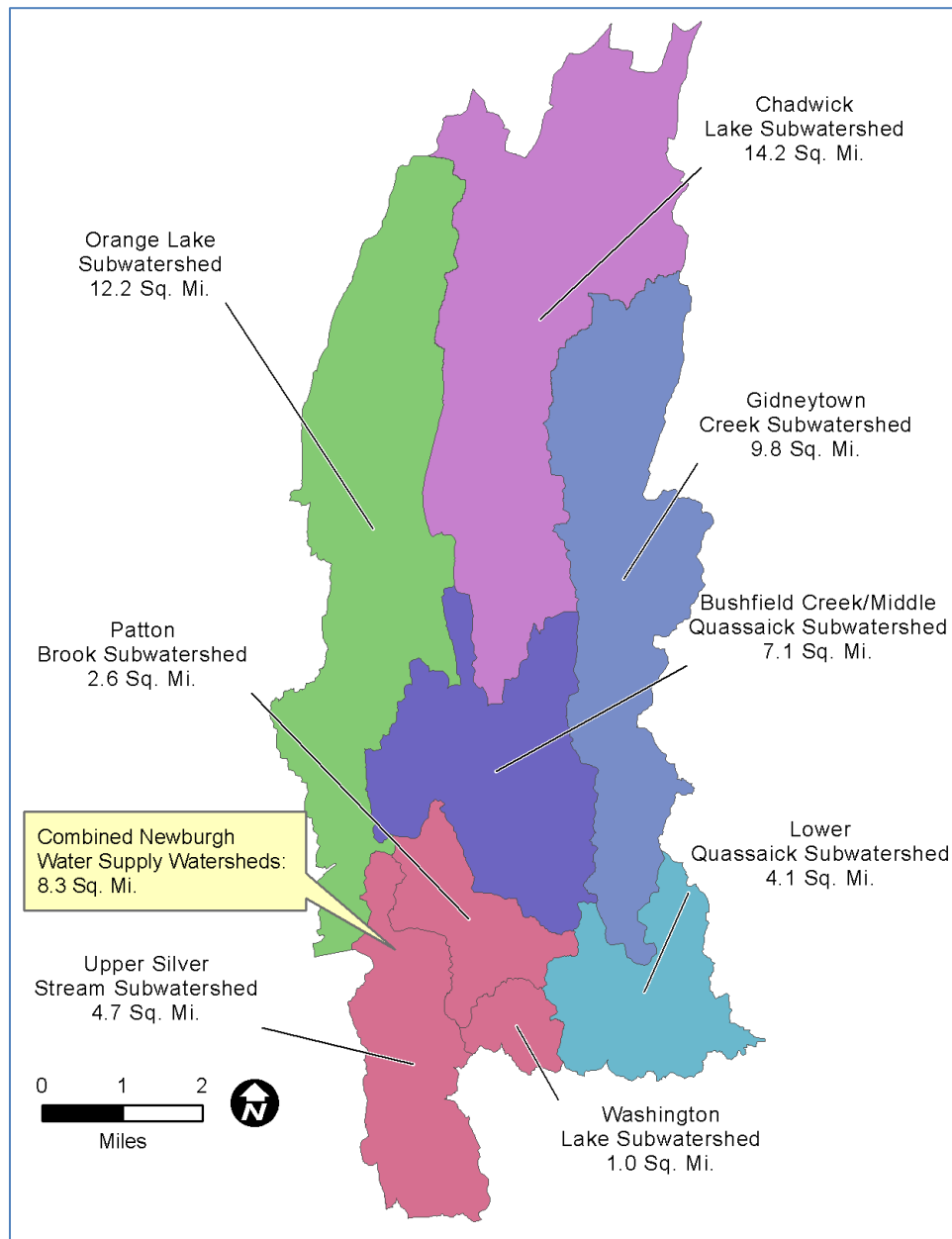


Figure B-1. Quassaick Creek Subwatershed Grouping for the Pollutant Loading Analysis.

- The Watershed Treatment Model (WTM) provides estimates of runoff volume and pollutant loading to waters in each subwatershed based primarily on the land uses found within the drainage area. In general, areas of high residential density, commercial and industrial uses and roadways are computationally ascribed to generate higher rainfall runoff, which depends primarily on impervious surface area, and consequently higher pollutant loading than areas of low residential density, forest and farming.
- For a given pollutant (for example, total phosphorus), the WTM provides an “annual loading rate” for each land use category which, when multiplied by the land area within that category, yields an estimate

Appendix B. Pollutant Loading Analysis

of the quantity of pollutant in pounds estimated to be loaded for that category each year. The sum of the pollutant loading from all of the land use categories is the total estimated pollutant loading for the subwatershed. This annual loading rate is for some categories a constant (e.g., the rate for total phosphorus loading from forest land is always 0.2 lbs/acre), and for some categories, such as the different classes of residential land, is derived by a calculation which takes into account local rainfall and (where data is available) other conditions that cause variations in runoff. The table below tabulates the annual loading rates generally applied by the WTM analysis for phosphorus loading in the Quassaick Creek watershed:

TABLE B-1: PHOSPHORUS LOADING RATES BY LAND USE TYPE	
Land Use Type	Total Phosphorus Loading Rate (lb/acre/yr)
Open Water	0.5
Rural	0.7
Forest	0.2
Industrial	1.8
Roadway	2.0
Commercial	1.9
Multifamily	1.7
HDR (>4 du/acre)	1.7
MDR (1-4 du/acre)	1.6
LDR (<1du/acre)	1.5

- It is these rates which, when multiplied by the land areas tabulated in Table B-2 below, produce the Total Phosphorus loading, by subwatershed and by land use category, shown in Table B-3 and Figure B-3 below.
- This application of the WTM considers only separate stormwater drainage and collection systems. A portion of the Lower Quassaick Subwatershed is served by the City of Newburgh's combined sewer system. Combined sewer overflows are not included in the pollutant loading analysis as a separate CSO Characterization Study would be more relevant than the WTM in addressing such pollutant loadings.

Input Data

- Two major inputs are required for the WTM model: land use, by area, in the ten categories listed in Table B-1, and estimated annual rainfall in inches. For other inputs of lesser impact, including hydrogeologic soil group and depth to groundwater, the default values contained in the model were accepted
- Geographic information system methods and data were used to generate measurements of total land use in each subwatershed in each of these categories. Two primary sources, courtesy of the Ulster County Information Services Office and the Orange County Planning Department, were parcel datasets identifying block, lot and use classification of the tax lots within the Quassaick Watershed, both in Ulster



Appendix B. Pollutant Loading Analysis

and Orange Counties. Working with these parcel polygons, it was possible to classify areas of the watershed into high, medium and low-density and multi-unit residential use, commercial use, and industrial use.

- The National Land Cover Dataset (NLCD) land cover layer was used to identify rural, forest, open water and roadway areas within the Quassaick Watershed. The NLCD is a nationwide 30-meter resolution dataset processed from LANDSAT satellite imagery and sponsored by the U.S. Geological Survey. It provides up to 16 classifications of land cover, including multiple classes of developed land and forest. The most recent version of NLCD, used in this study, was released in 2010 from imagery taken in 2006. In adapting the NLCD 2006 classifications to the Watershed Treatment Model, NLCD's hay/pasture, cultivated crops (e.g., orchards) and grassland/herbaceous classifications were treated as "rural" and NLCD's forest, wetland and shrub/scrub categories were treated as "forest" for purposes of the model. Developed land within the NLCD classification system and falling outside the Ulster and Orange residential, commercial and industrial parcels was treated as roadway; this treatment was checked by map overlay against GIS roadway data and was found to be substantially correct.
- The resulting composite land use dataset for the Quassaick Watershed was divided by subwatershed and used as inputs for the Watershed Treatment Model. Table X below sets out the composite land use inputs, by subwatershed



Appendix B. Pollutant Loading Analysis

TABLE B-2: LAND USE TYPES BY WATERSHED (ACRES)							
LAND USE TYPE	Bushfield Creek/ Middle Quassaick	Chadwick Lake	Gidneytown Creek	Lower Quassaick	Orange Lake	Combined Water Supply	TOTAL
LDR (<1 du/acre)	775	1,877	918	91	1,893	309	5,863
MDR (1-4 du/acre)	796	311	515	231	334	500	2,686
HDR (>4 du/acre)	66	6	68	265	18	54	477
Multifamily	102	495	144	83	160	17	1,001
Commercial	443	207	206	373	176	1,141	2,545
Roadway	417	196	209	451	257	908	2,437
Industrial	7	0	18	126	99	45	295
Forest	1,678	5,247	3,988	696	3,694	1,363	16,665
Rural	218	467	187	260	722	613	2,467
Open Water	7	259	27	16	414	348	1,070
TOTAL	4,508	9,064	6,278	2,591	7,768	5,297	35,504

- Another relevant input for the Watershed Treatment Model, average annual rainfall, has been derived from StreamStats for New York, a water resources web application made available by the United States Geological Survey in cooperation with New York State agencies (http://water.usgs.gov/osw/streamstats/new_york.html). The “Basin Characteristics Report” generated in StreamStats/New York for coordinates 41.4927, -74.0620 indicates a mean annual precipitation of 42.7 inches.
- Although the WTM offers the possibility of entry of inputs for varying hydrogeological soil conditions, the calculation and input of data in this category has not been attempted at this time. The default in the WTM of Soils Group C was used in all subwatersheds. The variation in annual runoff and pollutant loadings produced by different hydrogeological soil conditions is believed to be relatively small. For the Bushfield Creek/Middle Quassaick subwatershed, for example, varying the proportions of the hydrogeologic soil groups produced at most less than a 1% variation in total phosphorus.

Results

- The WTM includes calculations of pollutant load for total nitrogen, total phosphorus, total suspended solids and fecal coliform. Elevated total phosphorus loading is considered to be a good indicator of the impact of residential, commercial and industrial development on pollutant loads, and water quality of the receiving waterways. Total phosphorus is generally the limiting nutrient for algal growth in freshwater lakes. High algal concentrations can adversely affect drinking water supplies as well as aesthetics in all lakes and impoundments. The following Table B-3 summarizes the predicted quantities of total phosphorus loading, by land use type and subwatershed, for the assumed rainfall of 42.7 inches per year:



