TIDAL RONDOUT CREEK
WATERSHED MANAGEMENT PLAN

October 2015
Revised July 2016








Prepared for:

City of Kingston
420 Broadway
Kingston, NY 12401

Prepared by:

Milone & MacBroom, Inc.
231 Main Street, Suite 102
New Paltz, NY 12561
(845) 633-8153
MMI #4766-01-5

THIS DOCUMENT WAS PREPARED FOR THE NEW YORK STATE DEPARTMENT OF STATE WITH FUNDS PROVIDED UNDER TITLE 11 OF THE ENVIRONMENTAL PROTECTION FUND.

MILONE & MACBROOM®

TABLE OF CONTENTS

Page

Executive Summary ES-1

1.0 INTRODUCTION AND PLANNING BACKGROUND

1.1 Introduction 1-1
1.2 Background 1-3
1.3 Overview of Watershed Management 1-4
1.4 Community Involvement 1-6
1.5 Vision, Goals, and Objectives 1-9

2.0 WATERSHED CHARACTERIZATION

2.1 Geographic Setting 2-1
2.2 Community Demographics 2-1
2.3 Subwatershed Delineations 2-4
2.4 Land Use 2-25
2.5 Geology and Soils 2-28
2.6 Stormwater 2-32
2.7 Hydrology and Flooding 2-34
2.8 Water Quality 2-36
2.9 Wetland Habitats and Natural Heritage Areas 2-43
2.10 Bureau of Fisheries Annual Report 2-43
2.11 Impervious Surfaces 2-45
2.12 Assessment of Critical Watershed Areas 2-46

3.0 KEY NONREGULATORY STUDIES, REPORTS, AND PLANS

3.1 Upstream Watershed Management Plans 3-1
3.2 Hazard Mitigation and Flood Mitigation Plans 3-5
3.3 Climate Action and Adaptation Plans 3-6

4.0 REGULATORY AND COMMUNITY PLANS AND POLICIES

4.1 Federal and State Policies and Regulations 4-1
4.2 County Plans and Policies 4-3
4.3 City of Kingston Plans, Policies, and Regulations 4-7
4.4 Town of Esopus Plans, Policies, and Regulations 4-17
4.5 Town of Ulster Plans, Policies, and Regulations 4-18

TABLE OF CONTENTS (Continued)

5.0 MANAGEMENT STRATEGIES

5.1 Stormwater Management Strategies 5-3
5.2 Sanitary Wastewater Strategies 5-13
5.3 Land Use Planning and Regulations 5-16
5.4 Tributary Stream Restoration 5-23
5.5 Flood Mitigation 5-26
5.6 Wetlands and Habitat Restoration 5-35
5.7 Monitoring 5-36
5.8 Education and Training 5-40
5.9 Consideration of Changing Conditions 5-41

6.0 ACTIONS AND IMPLEMENTATION

6.1 Summary of Goals, Objectives, and Actions 6-1
6.2 Implementation Strategy 6-4

7.0 REFERENCES 7-1

LIST OF TABLES

Table 1-1 Status of Rondout Creek Watershed Planning 1-1
Table 2-1 Populations of Watershed Municipalities 2-3
Table 2-2 Subwatershed Summary 2-5
Table 2-3 Permanently Protected Open Space 2-25
Table 2-4 Land Use by Subwatershed 2-26
Table 2-5 Water Quality Classes and Standards for Tidal Rondout Creek 2-37
Table 2-6 Riverkeeper Sampling Results 2-41
Table 2-7 Subwatershed Development and Road Density Summary 2-45
Table 2-8 Subwatershed Prioritization for Management 2-48
Table 5-1 Management Strategies for Goal #1 5-1
Table 5-2 Management Strategies for Goal #2 5-2
Table 5-3 Best Management Practices on Individual Sites 5-4
Table 5-4 Use and Limitation of Some Common BMPs 5-4
Table 6-1 Implementation Matrix 6-7