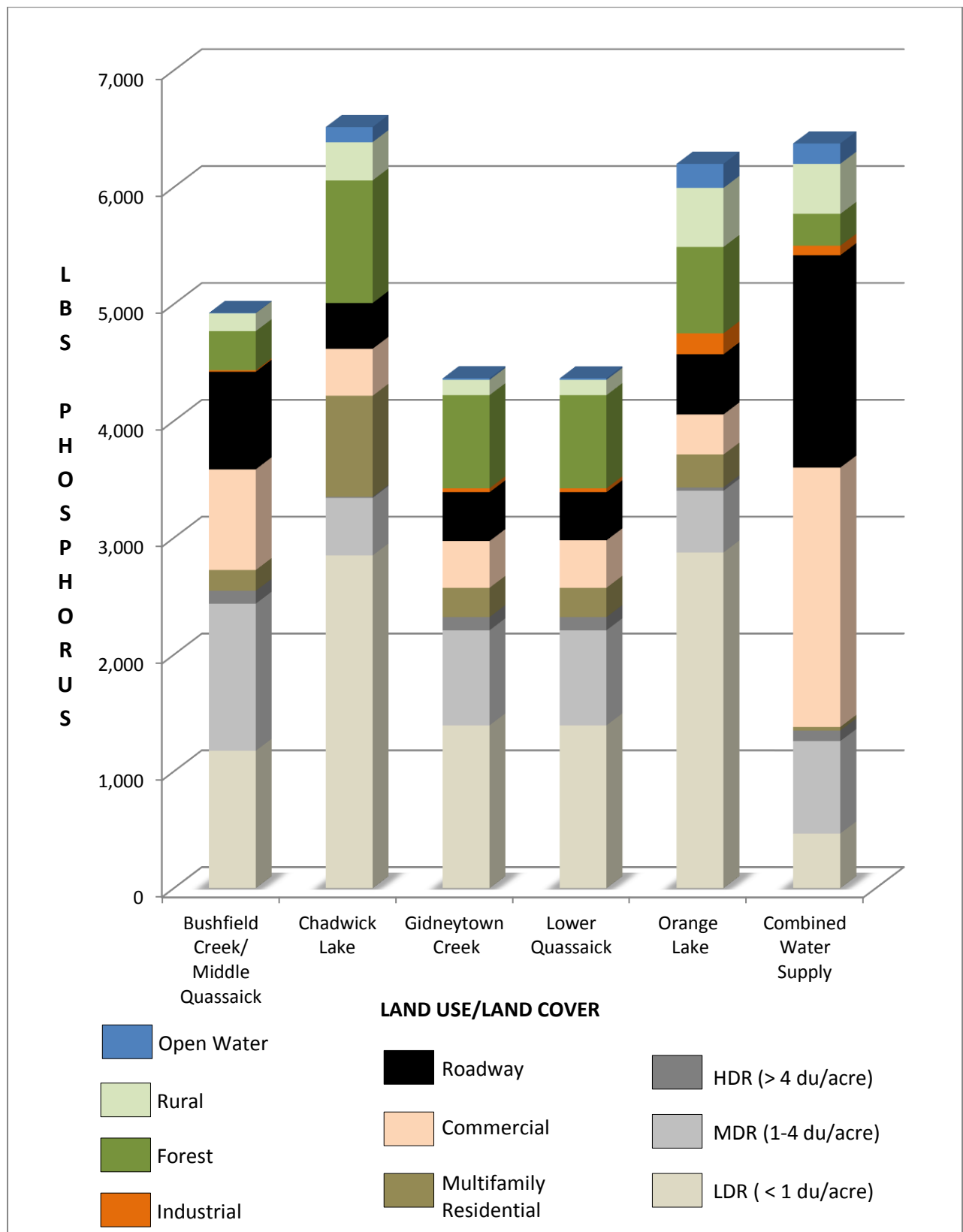
Appendix B. Pollutant Loading Analysis

TABLE B-3: PREDICTED ANNUAL TOTAL PHOSPHORUS LOADING BY SOURCE AND SUBWATERSHED (lb/yr)							
LAND USE TYPE	Bushfield Creek/ Middle Quassaick	Chadwick Lake	Gidneytown Creek	Lower Quassaick	Orange Lake	Combined Water Supply	TOTAL
LDR (<1 du/acre)	1,211	2,933	1,395	142	2,958	483	9,121
MDR (1-4 du/acre)	1,325	517	815	384	555	831	4,427
HDR (>4 du/acre)	118	10	113	477	32	98	848
Multifamily	196	951	251	159	308	33	1,898
Commercial	990	462	400	834	394	2,550	5,629
Roadway	969	455	418	1,049	598	2,110	5,598
Industrial	14	0	33	254	200	90	592
Forest	336	1,049	798	139	739	273	3,333
Rural	153	327	131	182	505	429	1,727
Open Water	3	129	13	8	207	174	535
TOTAL	5,313	6,834	4,365	3,628	6,497	7,071	33,707

The following graph presents these results in chart form.



Appendix B. Pollutant Loading Analysis



Appendix B. Pollutant Loading Analysis

Figure B-3. Estimated Pounds of Phosphorus Loading by Land Use and Subwatershed.

Conclusions

- Residential land cover, including High Density, Medium Density, Low Density and Multifamily, makes an especially large contribution to pollutant loading, accounting, in the aggregate, for 48% of all total phosphorus loading in the full Quassaick watershed.
- This effect is most marked in the Chadwick Lake and Orange Lake subwatersheds, where low density residential development alone provides approximately one-third of all total phosphorus loading.
- Roadways make a large contribution to phosphorus loading, especially in the more densely developed Lower Quassaick and Combined Water Supply subwatersheds.
- The Combined Water Supply Subwatershed (grouping) has the highest total phosphorus loading of the six subwatersheds. Commercial land use accounts for 36% of the total phosphorus loading in the Combined Water Supply subwatershed.

Recommendations

The results of the WTM can be used to identify the primary sources of pollutants in the six subwatersheds of the Quassaick Creek watershed for water quality management purposes. For example, the main source of nutrients in LDR, MDR and HDR areas is typically lawn fertilizer (NYSDOS 2009). New York State enacted a ban on fertilizers containing phosphorus that went into effect this year. Although this ban will reduce phosphorus applications it will not eliminate phosphorus because of the exempt applicators and allowed phosphorus use (i.e., gardens; agricultural lands and production; sod farms; phosphorus deficiency; establish new turf). The WTM loading calculation uses a TP concentration of 0.26 mg/l for the runoff from practically all land uses. The WTM can be refined by over-riding this concentration based on site-specific sampling data, if available. Stormwater sampling is recommended to obtain data that can be used to refine the WTM and assess trends in water quality that may result from the recent statewide phosphorus ban as well as local changes in land use.

APPENDIX C: DATA SOURCES UTILIZED

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Appendix C

Spatial Data Sources Utilized

Map/Figure	Feature/Shapefile	Source	
		Orange County	Ulster County
General/Base	Roads	O.C. GIS Department	U.C. Information Services
General/Base	Railroads	O.C. GIS Department	
General/Base	Municipal Boundaries	O.C. GIS Department	U.C. Information Services
General/Base	Hamlet Centers	O.C. GIS Department	
General/Base	Water Bodies	O.C. GIS Department/OCPD; delineated from aerial photography	New York State Department of Environmental Conservation and U.C. Planning Department; delineated from aerial photography
General/Base	Quassaick Creek Watershed and sub- watersheds	OCPD; delineated from 2-ft contour data	U.C. Information Services
General/Base	Aerial Photography	New York State Department of State, Division of Coastal Resources, GIS Unit	
Figure 2	Silver Stream Diversion	Estimated from aerial photography and hydrography data	N/A
Figure 2	Murphy's Ditch	Estimated from aerial photography and historic accounts	N/A
Figure 2	Potential Underground Channel	Quassaick Creek Watershed Alliance	N/A
Figure 9	Environmental Remediation Sites	NYSDEC	



Appendix C. Spatial Data Sources Utilized

Map/Figure	Feature/Shapefile	Source	
		Orange County	Ulster County
Figure 14/15	Environmental Justice Areas	NYSDEC	
Figure 19	Mapable Recommendations	OCPD	N/A
Figure 21	Stormwater Pond Locations	OCPD	OCPD
Figure 24	Wetland Restoration Opportunities	HDR	N/A
Map 1 Location Map	Wallkill River Watershed	USGS Water Resources and OCPD	
	Moodna Creek Watershed		
Map 2 Soils	Soils	United States Department of Agriculture	
Map 3 Hydrologic Features	NYSDEC Wetlands	NYSDEC	
	Nationwide Inventory Wetlands	U.S. Fish and Wildlife Service	
Map 4 Floodplains	High Risk Floodplain	Federal Emergency Management Agency	
	Sand and Gravel Aquifers	O.C. GIS Department and NYSDEC	NYSDEC
Map 5 Water Quality	NYSDEC Best Use Classification	NYSDEC	
	Stream Biomonitoring Data	OCPD and NYSDEC	
	NYSDEC 303D Waterbodies	NYSDEC	
	NYSDEC Priority Waterbodies	NYSDEC	



Appendix C. Spatial Data Sources Utilized

Map/Figure	Feature/Shapefile	Source	
		Orange County	Ulster County
Map 6 Water Supply and Wastewater Treatment	Sewer Districts	O.C. GIS Department	U.C. Information Services
	Water Districts	O.C. GIS Department	U.C. Information Services
	Water Supply Wells	O.C. GIS Department	N/A
	SPDES Permits	NYSDEC	
	NYC Aqueducts	Derived from National Hydrography Dataset	
Map 7 Rare Species and Significant Natural Communities	Dams	NYSDEC/NOAA/Quassaick Creek Watershed Alliance	
	Rare Animals	NYSDEC Natural Heritage Program, 6/13/2012	
	Rare Plants		
	Significant Natural Communities		
Map 8 Land Use/Land Cover	Agriculture Districts	OCPD/O.C. Real Property	U.C. Information Services
	National Land Cover Data 2006	USGS Land Cover Institute	
Map 9 Impervious Surface and Riparian Areas	Riparian Area	OCPD	
	Impervious Surface	National Land Cover Data 2006/USGS Land Cover Institute	
	Natural Areas	National Land Cover Data 2006/USGS Land Cover Institute	
Map 10 Protected Open Space and Development Trends	Priority Growth Areas	OCPD	UCPD
	Developed Land	O.C. Real Property	U.C. Information Services
	Future Development	OCPD	N/A
	Open Space, Parks, etc.	OCPD	UDPD
	Public Access Locations	Quassaick Creek Watershed Alliance	



Appendix C. Spatial Data Sources Utilized

Acronyms:

New York State Department of Environmental Conservation (NYSDEC); OCPD (Orange County Planning Department); UCPD (Ulster County Planning Department); USGS (United States Geological Survey)



APPENDIX D: PRIORITY ACTIONS

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Quassaick Creek Watershed Management Plan

Priority Action: CRYSTAL LAKE AND SNAKE HILL

Action Description:

Snake Hill is a local landmark that offers sweeping views of the Hudson River and surrounding landscape from its summit. The ridgeline of the Hill was privately-owned until recently when ownership was transferred to Scenic Hudson, who manages the property as an unimproved nature preserve. The Hill straddles the City of Newburgh/Town of New Windsor border and is flanked on its northwestern slope by Crystal Lake, an 8-acre pond that was once a the centerpiece of public park, and the smaller Miller's Pond. A small Jewish cemetery resides on the western slope of the Hill. Aside from Scenic Hudson's parcel, the ownership of these three resources is predominantly municipal (see Figure 1). This entire area is largely unused but could provide an appealing natural respite for area residents and an outdoor classroom for science students of all ages if improved and opened to the public. Best uses for this area include bird watching, fishing, picnicking, nature study, hiking, and paddling.

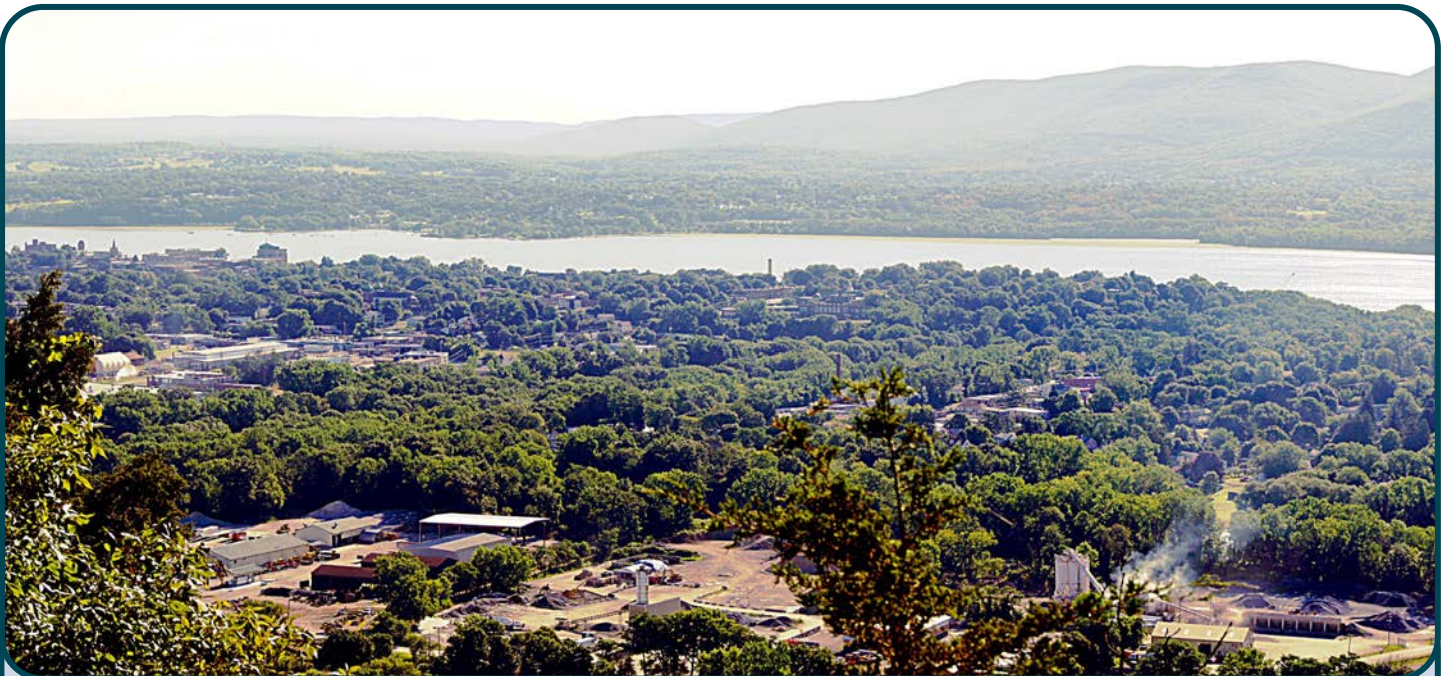


Photo 1: Panoramic view from the summit of Snake Hill. City of Newburgh and Town of New Windsor in foreground, with Dutchess and Putnam Counties across the Hudson River.

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
4-2	Protect critical open spaces and biological areas	Enhance Natural Processes, and Promote Watershed Awareness	\$-\$\$	6+	Put protective regulations in place and/or protect critical properties
8-4	Increase public access to water, in particular in under-served areas	Promote Watershed Awareness	\$-\$\$	6+	Establish new access points

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: CRYSTAL LAKE AND SNAKE HILL

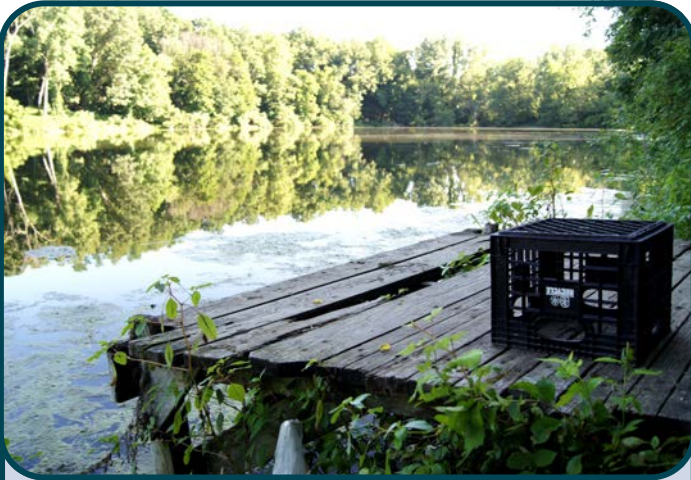


Photo 2: An informal fishing area on Crystal Lake, looking north towards the lakes dam.

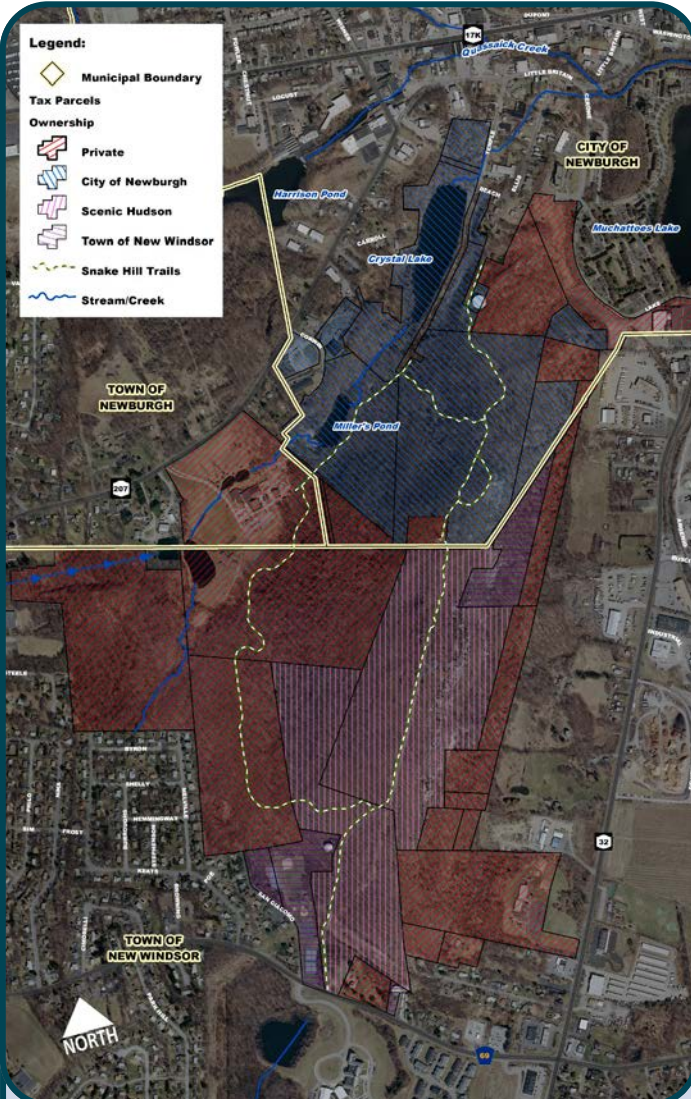


Figure 1: Aerial photography showing ownership of lands associated with Crystal Lake and Snake Hill, as well as an undeveloped/informal trail network.

Action Considerations:

- ◆ Potential **improvements** that would need to be made include: removal of garbage, trail development, signage, barriers to prevent cars from entering, removal of rusted metal dock and bridge on Crystal Lake, and safety improvements of bridge over Miller's Pond dam.
- ◆ Wetlands **permitting** may be required to construct public access infrastructure
- ◆ Development of a **lake management** program could help control aquatic vegetation.
- ◆ Parkland designation needs to be balanced with potential residential development at base of Snake Hill.

Funding Opportunities:

- ◆ Municipal
- ◆ Land conservation organizations
- ◆ Grants

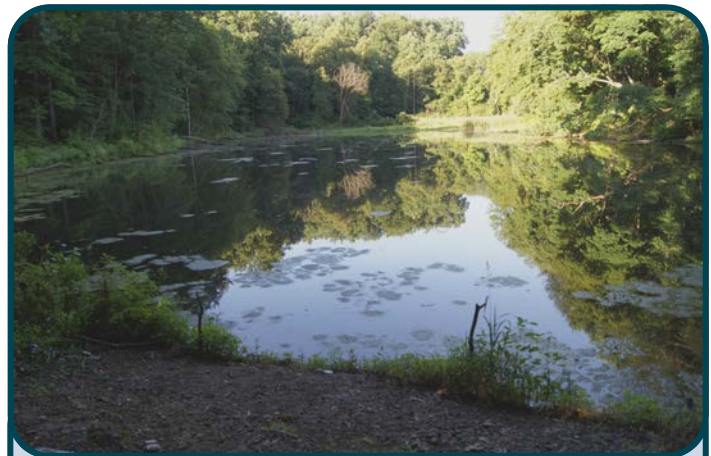


Photo 3: View across Miller's Pond, looking south. The area is informally utilized for fishing.

Potential Partners:



Quassaick Creek Watershed Management Plan

Priority Action: LOWER QUASSAICK

Action Description:

The lower reach of the Quassaick Creek, which forms the boundary between the City of Newburgh and the Town of New Windsor, is flanked by a well-vegetated corridor, much of which is municipally-owned. Although past efforts to develop an estuary preserve in this corridor were unsuccessful, recent work performed due to a sewer blow-out have created new opportunities for public access, stream restoration, and corridor improvements. Efforts to encourage the public to view and walk along the Quassaick Creek would serve to increase public appreciation of the Creek, increase tourism and foot traffic in the area, and reduce crime in the immediate vicinity. A recent grant secured by the Quassaick Creek Watershed Alliance in collaboration with Hudson River Sloop Clearwater as a financial partner will support the design and establishment of public open space along the Quassaick Creek, including a fitness trail, habitat restoration and green infrastructure.

Restoration projects were identified by stakeholders during a site assessment in the summer of 2013. The assessment covered the

Creek's corridor from the Hudson River to the Holden Dam. In addition to the project ideas depicted on Figure 1 (see reverse), invasive species management is needed throughout this stretch of the Creek.



Photo 1: Shown is the Mill Street Bridge with Quassaick Creek flowing on the right and construction road, which could potentially serve as a public trail, on the left.

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
4-2	Protect critical open spaces and biological areas	Enhance Natural Processes, and Promote Watershed Awareness	\$-\$\$	6+	Put protective regulations in place and/or protect critical properties
8-4	Increase public access to waterbodies, particularly in under-served areas	Promote Watershed Awareness	\$-\$\$	6+	Establish new access points
10-2	Develop interpretive and educational plan for significant cultural resource sites, where appropriate	Promote Watershed Awareness	\$	2-5	Develop plan
10-3	Perform focused archaeological survey of Lower Quassaick Creek	Promote Watershed Awareness	\$\$	6+	Perform survey

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: LOWER QUASSAICK



Figure 1: Restoration project ideas for Lower Quassaick Creek based on field investigation in summer of 2013. The Town of New Windsor is south of the Creek and the City of Newburgh is north.

Action Considerations:

- ◆ **Access** issues include possible need for permission to legally cross CSX rail line and private property. CSX crossing, if required and permitted, may take one year to acquire. Landowner buy-in may be needed for public access easements
- ◆ At least the following **improvements** would need to be made: removal of garbage, lighting, trail development, safety features including railings and possibly security cameras. Existing stream crossing (Photo 2) requires rehabilitation to improve safety for public use.
- ◆ **Phase 1 survey** will be required due to the post-industrial nature of area and archaeologically-sensitive areas near Creek. Coordination with NYS Office of Parks, Recreation, and Historic Preservation (OPRHP).

Funding Opportunities:

- ◆ Municipal
- ◆ Grants :
 - ⇒ US EPA's Environmental Justice grant
 - ⇒ NYS OPRHP grants
 - ⇒ Environmental Protection Fund's Recreational Trails Program

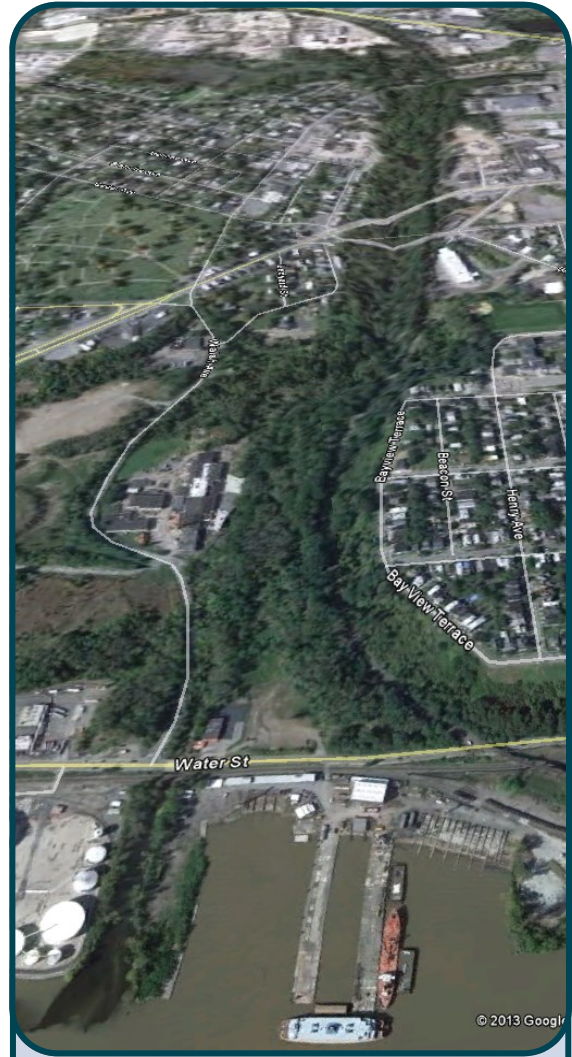


Figure 2: Referred to as “Newburgh’s Other Waterfront,” the Quassaick Creek flows through a well-vegetated corridor before emptying into the Hudson River.



Project Partners:



Clearwater

Quassaick Creek Watershed Management Plan

Priority Action: MODEL CODES & ENHANCED LOCAL PLANNING

Action Description:

While each of the Watershed's four municipalities have similarities –their climates, their home-rule structure, and the fact that all are governed by the same state and federal laws – they also have their own unique landscapes, natural resources, land-use dynamics, and local leaders. It is this uniqueness that challenges a one-size-fits-all approach to watershed management and necessitates significant community involvement, and customized planning and implementation. There are general principles and myriad methods to address water quality concerns, but management approaches need to reflect the needs, issues, and opportunities of each community in order to be effective.