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

Figure 1-1 Status of Rondout Creek Watershed Planning 1-2
Figure 2-1 Location Map 2-2
Figure 2-2 Subwatershed Delineations 2-2
Figure 2-3 Bedrock Geology 2-29
Figure 2-4 Surficial Geology 2-30
Figure 2-5 Soil Types 2-31
Figure 2-6 FEMA Mapping 2-35
Figure 2-7 Existing Water Quality Monitoring Locations 2-39
Figure 2-8 Wetlands Map 2-43
Figure 4-1 Stormwater Outfalls 4-3
Figure 5-1 Areas Served by Sanitary Sewer Systems 5-16
Figure 5-2 Potential Water Quality Monitoring Locations 5-39

APPENDICES

Appendix A Project Advisory Committee
Appendix B Community Outreach Plan
Appendix C Results of Limited Survey
Appendix D Rondout Creek Peak Discharge Summary
Appendix E Subwatershed Priorities for Each Action
Appendix F Funding Sources
Appendix G *How's the Water 2015 – Fecal Contamination in the Hudson River and its Tributaries*

EXECUTIVE SUMMARY

The City of Kingston has completed a watershed management plan for the tidal section of Rondout Creek. This is the 3.6-mile section of the creek downstream of the dam at Eddyville that is influenced by the tidal cycle of the Hudson River. This 3.6-miles section represents 6% of the 63-mile length of Rondout Creek. Financial resources for this watershed management plan were provided through the New York State Department of State with funds provided under Title 11 of the Environmental Protection Fund.

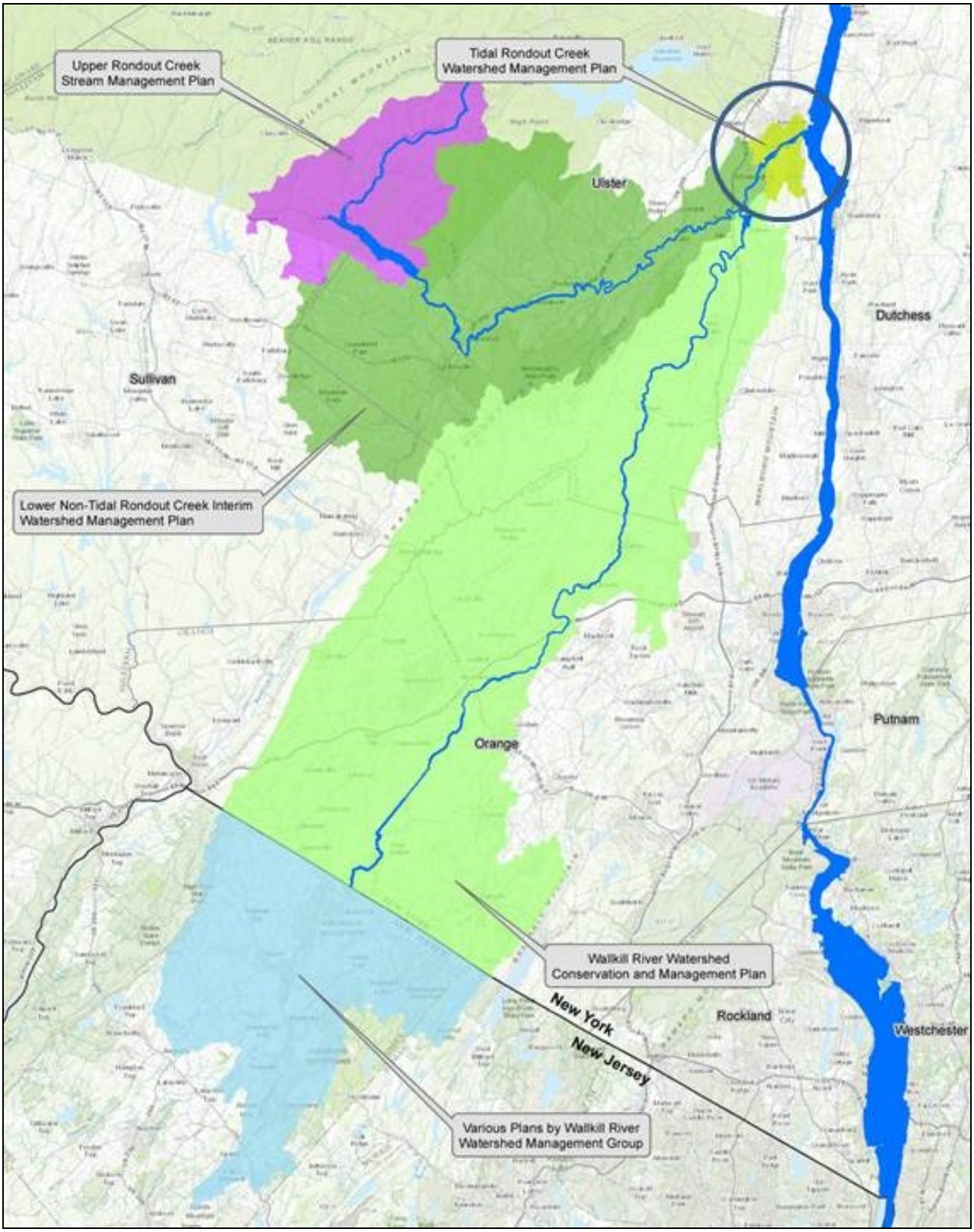
Rondout Creek is one of the largest tributary watersheds to the Hudson River, with an area of approximately 1,199 square miles. The watershed includes the entire Wallkill River subwatershed as well as Rondout Reservoir, which is part of the New York City water supply network. The headwaters of Rondout Creek begin in the town of Shandaken in the eastern Catskills. The river flows south into Rondout Reservoir then continues east and northeast until it reaches the Hudson River along the city of Kingston waterfront, pictured to the right. The image on the next page illustrates the entire watershed and identifies the planning activities in other portions of the watershed.