A review of local regulations, which focused heavily on stormwater best management practices and source water protection, was completed for this Watershed Plan and revealed both strengths and weaknesses among local planning, policies, and regulations. The results of this work can be found in Chapter 3 of the Plan. Specifically, watershed protection could be enhanced if municipalities in the Watershed adopt measures that:

- ◆ afford additional protections for wetlands, especially isolated wetlands
- ◆ locate development further back from streams and lakes
- ◆ further reduce erosion and sedimentation during construction
- ◆ require minimal impervious surface for new development

Continued on the next page

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
2-3	Develop/maintain intermunicipal agreements on Source Water Protection	Protect Water Quality and Source Water, Inter-municipal Implementation, Promote Watershed Awareness	\$	1+	Adopt intermunicipal agreements
2-5	Develop model codes for water resource protection and climate change resilience	Protect Water Quality and Source Water, Manage Quantity, Inter-municipal Implementation, Promote Watershed Awareness, Create a Resilient Watershed	\$	1+	Identify/develop and advocate for model codes
2-7	Encourage local regulatory measures for water resource protection, especially for drinking water supplies, and stormwater reductions	Protect Water Quality and Source Water, Manage Quantity, Inter-municipal Implementation, Promote Watershed Awareness, Create a Resilient Watershed	\$	1+	Identify/develop and advocate for regulatory measures at the local level
2-8	Encourage planning and zoning in urban reaches of the stream corridor that improves the quality of life for people living near it	Promote Watershed Awareness	\$	1+	Develop and advocate for planning principles and design standards

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: MODEL CODES & ENHANCED LOCAL PLANNING

	Selected Water Quality and Stormwater Management Practices by Landscape Type			
	Rural			Urban
	Rural Area	Agriculture	Suburban	Neighborhood Center
Porous Pavement				
Reduction of pavement				
Bioretention/Swales				
Conservation Easements				
Soil Conservation				
Stormwater Ordinances				
Repair/Replace Septic Systems				
Educational Outreach				
Detention Basins				
Tree Boxes/Sand Filters				
Green Roofs				

Table Legend:
Most appropriate
Sometimes appropriate
Appropriate but less effective
Not appropriate or applicable

Figure 1. Examples of which landscape types are best suited to various best management practices (BMPs).

(Continued from previous page)

- ◆ encourage creation of pervious pavement and constructed wetlands to manage stormwater
- ◆ require septic system inspections in areas that drain to reservoirs or waterbodies known to be affected by nutrients

Priority natural areas could also be better protected through the development of Natural Resource Inventories, which are used as tools for town-wide planning and site-specific development review.

Action Considerations:

- ◆ **Education and outreach** will be needed in order for municipalities to be motivated to update their plans and regulations.
- ◆ Municipalities will likely need to tailor **model codes, standards, regulations, and plans** to meet their community's unique setting and circumstances.

Funding Opportunities:

- ◆ Municipal

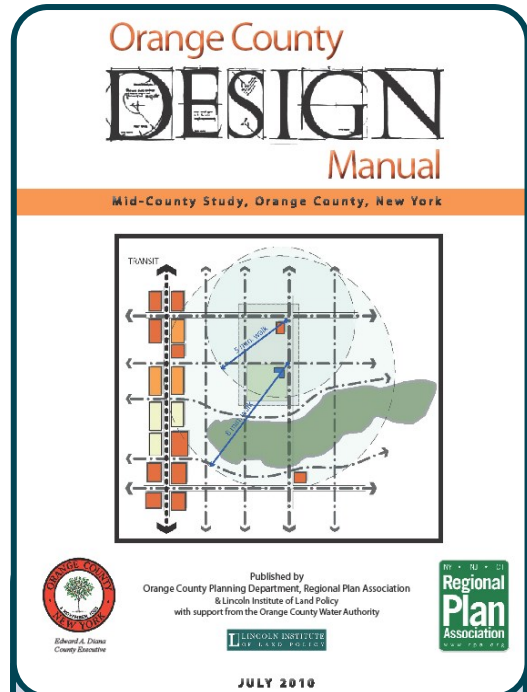


Figure 2: The Design Manual provides guidance for neighborhood planning and development design and review.

Project Partners:



Quassaick Creek Watershed Management Plan

Priority Action: MUCHATTOES LAKE IMPROVEMENTS

Action Description:

Given its central location in the City of Newburgh, Muchattoes Lake is an ideal candidate for public recreation, green infrastructure demonstration projects, and other improvements. This 13-acre lake is adjacent to a large apartment complex but is currently fenced off around most of its perimeter, thus discouraging residents from making contact with the Lake. In of 2013, a DEC Environmental Justice grant was awarded to the Quassaick Creek Watershed Alliance in partnership with the Hudson River Sloop Clearwater to plan and construct a series of projects focused on Muchattoes Lake. A primary element will be the development of a walking trail around and in

(Continued on next page)



Figure 1: Conceptual layout of walking trail connecting the Newburgh Armory Unity Center with residences near Muchattoes Lake, additionally providing access points to the lake for the residents. This concept will be implemented, in part, with the grant funds from the EPA's Environmental Justice Small Grants Program.

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
8-2	Conduct regular stream and lake clean-ups	All	\$	1+	Conduct cleanup of stream and lake on as-needed basis
8-4	Increase public access to water, particularly in under-served areas	Promote Watershed Awareness	\$-\$\$	6+	Establish formal public access location (s)
11-1	Explore potential for Micro-hydro power on existing dams	Promote Watershed Awareness	\$-\$\$	2-5	Perform assessment of micro-hydro potential

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: MUCHATTOES LAKE IMPROVEMENTS



Photo 1: A view across Muchattoes Lake, from the vicinity of Lake Drive looking south/southwest.



Photo 2: Muchattoes Lake Dam.



Photo 3: Trees for Tribes planting, plants provided by the NYSDEC and planted by volunteers.

(Continued from previous page)

the vicinity of the Lake, but other projects include green infrastructure, street tree plantings, and lakeside habitat restoration projects. Such improvements would have a positive impact on water quality and habitat value. The proposal also included engaging nearby residents in workshops and hands-on activities such as construction of a rain garden, street tree planting, trail making, invasive species removal, lakeside plantings, and duck box construction.

Other projects that could benefit Muchattoes Lake include regular water quality monitoring, additional lakeshore restoration/vegetation, and the installation of a hydroelectric system at the dam that impounds the Lake. Electricity that is generated could be used for local needs.

Action Considerations:

- ◆ **Wetlands permit** would be required for in-lake work, which may be needed for construction of access point.
- ◆ **Design considerations** for stormwater BMPs and/or diversion prior to stormwater entering the Lake.
- ◆ Certain funding streams that could help finance the walking trail would require that the trail be **ADA-compliant**.

Funding Opportunities:

- ◆ Grants:
 - ⇒ EPA's Environmental Justice grant
 - ⇒ NYS OPRHP grants
- ◆ Municipal

Project Partners:



Clearwater

Quassaick Creek Watershed Management Plan

Priority Action: ORANGE LAKE

Action Description:

Orange Lake, the largest waterbody in the Quassaick Creek Watershed, is a private lake in the Town of Newburgh and has been widely used for recreation since the 1800s. Flanked by residences along much of its shore, this eutrophic Lake is on New York's 303(d) List of Impaired Waterbodies due to nutrients from habitat modifications and wastewater/stormwater; the primary pollutant of concern is phosphorous. Water quality monitoring performed by the Orange Lake Civic Association, the Orange Lake Fish & Game Association through the

(Continued on next page)



Figure 1: Oblique aerial view of Orange Lake (Bing Maps), showing the Bushfield Creek as it enters the northern end of the lake and the concentration of development along the east and west shorelines.

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
1-3	Identify a mechanism to remove Orange Lake from 303(d) list and/or recognize water quality improvements	Protect Water Quality and Source Water, Manage Quantity, and Promote Watershed Awareness	\$	2-5	Remove from 303(d) list or formally recognized by NYSDEC for improvements
1-5	Collect and monitor water quality data at reservoirs and lakes	Protect Water Quality and Source Water, Manage Quantity, and Promote Watershed Awareness	\$	2-5	Long-term monitoring of Orange Lake
3-7	Prioritize catch basins at Orange Lake for cleanout on a regular basis	Protect Water Quality and Source Water, Manage Quantity, Enhance Natural Processes, and Create a Resilient Watershed	\$	2-5	Clean out catch basins on regular basis
9-7	Develop a septic pump-out program for Orange Lake	Protect Water Quality and Source Water, Manage Quantity, and Promote Watershed Awareness	\$	2-5	Develop and implement program

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: ORANGE LAKE

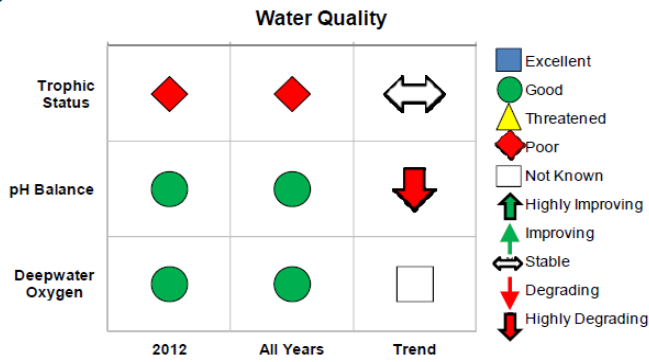


Figure 2: Water quality data taken over a 15-week period in 2012 for the CSLAP testing indicate a poor trophic status, which is a combined measure of Total Phosphorous, Chlorophyll *a*, and water clarity. Deepwater oxygen levels and pH balance were both categorized as Good, which is a positive sign for ecological health.

Long Term Trends: Phosphorus

- No trends apparent
- Most readings typical of *eutrophic* lakes, similar to chlorophyll *a*

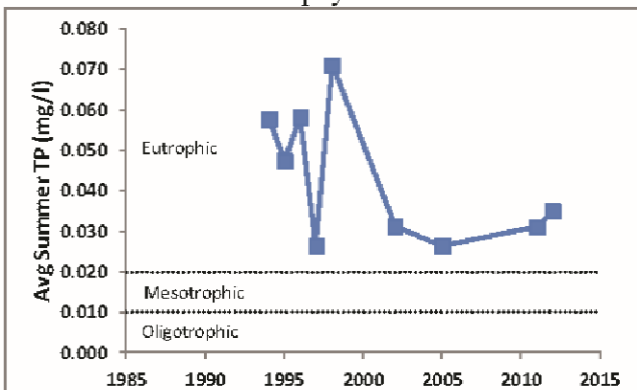


Figure 3: Graph from 2012 CSLAP report showing trend in Phosphorous levels in Orange Lake. Decreases in phosphorous over time are an indication of improved water quality.

Project Partners:



(Continued from previous page)

NYSDEC's Citizen Statewide Lake Assessment Program (CSLAP) in several years from 1994 to 2012 indicate that phosphorous levels continue to be higher than recommended levels, despite various management actions taken by the Association. Additional efforts that could reduce phosphorous in the lake include education and outreach to residents about best management practices for yard and pet waste, enhanced maintenance of septic systems on the western side of the Lake, and more frequent cleanout of catch basins. Ongoing management actions, such as monitoring of geese populations, should be continued, as should lake monitoring, which will enable lake managers to assess the effectiveness of management measures. Another management concern at Orange Lake is the invasive aquatic plant, Eurasian milfoil, which had become so dominant that the Association received a permit from the NYSDEC to introduce non-reproductive triploid carp. The carp have so far been effective, although the amount of aquatic vegetation they have eaten may be diminishing habitat for spawning fisheries.

Action Considerations:

- ◆ Advancing initiatives requires **continued program coordination and management** by the Association (with collaboration from NYSDEC)
- ◆ Orange Lake is naturally eutrophic. While improving water quality and removing the Lake from the 303(d) list are worthy goals, **changing its trophic status may be difficult to accomplish.**

Funding Opportunities:

- ◆ Grants
- ◆ Municipal



Photo 1: Historic postcard showing recreation use of Orange Lake.

Quassaick Creek Watershed Management Plan

Priority Action: PROMOTE WATERSHED AWARENESS

Action Description:

Watershed health and resilience is a factor of actions taken by a multitude of diverse stakeholders. Government arguably has the most lasting effect on the Quassaick Creek Watershed due to its control over land use decisions, transportation and other infrastructure development/maintenance, and creation/implementation of policies. Outreach to all levels of government, especially local governments, about the values, impairments, and vulnerabilities of the Watershed is therefore critical for effective watershed management. But other stakeholder groups also have profound impacts on the Watershed as well and should be targeted for outreach efforts. Residents, utility companies, community service and religious groups, businesses and other organizations can all

(Continued on next page)

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
8-1	Promote community involvement and education on changes in water resources and protecting water supply	Protect Water Quality and Source Water, Manage Quantity, Intermunicipal Implementation, Promote Watershed Awareness, and Create a Resilient Watershed	\$	2-5	Increase participation in WQ monitoring, broaden QCWA membership
8-3	Develop outreach and education program that is revisited on an annual basis	Protect Water Quality and Source Water, Manage Quantity, Intermunicipal Implementation, Promote Watershed Awareness, and Create a Resilient Watershed	\$	2-5	Establish program; possible Outreach Subcommittee
9-3	Inform and engage public on pollution-reducing behaviors (including tips for homeowners, impact of pet waste)	Protect Water Quality and Source Water, Manage Quantity, Intermunicipal Implementation, and Promote Watershed Awareness	\$	2-5	Develop outreach materials, incentivize participation to engage public
9-4	Highlight stormwater retrofits and other BMP demonstration sites, as well as their impacts (e.g. before/after, cost/benefit)	Protect Water Quality and Source Water, Manage Quantity, Intermunicipal Implementation, and Promote Watershed Awareness	\$	2-5	Obtain property owner permission, conduct workshop/site visit or create signage
9-5	Increase public awareness of potential climate change impacts on drinking water supplies	Protect Water Quality and Source Water, Manage Quantity, Promote Watershed Awareness, and Create a Resilient Watershed	\$	2-5	Assess source water vulnerabilities, communicate findings to municipal boards
9-6	Develop program to encourage septic maintenance	Protect Water Quality and Source Water, Manage Quantity, and Promote Watershed Awareness	\$	2-5	Identify incentive to engage public, develop program

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: PROMOTE WATERSHED AWARENESS



Photo 1: Members of the Quassaick Creek Watershed Alliance pose for a photo behind trash they collected.

(Continued from previous page)

impact the Watershed and are appropriate audiences for strategic outreach and education.

There are several existing entities that have been engaged in such outreach; their efforts should be supported, enhanced, and coordinated so as to avoid duplication and maximize impacts. Foremost in this ensemble is the Quassaick Creek Watershed Alliance, which includes individuals and entities, both public and private. Over the past several years, the Alliance has taken physical measures to enhance water resources (e.g. riparian plantings, stream cleanups), monitored water quality, partnered with other entities on successful grant applications, and advocated for the creation of a Conservation Advisory Council in the City of Newburgh.

Other entities that could help promote watershed awareness include the Orange County Municipal Planning Federation, Ulster County Planning Board, Orange County, Soil & Water Conservation Districts, NYSDEC, and the Hudson River Watershed Alliance. For more information on the Quassaick Creek Watershed Alliance, visit:

waterauthority.orangecountygov.com/quassaick.html

Action Considerations:

- ◆ **Coordination** of outreach efforts is important to avoid duplication or conflicting messages.
- ◆ While highlighting issues is important, **messaging**

that focuses on **benefits**, especially economic benefits, will likely be more effective.

- ◆ Establish institutional framework that ensures the continued coordination of this management Plan
- ◆ **Increase QCWA membership** to include diverse stakeholders and municipal officials.

Funding Opportunities:

- ◆ Partner collaboration (e.g. county planning departments and federations, state agencies, soil & water conservation districts, watershed groups, etc.)
- ◆ Grants



Photo 2: NYSDEC Trees for Tributaries riparian planting being completed by volunteers

Soil & Water
Conservation Districts



Project Partners:



Priority Action: SEPTIC MANAGEMENT/MAINTENANCE

Action Description:

High concentrations of nutrients are a common pollutant, causing water quality impairment throughout the Watershed, as documented by stream monitoring performed by the NYSDEC and the OCWA and by monitoring work performed at Orange Lake. Excess nutrients are detrimental to recreational waters and to the aquatic environment, because they cause excessive plant growth, algal blooms, and, in extreme cases, fish die-offs. Primary sources of nutrients include fertilizers, vegetation (grass cuttings, leaf litter), road salt, soil and dust, soaps/detergents, and animal waste (livestock, geese, dogs, etc.).

Management practices and good housekeeping techniques, including regular septic maintenance, proper disposal of yard and pet waste, and minimization of fertilizer application, can have a dramatic impact on nutrient levels. Strategic outreach to homeowners can help to better inform them of pollution-reducing behaviors.



Figure 1: An example of residential educational material available from the Environmental Protection Agency.

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
9-3	Inform and engage public on pollution-reducing behaviors (including tips for homeowners, impact of pet waste)	Protect Water Quality and Source Water, Manage Quantity, and Promote Watershed Awareness	\$	1+	Develop outreach materials; Incentivize participation to engage public
9-6	Develop program to encourage septic maintenance	Protect Water Quality and Source Water, Manage Quantity, and Promote Watershed Awareness	\$	1+	Identify incentive to engage public; Develop program
9-7	Develop a septic pump-out program for Orange Lake	Protect Water Quality and Source Water, Manage Quantity, and Promote Watershed Awareness	\$	1+	Identify incentive to engage public; Develop program

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: SEPTIC MANAGEMENT/MAINTENANCE

Action Considerations:

- ◆ **Enforce** maintenance of failing systems
- ◆ Encourage **participation** from land owners and municipalities
- ◆ Develop **incentives**, e.g. cost sharing programs, as will be necessary for maintenance program,.
- ◆ **Prioritize** program development along **impaired waterbodies**, e.g. Orange Lake, and drinking water reservoirs. Perhaps develop a pilot program to demonstrate success before rolling out to other areas.

Funding Opportunities:

- ◆ Bulk negotiations with a qualified professional
- ◆ Grants
- ◆ Establish a capital reserve fund
- ◆ Punitive fees
- ◆ Developer-paid fees

Potential Partners:



Photo 2: Periodic pump outs are required to ensure systems function properly.



Photo 3: Sewage fungus, shown above as green matter, is found in streams that are heavily impacted by wastewater.

Photo 1: Examples of failing septic systems, photo obtained from <http://www.eri.us.com>.



Quassaick Creek Watershed Management Plan

Priority Action: SOURCE WATER PROTECTION

Action Description:

Maintaining the integrity of drinking water supplies will require a comprehensive approach involving regulation and monitoring of land uses and activities, land conservation, and land management that maximizes treatment of stormwater and soil stabilization. All of the reservoirs in the Quassaick Creek Watershed span more than one municipality, emphasizing the need for intermunicipal cooperation. As described in Chapter 3 of the Watershed Plan, the Town of New Windsor adopted an overlay zone for streams within reservoir watersheds and the Town of Newburgh has a Reservoir Residential zone, but additional actions may be warranted to fully safeguard drinking water supplies.

Action Considerations:

- ◆ **Intermunicipal cooperation** needed for comprehensive protection
- ◆ **Updates to municipal plans and zoning codes** will likely be needed to locate and design future develop so as to protect water quality.

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
2-1	Identify and protect priority lands, wetlands, riparian buffers and other natural areas within reservoir subwatersheds	Protect Water Quality and Source Water, Manage Quantity, Enhance Natural Processes, Inter-municipal Implementation, Promote Watershed Awareness, and Create a Resilient Watershed	\$\$	1+	Identify and, where appropriate, protect priority lands
2-2	Track monitoring results of closed landfills in Washington Lake watershed	Protect Water Quality and Source Water, Manage Quantity, and Inter-municipal Implementation	\$	1+	Annually assess monitoring results
2-3	Develop/maintain intermunicipal agreements on source water protection	Protect Water Quality and Source Water, Manage Quantity, Inter-municipal Implementation, and Promote Watershed Awareness	\$	1+	Adopt intermunicipal agreement (s)
2-7	Encourage local regulatory measures for water resource protection, especially for drinking water, & stormwater reductions	Protect Water Quality and Source Water, Manage Quantity, Enhance Natural Processes, Inter-municipal Implementation, Promote Watershed Awareness, and Create a Resilient Watershed	\$	1+	Adopt protective zoning language in four (4) municipalities
8-1	Promote community involvement and education on changes in water resources and protecting water supply	Protect Water Quality and Source Water, Manage Quantity, Inter-municipal Implementation, Promote Watershed Awareness, and Create a Resilient Watershed	\$	2-5	Develop public education program

1+ = Year 1 2-5 = Year 2 to 5 6+ = Year 6 and beyond \$ = Under \$50,000 \$\$ = \$50,000 to \$250,000 \$\$\$ = \$250,000 +

Priority Action: SOURCE WATER PROTECTION

Funding Opportunities:

- ◆ County planning departments and planning federations (technical support)
- ◆ Land conservation organizations
- ◆ Transfer of Development Rights (TDR)
- ◆ Grants for various protective measures (e.g. stormwater retrofits, riparian plantings, zoning code updates, land conservation, etc)

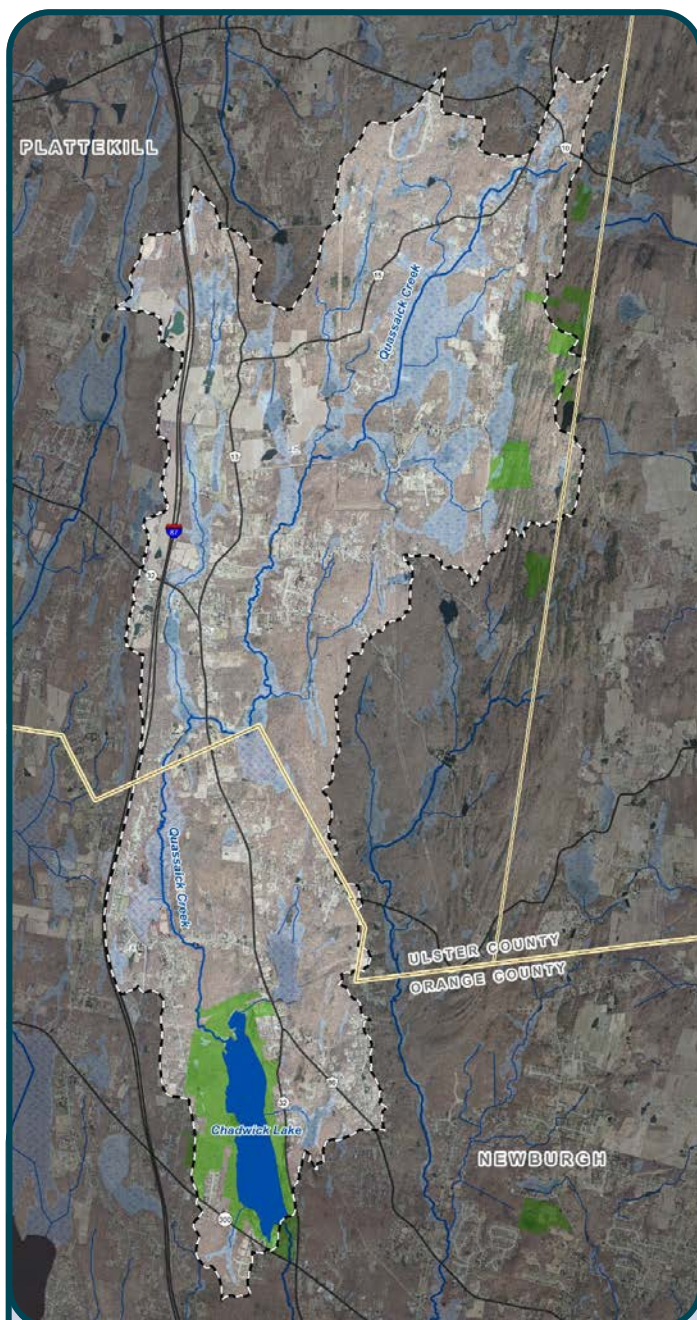


Figure 1: Aerial photograph/map of the Town of Newburgh's Chadwick Lake and its watershed.



Figure 2: Aerial photograph/map of the City of Newburgh's reservoir system, showing constructed connection of Brown's Pond to Washington Lake.