The 11-square-mile watershed of the *tidal* section of Rondout Creek consists of portions of the city of Kingston, town of Ulster, and town of Esopus. Although this watershed management plan addresses only 1% of the entire watershed of Rondout Creek, actions in these three communities may directly affect water quality in the tidal section of the creek. To help evaluate the sometimes subtle differences between issues in different parts of the watershed, the tidal watershed was divided into 17 subwatersheds. Eight of the subwatersheds are located along the north bank of the creek in Kingston and Ulster, and nine are located along the south bank of the creek in Esopus.

In order to educate the general public on the watershed planning effort, gain community support, and learn from the community, a Project Advisory Committee (PAC) was developed to guide the watershed planning effort. The PAC developed a public participation plan to encourage a meaningful dialog.

The Tidal Rondout Creek Watershed Management Plan is organized by the following series of chapters:

- ❑ Chapter 1.0 identifies the study area, project stakeholders, watershed vision, and project goals and objectives.
- ❑ Chapter 2.0 presents an inventory of existing conditions based upon available data and information, including the assessment of the watershed.
- ❑ Chapter 3.0 presents the key studies and plans that are most directly relevant to the subject plan.
- ❑ Chapter 4.0 provides a review of plans, policies, and regulations that affect the watershed.
- ❑ Chapter 5.0 describes potential management strategies for identified problems.
- ❑ Chapter 6.0 presents the findings and suggested actions for watershed management objectives.


Upper Rondout Creek
Stream Management Plan
Tidal Rondout Creek
Watershed Management Plan
Ulster
Dutchess
Sullivan
Lower Non-Tidal Rondout Creek Interim
Watershed Management Plan
Putnam
Orange
Wallkill River Watershed
Conservation and Management Plan
New York
New Jersey
Rockland
Westchester
Various Plans by Wallkill River
Watershed Management Group

The vision and goals of the watershed management plan were developed through a thorough public outreach process. The vision statement describes desired accomplishments, sets the tone of the watershed plan, and was used throughout the planning process. The vision statement was structured to translate into a set of goals and objectives.