Potential Partners:

Quassaick Creek Watershed Management Plan

Priority Action: STREAM MONITORING

Action Description:

In its Priority Waterbodies List, the NYS Department of Environmental Conservation (NYSDEC) categorized the lower Quassaick Creek as having impaired aquatic life, recreation, and aesthetics due to combined sewer overflows (CSOs) and urban/stormwater runoff. The causes of impairment are listed as being nutrients and unknown toxicity. Additionally, stream biomonitoring data commissioned by Orange County have consistently classified the Creek as “moderately impacted” since 2006 at a site immediately upstream of the Creek’s confluence with the Hudson River. Other stream locations in the Watershed were determined to be slightly or moderately impacted in 2012 based on Orange County’s stream biomonitoring data.

More information is needed in order to identify and remediate specific causes of impairment and to better manage areas of the Watershed that are contributing pollutants to streams. The biomonitoring work that the NYSDEC and Orange County have been undertaking should also be continued in order to monitor for changes in water quality. Additional stream chemistry and pathogen data collected in the field would build an even richer database of stream characteristics and could help lead to identification of specific pollution sources as well as highlight public health hazards. Volunteers should be utilized whenever possible for cost-saving reasons, with the added benefit of promoting public awareness of the Quassaick Creek's water quality.

In addition to water quality concerns, portions of the Watershed are also subject to periodic flooding and to drought or dry streambed conditions. Strategic stream gage installations would lead to a better understanding of the Watershed’s hydrology and enable more informed planning and management decisions, thereby lessening the Watershed’s vulnerability to wet and dry conditions. Collecting baseline flow and water quality data can be used to evaluate patterns over time and pollutant loading rates. These are valuable data sets that can be used by resource managers to assess the success of management practices, like those outlined in the MS4 (Municipal Separates Storm Sewer System) Programs.

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestone
1-1	Establish a program for ongoing monitoring of various stream water quality parameters	Protect Water Quality and Source Water, Manage Quantity, Enhance Natural Processes, Promote Watershed Awareness, and Create a Resilient Watershed	\$	1+	Program established
1-2	Work with existing MS4s to inventory and address illicit discharges	Protect Water Quality and Source Water, Manage Quantity, Enhance Natural Processes, Promote Watershed Awareness, and Create a Resilient Watershed	\$	1+	Partnerships established and MS4 work completed
1-3	Collect nutrient loading baseline data during storm events	Protect Water Quality and Source Water, Manage Quantity, Create a Resilient Watershed.	\$	6+	Data collected and analyzed

1+ = Year 1 **2-5** = Year 2 to 5 **6+** = Year 6 and beyond **\$** = Under \$50,000 **\$\$** = \$50,000 to \$250,000 **\$\$\$** = \$250,000 +

Priority Action: STREAM MONITORING

Action Considerations:

- ◆ **Funding** needed for sample analysis and possibly for volunteer training.
- ◆ Stream gauges require regular **oversight and data management**.
- ◆ Some stream monitoring methods are dependent on appropriate **weather or field conditions**.

Funding/Training Opportunities:

- ◆ Grants
- ◆ Orange County Water Authority
- ◆ NYSDEC's WAVE program



Photo 1: Kick-net sampling by a citizen volunteer for macroinvertebrates.

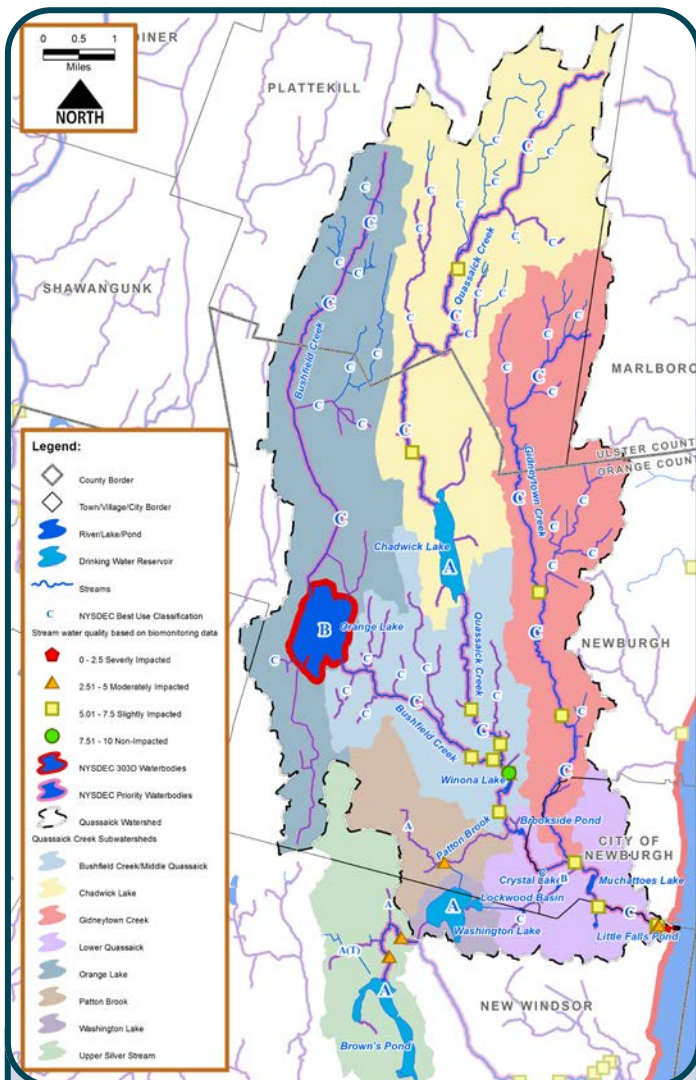


Figure 1: Stream biomonitoring results and waterbody classifications within the Quassaick Creek Watershed.



Photo 2: Example of a stream gauge that could be installed to gather data in support of developing a better understanding of the Watershed's hydrology.

Potential Partners:



Quassaick Creek Watershed Management Plan

Priority Action: WINONA LAKE REMEDIATION



Figure 1: Aerial view of Winona Lake spillway breach and affected area. Stream flow patterns after the breach have caused undercutting of the back side of the dam, streambank erosion that is encroaching upon a neighboring residence, and incision of the stream channel.

Action Description:

Based on observations from the Winona Lake Homeowner's Association and the Quassaick Creek Watershed Alliance, a small breach in the Winona Lake spillway was enlarged as a result of a large storm in 2007. This breach effectively drained Winona Lake down from nine (9) acres to 5.5 acres in size and created a flow pattern immediately after the spillway that has resulted in significant streambank erosion and incision of the stream channel. Although minor stabilization measures (e.g. armoring the toe of the bank, planting the bank with trees and shrubs) were undertaken during 2007-2010 to temporarily arrest the eroding bank, downstream bank erosion has significantly worsened since 2009. As of the summer of 2013, the dam is also being undercut. Downstream impacts of this erosion, such as stream and wetland siltation, are not yet known but should be evaluated.

As recommended by engineers of Stone Environmental, Inc and Milone & MacBroom, Inc in 2009, an assessment and remediation study should be prepared in order to fully evaluate the range of alternatives for Winona Lake and the Quassaick Creek reach that is immediately downstream. The study should evaluate the following alternatives: grade control of stream banks, channel stabilization, spillway and dam repair or replacement, additional dam breach to redirect stream flow, dam removal coupled with conversion of the Lake to wetland and stream corridor, and/or other sustainable options.

(Continued on next page)

Table 1: Management Recommendations

No.	Recommendation	Goals	Cost	Time	Milestones
6-1	Address streambank erosion and other downstream impacts of breached spillway at Winona Lake	Enhance Natural Processes, and Create a Resilient Watershed	\$-\$\$\$	2-5	Assessment Study (\$); Design and construct (\$\$\$)

1+ = Year 1

2-5 = Year 2 to 5

6+ = Year 6 and beyond

\$ = Under \$50,000

\$\$ = \$50,000 to \$250,000

\$\$\$ = \$250,000 +

Priority Action: WINONA LAKE REMEDIATION

As of the fall of 2013, the consensus of project partners is that the most sustainable and cost-effective solution is to both breach the dam to reroute the outflow of the Lake and perform stream restoration and streambank stabilization in the affected areas. Since such actions would further reduce the Lake's water level, additional grading or restoration work may be needed along the rear portions of some residential lots that border the Lake. Failure to take remedial action would mean the continuance and likely enhancement of the hazardous situation that currently exists. Some nearby and downstream properties would likely be negatively affected and damaged if the dam were to continue to destabilize. The financial implications associated with a dam failure could possibly exceed the cost of remedial actions.

Action Considerations:

- ◆ **Cost** of any work on dam (e.g. repair, removal, replacement) will be high due to engineering studies and the costs of permitting and construction.
- ◆ **Dam removal and stream reclamation may be unpopular** option by residents given that the Lake is an aesthetic focal point of the neighborhood and is used for recreation.
- ◆ No Emergency Action Plan is available (EAP is not required)
- ◆ Identifying **willing project sponsor** to oversee planning studies, design, & construction may be difficult.

Funding Opportunities:

- ◆ Fund-raising by Winona Lake Homeowners Association
- ◆ Grants: NYSDEC's Water Quality Improvement Program (WQIP)



Figure 2: Winona Lake in 2004, prior to 2007 breaching of dam's spillway, and in 2011. Images courtesy of Google Earth.



Photo 1: Streambank erosion along the down stream side of the Winona Lake dam, photo courtesy of Ted Kolhmann. Undercutting of the dam shown on the right.



OC Soil & Water
Conservation District



Winona Lake
Homeowners Association

Potential Partners:



APPENDIX E: RECOMMENDATIONS TABLE

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QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS														See final page of table for key to acronyms and symbols		
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.																
Recommendation	Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action	
	Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs		
Objective 1: Develop a more comprehensive understanding of surface water and groundwater quality and quantity, including sources of impairments, throughout watershed.																
1-1	Establish a program for ongoing monitoring of various stream water quality parameters	X	X		X	X	All	OCWA (professional sites), QCWA (volunteer sites), NYSDEC (state sites), schools	\$	1+	●	○	○	○	●	★
1-2	Work with existing MS4s to inventory and address illicit discharges	X	X	X	X	X	All	MS4s, QCWA	\$	1+	●	●	○	●	○	★
1-3	Identify a mechanism to remove Orange Lake from 303d List and/or recognize water quality improvements	X			X		Orange Lake	NYSDEC	\$-\$\$	6+	○	●	○	●	○	★
1-4	Develop system for monitoring and tracking groundwater quality	X			X		All	OCWA	\$-\$\$	2-5	●	●	○	○	●	
1-5	Collect and monitor water quality data at reservoirs and lakes	X			X		All	municipalities, OCWA, QCWA	\$	1+	●	○	○	○	●	

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS													See final page of table for key to acronyms and symbols			
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.																
Recommendation	Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action	
	Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs		
Objective 2: Promote water quality protection measures and watershed-friendly policies throughout the watershed																
2-1	Identify and protect priority lands, wetlands, riparian buffers and other natural areas within reservoir watersheds.	X	X	X	X	X	Chadwick Lake, Washington Lake, Silver Stream Reservoir	OCLT, municipalities	\$\$-\$\$\$	1+	●	●	○	●	●	★
2-2	Track monitoring results of closed landfills in Washington Lake watershed	X		X			Washington Lake	QCWA, Air National Guard, Town of New Windsor	\$	1+	●	○	○	○	●	★
2-3	Develop/maintain intermunicipal agreements on source water protection	X		X	X		Chadwick Lake, Washington Lake, Silver Stream Reservoir	OCPD, UCPD, municipalities	\$	2-5	○	●	○	●	●	★
2-4	Develop a watershed protection guide that can be adopted by municipalities	X		X	X	X	All	OCPD, UCPD, municipalities	\$	2-5	○	●	●	●	●	
2-5	Develop model codes for water resource protection and climate change resilience	X			X	X	All	OCPD, UCPD, municipalities	\$	2-5	○	●	●	●	○	★

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS													See final page of table for key to acronyms and symbols			
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.																
Recommendation		Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action
		Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
2-6	Recommend standards that incorporate adaptability to climate change for new construction	X		X	X	X	All	OCPD, UCPD, municipalities	\$	2-5	○	●	●	●	○	★
2-7	Encourage local regulatory measures for water resource protection, especially for drinking water, & stormwater reductions	X	X	X	X	X	All	OCPD, UCPD, municipalities	\$	2-5	○	●	●	●	○	★
2-8	Encourage appropriate planning and zoning in urban reaches of the stream corridor that improves the quality of life for people living near it				X		Lower Quassaick Creek	City of Newburgh	\$	2-5	○	●	●	●	○	★
2-9	Promote incentive billing for centralized water and sewer services to encourage conservation	X			X	X	All	water and sewer service providers	\$	2-5	○	●	○	●	●	

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS														See final page of table for key to acronyms and symbols	
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.															
Recommendation	Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action
	Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
2-10	Promote water conservation measures for all water users, both municipal customers and those on private wells	X			X	All	OCPD, UCPD, municipalities	\$	2-5	○	○	●	●	●	
Objective 3: Improve stormwater management, where appropriate, in order to reduce point and non-point source loadings															
3-1	Implement stormwater retrofits at identified sites and other appropriate locations	X		X	X	All	SWCD, QCWA	\$\$-\$\$\$	1+	●	●	●	○	●	
3-2	Incentivize stormwater management	X			X	All	municipalities	\$	2-5	○	○	○	○	●	
3-3	Continue to promote appropriate use of green infrastructure	X	X	X	X	All	OCPD, UCPD, SWCD, DEC's HREP, CCE, municipalities	\$\$	1+	●	○	●	○	●	
3-4	Reduce CSO events	X	X		X	Lower Quassaick	City of Newburgh	\$\$-\$\$\$	2+	○	●	●	○	●	
3-5	Increase maintenance of stormwater infrastructure, possibly through outreach and training of municipal officials, contractors, and landowners	X			X	All	municipalities	\$\$	6+	●	○	●	●	●	

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS												See final page of table for key to acronyms and symbols				
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.																
Recommendation		Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action
		Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
3-6	Update local codes to require regular inspections and reporting on stormwater infrastructure	X				X	All	municipalities	\$	2-5	○	●	○	●	●	
3-7	Prioritize regular cleanout of catch basins at Orange Lake	X	X			X	Orange Lake	Town of Newburgh	\$	1+	○	○	○	○	○	★
Objective 4. Protect, enhance and restore critical habitat for fish and wildlife																
4-1	Restore and protect riparian and wetland habitats	X	X	X	X	X	All	SWCD, QCWA, NOAA municipalities	\$-\$\$\$	1+	●	●	●	●	○	★
4-2	Protect critical open spaces and biological areas		X		X	X	All	OCLT, NOAA, municipalities	\$-\$\$\$	1+	●	●	○	○	●	★
4-3	Continue monitoring eel and river herring populations in lower Quassaick Creek		X	X	X		Lower Quassaick	DEC, QCWA, NOAA, schools	\$	1+	●	●	○	○	●	★
Objective 5. Reduce negative effects of hydraulic constrictions, including those created by bridges and culverts																

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS														See final page of table for key to acronyms and symbols	
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.															
Recommendation	Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action
	Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
5-1	Inventory hydraulic constrictions and document impacts, both positive and negative		X		X	All	QCWA, DEC's HREP, NOAA	\$	6+	●	○	●	●	○	
5-2	Resolve hydraulic constrictions, where appropriate, to reduce ponding and flooding		X		X	All	municipalities	\$\$	6+	●	●	●	●	●	
<i>Objective 6. Address impacts of problematic dams through repair, removal or other mitigation</i>															
6-1	Address streambank erosion and other downstream impacts of breached spillway at Winona Lake		X		X	Bushfield Creek, Middle Quassaick	Winona Lake Homeowners Assoc	\$\$\$	2-5	●	●	●	●	●	★
6-2	Address concerns at Holden Dam section of the Lower Quassaick Creek		X			Lower Quassaick	Dam owner, City of Newburgh	\$\$\$	6+	●	●	●	●	●	
6-3	Inventory dams; Identify candidates for removal, repair, fish/eel ladders, etc		X		X	All	QCWA, DEC's HREP, OCPD, NOAA	\$	2-5	●	○	○	●	○	
6-4	Remove/repair dams, where appropriate		X		X	All	QCWA, DEC's HREP, OCPD	\$\$\$	6+	●	●	●	●	●	
6-5	Maintain adequate stream flows below impoundments (dams)		X			All	municipalities	\$\$	6+	●	●	●	●	●	

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS														See final page of table for key to acronyms and symbols		
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.																
Recommendation	Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action	
	Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs		
Objective 7. Develop a mechanism for ongoing collaboration and maximize funding opportunities to advance Plan implementation																
7-1	Establish intermunicipal watershed group to implement this Plan			X			N/A	all partners	\$	1+	○	○	○	●	●	★
7-2	Develop workplans and progress memos to track implementation of this Plan			X			N/A	all partners	\$	1+	○	○	○	●	●	★
7-3	Identify funding opportunities to implement this Plan			X			N/A	all partners	\$	1+	○	○	○	○	●	★
7-4	Implement stormwater maintenance districts			X			All	municipalities	\$	2-5	○	●	○	●	●	★
Objective 8. Enhance awareness of and public access to the Creek and other waterbodies of the Watershed																
8-1	Promote community involvement and education on changes in water resources and protecting water supply	X		X	X	X	All	all partners	\$	2-5	●	○	○	●	●	★
8-2	Conduct regular stream and lake clean-ups	X	X	X	X	X	All	QCWA	\$	1+	●	○	○	●	●	★
8-3	Develop outreach and education program that is revisited on an annual basis	X		X	X		All	all partners	\$	1+	○	○	○	●	●	★

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS														See final page of table for key to acronyms and symbols	
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Recommendation	Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action
	Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
8-4	Increase public access to waterbodies, particularly in under-served areas				X	All	Counties, OCLT, municipalities+I63	\$\$	1	●	●	○	●	●	★
<i>Objective 9. Encourage watershed stakeholders to act in ways that are conducive to watershed protection</i>															
9-1	Promote municipal board awareness of existing regulations	X		X	X	All	OCPD, UCPD, municipal planning federations, municipalities	\$	1+	○	●	○	●	○	★
9-2	Create checklist and/or maps of sensitive areas for municipal boards	X		X	X	All	OCPD, UCPD, municipal planning federations, municipalities	\$	2-5	●	○	○	●	○	
9-3	Inform and engage public on pollution-reducing behaviors (including tips for homeowners, impact of pet waste)	X	X		X	All	OCPD, UCPD, municipal planning federations, municipalities	\$	2-5	○	●	○	●	●	★
9-4	Highlight stormwater retrofits and other BMP demonstration sites, as well as their impacts (e.g. before/after, cost/benefit)	X	X		X	All	SWCD	\$	2-5	●	●	●	○	●	★

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS													See final page of table for key to acronyms and symbols			
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Recommendation		Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action
		Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
9--5	Increase public awareness of potential climate change impacts on drinking water supplies	X			X	X	Chadwick Lake, Washington Lake, Silver Stream Reservoir	OCDOH, DEC's HREP, OCWA	\$	6+	○	○	○	●	●	★
9--6	Develop program to encourage septic maintenance	X			X		Chadwick Lake, Bushfield Creek	OCDOH, OCWA	\$	2-5	●	○	○	●	●	★
9--7	Develop a septic pump-out program for Orange Lake	X			X		Orange Lake	Orange Lake Civic Assoc.	\$	2-5	●	○	○	●	●	★
Objective 10. Appropriately manage water-related cultural resources, including historic and archaeological sites																
10-1	Develop Cultural Resource Management plan for Watershed				X		All	Historical Society of Newburgh Bay and the Highlands, municipalities	\$\$	6+	●	●	●	●	○	
10-2	Develop interpretive and educational plan for significant cultural resource sites, where appropriate				X		All	Historical Society of Newburgh Bay and the Highlands, municipalities	\$	2-5	●	○	○	●	●	
10-3	Perform focused archaeological survey of Lower Quassaick Creek				X		Lower Quassaick	City of Newburgh, Town of New Windsor, SHPO, Historical Society of Newburgh Bay and the Highlands	\$\$	6+	●	●	●	●	○	

QUASSAICK CREEK WATERSHED - MANAGEMENT RECOMMENDATIONS														See final page of table for key to acronyms and symbols	
Green cells in the first column indicate recommendations that are elaborated upon in Chapter 4 of the Watershed Plan.															
Recommendation	Goals					Target Sub-Watershed	Project Partners	Potential Cost	Implementation Timing	Project Considerations					Priority Action
	Protect Water Quality and Source Water, Manage Quantity	Enhance Natural Processes	Inter-municipal Implementation	Promote Watershed Awareness	Create a Resilient Watershed					Site Access	Regulatory	Infrastructure	Social Acceptance	Ongoing Resource Needs	
Objective 11. Identify opportunities for renewable energy sources, creative partnerships and pairing watershed management w/economic development															
11-1	Explore potential for Micro-hydro power on existing dams				X		All	dam owners	\$-\$	2-5	●	●	●	●	●
11-2	Utilize and revitalize watershed resources as focal areas for compatible commercial, residential, and/or community service uses.				X		All	developers, municipalities	\$	1+		●	●		
Objective 12. Identify areas, facilities, and infrastructure that are vulnerable to sea level rise and flooding															
12-1	Assess vulnerability of transportation systems to the combination of increased flows and rising sea levels (e.g. River Road bridge and adjacent RR bridge and tracks)				X	X	Lower Quassaick	City of Newburgh, NYSDOT	\$	2-5	●	○	●	○	○
12-2	Assess vulnerability of wastewater systems to storm surges and flooding	X			X	X	All	municipalities	\$	2-5	●	○	●	○	○

KEY TO ACRONYMS AND SYMBOLS

Acronyms found in this chart are defined as follows: CCE = Cornell Cooperative Extension; HREP = Hudson River Estuary Program; MS4 = Municipal Separate Storm Sewer Systems; NOAA = National Oceanic and Atmospheric Administration; (NYS)DEC = (New York State) Department of Environmental Conservation; NYSDOT = New York State Department of Transportation; OCDOH = Orange County Department of Health; OCLT = Orange County Land Trust; OCPD = Orange County Planning Department; OCWA = Orange County Water Authority; QCWA = Quassaick Creek Watershed Alliance; SHPO = State Historic Preservation Office; SWCD = Soil and Water Conservation District; UCPD = Ulster County Planning Department

● Symbol indicates that the recommendation is relevant to this project consideration

○ Symbol indicates that the recommendation is not relevant to this project consideration

★ Symbol indicates that the recommendation is a Priority Action for this Plan

X Symbol indicates that the recommendation furthers this watershed goal

\$-\$\$\$ Symbol indicates the cost of implementing the recommendation. \$ means the cost is expected to be under \$50,000; \$\$ means the cost should be between \$50,000 and \$250,000; and \$\$\$ means that the cost is expected to be greater than \$250,000.

1+, 2-5 6+ Number indicates when this recommendation should be implemented. 1+ means the recommendation should be implemented in Year 1; 2-5 indicates the recommendation should be implemented in Year 2 to Year 5, and 6+ means that the recommendation should be implemented in Year 6 or afterwards.

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APPENDIX F: GRANT OPPORTUNITIES

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Government Grant Opportunities - STATE GRANTS

Funding Agency	Grant Program	Program Description	Deadline	Website	Funding Type	Eligible Applicants	Eligible Uses
NYS Environmental Facilities Corporation	Clean Water State Revolving Loan Program	Provides low interest rate financing to municipalities for water pollution control projects including waste water treatment facilities, sewers, and non-point source projects such as salt storage facilities. In addition, the Green Project Reserve (GPR) requires all CWSRF programs to direct a portion of their grants toward projects that address green infrastructure, water efficiency, energy efficiency or other environmentally innovative activities.	rolling	http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm	Interest free short term loans with terms up to 3 years, and low-interest rate long term financing with terms up to 30 years.	Municipalities and public financing authorities in NYS	Projects that protect, maintain or improve water quality. Projects that are ready to proceed and score above the annual funding line are generally funded.
NYS Environmental Facilities Corporation	Clean Water State Revolving Fund Hardship Assistance	Funds municipal wastewater treatment projects where financial hardship exists.	rolling	http://www.nysefc.org/	Reduced interest rate financing as low as 0% with terms up to 30 years.	Municipalities with projects under \$14 million that serve residential areas.	To be eligible, total estimated annual sewer service charge must exceed a target service charge as determined by EFC based on Median Household Income (MHI.)
NYS Environmental Facilities Corporation and NYS Department of Health	Drinking Water State Revolving Loan Fund	Provides low interest rate financing for drinking water projects including upgrades, treatment facilities, storage facilities, transmission and consolidation of water supplies.	rolling	http://www.epa.gov/safewater/dwsrf.html	Interest free short term loans with terms up to 3 years, and low-interest rate long term financing with terms up to 30 years.	Community water systems, both public and privately owned, and non-community, non-profit projects.	Projects must have a public health benefit, and are scored and prioritized. Projects that are ready to proceed and score above an established funding line are generally funded.
NYS Environmental Facilities Corporation and NYS Department of Health	Drinking Water State Revolving Loan Fund Hardship Assistance	Provides interest free 20 year and up to 30 year financing and grants for projects previously described.	rolling	http://www.nysefc.org	Interest free 20 year and up to 30 year financing and grants of up to \$2 million or 75% of eligible costs, whichever is less.	Same as previously mentioned but only for projects less than \$14 million.	Grant money is only offered if community cannot achieve target user fee with a zero interest financing at 20 or 30 years. Communities above statewide average MHI are eligible for reduced interest rate financing, but not grants. To be eligible, total estimated annual water service charge must exceed a target service charge based on MHI. Project must score above the "funding line" in order to be funded.