THE VISION FOR THE TIDAL RONDOUT CREEK WATERSHED IS THAT IT BECOMES A HEALTHY, NATURALLY SUSTAINABLE STREAM SYSTEM SURROUNDED BY A VIBRANT WATERFRONT COMMUNITY.

Two goals were identified through the planning process to provide a framework for the suggested watershed management actions:

Goal #1

Restore tributary streams and subwatersheds to improve water quality.

This goal focuses on conditions along tributary streams and subwatersheds within the watershed communities of Kingston, Ulster, and Esopus.

Goal #2

Create a vibrant waterfront by improving water quality.

This goal focuses on the main stem of the tidal Rondout Creek abutting Kingston, Ulster, and Esopus.

Because the tributary streams and subwatersheds are directly connected to the main stem of the Tidal Rondout Creek, the two goals support the vision that the Tidal Rondout Creek watershed becomes a healthy, naturally sustainable stream system surrounded by a vibrant waterfront community. The following objectives were developed for each goal:

Goal #1 – Restore tributary streams and subwatersheds to improve water quality

- ❑ Restore tributary streams and enhance riparian vegetation along tributary streams.
- ❑ Reduce streambank and channel erosion along tributary streams.
- ❑ Prevent or minimize flood damage along tributary streams.
- ❑ Modify stormwater management in tributary subwatersheds.
- ❑ Manage land use and redevelopment in tributary subwatersheds.
- ❑ Manage disposal of sanitary wastewater in tributary subwatersheds.

Goal #2 – Create a vibrant waterfront by improving water quality

- ❑ Manage land use and redevelopment along the Kingston waterfront.
- ❑ Mitigate tidal flooding in the Kingston, Esopus, and Ulster waterfront areas.
- ❑ Reduce sewer overflows into Rondout Creek.
- ❑ Improve water quality classification of Rondout Creek from C to B.
- ❑ Increase training, education, and stewardship.

Rondout Creek is a Class C watercourse in its tidal section. According to NYSDEC, "the best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes."

One of the key findings of the watershed management planning process is that the tidal section of Rondout Creek is not listed on the Section 303(d) List of Impaired Waters. The City of Kingston's recently completed water quality study found that water quality parameters in Rondout Creek did not exceed the water quality standards set by the New York State Department of Environmental Conservation (NYSDEC). On the other hand, water quality monitoring results provided by Riverkeeper demonstrate that water quality in Rondout Creek stands to benefit from improvements in the watershed. These conclusions are not mutually exclusive nor do they directly contrast with the lack of Rondout Creek appearing on the list of impaired waters. The bottom line is that there is room for improvement in the water quality found in Rondout Creek.

Another key finding of the watershed management planning process is that flooding in the watershed communities has negatively impacted Rondout Creek whether it occurs (1) along tributary streams, (2) where streams are *not* present, or (3) directly from tidally influenced flooding of the creek. Consideration of floods is essential in the context of watershed planning because floods are a significant cause of water quality impairment. Floodwaters mobilize pollutants from developed land including petroleum products, chemicals, and sanitary wastewater. Floodwaters can disengage tanks, equipment, and vehicles and carry them downstream to sensitive watercourses. Reduction of flood damage is one of the most important aspects of protecting water quality.

Other important findings are related to stormwater runoff, combined sewer overflows, land use and development densities, and the condition of tributary streams. In many parts of the watershed, tributary streams are not visible because they have been relegated to stormwater systems and buried culverts. Ecological functions have been lost, and floodplains have been disconnected from these tributaries. All of these factors may contribute to water quality impairment.

In light of the vision, goals, objectives, and findings, the following management strategies were explored in the planning process:

- ❑ Stormwater management
- ❑ Sanitary wastewater management
- ❑ Land use planning and regulations
- ❑