Government Grant Opportunities - STATE GRANTS

Funding Agency	Grant Program	Program Description	Deadline	Website	Funding Type	Eligible Applicants	Eligible Uses
NYS Environmental Protection Fund-NYS DEC	Hudson River Estuary Program	The Estuary Program protects and improves the natural and scenic Hudson River watershed for all its residents. The program was created in 1987; its work focuses on the tidal Hudson and its adjacent watershed from the federal dam at Troy to upper New York harbor. Its core mission is to: Ensure clean water, protect and restore fish, wildlife and their habitats, provide water recreation and river access, adapt to climate change, and conserve scenery.	Last round of RFA's were due March-April 2013.	http://www.neiwpcc.org/contractors/opportunities.asp	Minimum grant award is \$5,000 and maximum is \$10,000, with a 50% local match.	Municipalities (counties, cities, towns or villages) and not-for-profit corporations with a 501 (c) (3) designation.	Eligible projects must implement one or more of the goals and targets identified in the 2010-2014 Hudson River Estuary Action Agenda.
NYS Department of State-EPF Funding-CFA	Local Waterfront Revitalization Program	Funds can be used to prepare, refine or implement Local Waterfront Improvement Plans.	There is no current EPF LWRP solicitation. Last round of applications were due July 2012.	http://www.dos.ny.gov/communitieswaterfronts/grantOpportunities/epf_lwrpGrants.html	50/50 matching program, no minimum or maximum awards	Any municipality located on State's designated inland waterway or a county that encompasses an eligible waterbody/waterway and is working in partnership with an eligible municipality.	Funding may be used for all aspects of the planning phase required to complete a Local Waterfront Implementation Plan. Implementation funding may include: project specific planning, feasibility, design, or marketing needed to implement an approved LWRP, construct projects necessary to implement an approved LWRP, develop systems for defining and measuring progress and success in community and waterfront revitalization, and develop regional, intermunicipal or local GIS to improve management of coastal areas and resources.
NYS DEC	Water Quality Improvement Program	NYS DEC supports water quality improvements through WQIP Statewide Grant Program. The WQIP program is a competitive reimbursement grant program that directs funds from the NYS EPF to projects that reduce polluted runoff, improve water quality and restore habitat in New York's waterbodies.	Last round was due December 2013	http://www.dec.ny.gov/pubs/4774.html	Depending on project, reimbursement is available up to 85% of total project cost.	Municipalities, Soil and Water Conservation Districts, Not for Profit Corporations	Five basic types of projects eligible for funding: Municipal Wastewater Treatment, Municipal Storm Sewer Systems, Nonagricultural Nonpoint Source Abatement and Control, Aquatic Habitat Restoration, Water Quality Management

Government Grant Opportunities - STATE GRANTS

Funding Agency	Grant Program	Program Description	Deadline	Website	Funding Type	Eligible Applicants	Eligible Uses
NYS Environmental Facilities Corporation-CFA	Clean Water State Revolving Fund (CWSRF) Engineering Planning Grant	EFC, in conjunction with DEC, offers a grant program for municipalities that need to construct or improve their municipal wastewater system.	Summer 2013	http://regionalcouncils.ny.gov/	Up to \$30,000 with a 20% local match required.	Municipalities with a population under 30,000 and with MHI equal or less than \$55,000.	The CWSRF Engineering Planning grant program will provide funding for the preparation of an engineering report and planning activities to determine the scope of water quality issues. Priority will be given to municipalities proposing projects required by an Order on Consent; required by a SPDES permit; to upgrade or replace an existing wastewater system; to construct a wastewater treatment and/or collection system for an unsewered area. Projects must be publically owned.
NYS Environmental Facilities Corporation-CFA	Green Innovation Grant Program	Funding for green stormwater infrastructure projects. All projects must meet or exceed standards set forth in the NYS Stormwater Management Design Manual.	Summer 2013	http://regionalcouncils.ny.gov/	TBD	Municipalities, state agencies, public benefit corporations, public authorities, not-for-profit corporations, for-profit corporations, individuals, firms, partnerships, associations, and soil and water conservation districts.	Projects must include at least one of the practices listed below in order to be considered eligible: Permeable pavement, bioretention, green roofs, street trees or urban forestry programs to manage stormwater, construction or restoration of wetlands, floodplains or riparian buffers, stream daylighting, downspout disconnection, or stormwater harvesting and reuse.
NYS Department of State	NYS Local Government Efficiency Grants (LGEG)	Local Government Efficiency grants may be used to develop plans for implementation or to implement projects that reduce municipal expenses and property taxes. Projects may range from the creation of a single service cooperative agreement or a complete reorganization of a service on a regional basis. Specific projects may include: the regionalization of water or wastewater infrastructure services.	Last round was due March 13, 2013	http://www.dos.ny.gov/lge/	Planning-\$25,000 for each local government participating, not to exceed \$200,00. Implementation-\$200,00 for each local government participating, not to exceed \$1 million.	Counties, towns, cities, villages, special improvement districts, water authorities and sewer authorities.	May be used to cover costs including, but not limited to, legal and consultant services, capital improvements and certain equipment purchases and transitional personnel costs that are integral to project implementation. Must promote development that meets the principles of "Smart Growth."

Government Grant Opportunities - FEDERAL GRANTS

Funding Agency	Grant Program	Program Description	Deadline	Website	Funding Type	Eligible Applicants	Eligible Uses
U.S. Department of Commerce	Economic Development Grants for Public Works and Development Facilities	The Economic Development Administration (EDA) provides grants to economically distressed areas for public works projects, including water and wastewater facilities.	Quarterly	http://www.grants.gov/search/search.do;jsessionid=knDpQzXGJ6gWnzy1h6Tn3D1fjKBK9Fw40vITDxWx3xrJGpLpCN4!-861966415?oppId=208353&mode=VIEW	EDA may award grants or cooperative agreements to eligible applicants to help support economic development activities.	States, cities, counties, and other political subdivisions	Projects must promote economic development; create long term jobs; and/or benefit low-income persons or the long-term unemployed. Projects must fill a pressing need of the area (i.e. help establish or expand industrial or commercial plants or facilities or help create long term employment.)
U.S. Department of Agriculture, Rural Utilities Service	Rural Utilities Service Water and Waste Disposal Program	Will fund almost anything related to getting water, wastewater, and solid waste systems up and running in small municipalities. For instance, funds may be used to install, repair, improve or expand rural or wastewater disposal facilities.	Rolling	http://www.usda.gov/rus/water/	The WWD program provides both loans and grants to rural communities (10,000 people or fewer) for drinking water, wastewater, solid waster, and storm drainage projects.	Municipalities, counties, districts, authorities, associations, cooperatives, nonprofit corps.	Will fund legal fees, engineering fees, capitalized interest, equipment, initial operation and maintenance costs, construction, land acquisition, project contingencies and related costs for completing the project.
U.S. Fish & Wildlife Service, Division of Bird Habitat Conservation	Standard Grants Program and Small Grants Program	Fish & Wildlife provides competitive, matching grants that support public-private partner projects in the U.S. that further the goals of the North American Wetlands Conservation Act. Projects involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats for the benefit of all wetlands associated migratory birds.	Standard Grants: March 1, 2013 and July 26, 2013; Small Grants: October 31, 2013	http://www.fws.gov/birdhabitat/grants/nawca/Standard/US/index.shtm	Standard grants up to \$1 million, Small grants up to \$75,000. Both require 1:1 match, non-federal.	Unrestricted	Eligible expenses include direct and indirect costs associated with long-tem migratory bird and wetlands conservation work including: acquisition, wetland restoration, wetland enhancement and wetland establishment.

Government Grant Opportunities - FEDERAL GRANTS

Funding Agency	Grant Program	Program Description	Deadline	Website	Funding Type	Eligible Applicants	Eligible Uses
U.S. Department of Housing and Urban Development	State Community Development Block Grant Program (CDBG)	The CDBG program provides loans and grants for community and economic development activities, wastewater and drinking water facilities, housing and public infrastructure projects.	Annual Competitive Round and Economic Development Open Round	http://www.nyshcr.org/AboutUs/Offices/CommunityRenewal/	Annual Round Competition: Grants up to \$400,000 for cities, towns and villages; \$600,000 for counties and joint applications. ED Open Round: \$100,000-\$750,000 (at \$15,000 per job created/retained)	Non-entitlement communities, units of local government with a population of less than \$50,000 and non-urban counties. The only Orange County municipalities eligible are Village of Kiryas Joel and City of Port Jervis. All other municipalities must apply through the Orange County Office of Community Development at: http://www.orangecountygov.com/content/124/620/default.aspx	Must benefit low and moderate income persons or help correct or prevent public health and safety problems, slums, or blight. There are three types of eligible projects: neighborhood revitalization projects that emphasize private housing rehabilitation; economic development projects that can expand employment and water, sewer and other public facilities projects that protect public health and reduce environmental risk.
U.S. Environmental Protection Agency (EPA)	Urban Waters Small Grants	The EPA will consider proposals for projects that will contribute to improved water quality in urban areas. The goal of the Urban Waters Small Grants is to fund research, studies, training and demonstration projects that will advance the restoration of urban waters by improving water quality through activities that also support community revitalization.	Last round was due December 16 2013	http://www.epa.gov/urbanwaters/funding	\$40,000-\$60,000 with a \$2,500 non federal required match.	States, local governments, public or private not-for-profits, interstate agencies, and public and private universities or colleges.	In general, projects should promote a comprehensive understanding of local water quality issues; identify and support activities that address these issues at the local level, engage, educate and empower communities surrounding the urban water body; and benefit surrounding communities, including those that have been adversely impacted by the water pollution issues affecting the urban water body.

Government Grant Opportunities - FEDERAL GRANTS

Funding Agency	Grant Program	Program Description	Deadline	Website	Funding Type	Eligible Applicants	Eligible Uses
U.S. Environmental Protection Agency (EPA)	Environmental Justice Small Grants Program	The EPA Small Grants program is designed to provide financial assistance to community based organizations to work on local solutions that address local environmental or public health issues. The program helps to build the capacity of communities and supports the creation of self-sustaining community based partnerships that address environmental and public health issues.	Last round was due January 7, 2013	www.epa.gov/environmentaljustice/grants/ej-smgrants.html	Up to \$30,000 per award.	Incorporated, non-profit, community based organizations.	The EPA's top seven priorities for funding are: reducing greenhouse gas emissions; improving air quality; managing chemical risks; cleaning up hazardous waste disposal sites; protecting America's water; expanding the conversation on environmentalism and working for environmental justice.

Government Grant Opportunities -FOUNDATIONS

Funding Agency	Grant Program	Program Description	Deadline	Website	Funding Type	Eligible Applicants	Eligible Uses
National Fish & Wildlife Foundation (in partnership with Environmental Protection Agency (EPA))	Five Star Restoration Program	Grants to support community-based wetland, riparian and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach and training activities.	Applications open late fall	http://www.nfwf.org/pages/grants/home.aspx	Competitive grants ranging from \$10,000-\$40,000, with a minimum 1:1 match required.	Any entity that can receive grants. Should partner with a state or federal agency, but the agency cannot be the lead applicant.	Five star projects include, but are not limited to, creating stream buffers to improve local water quality and habitat, building riverfronts, wetlands or coastal habitats for outdoor classrooms, ecotourism and recreation, restoring natural function and community value to native ecosystems by enhancing parks and natural areas, and empowering communities to support spaces for learning, recreation, and growth, while protecting vital resources.

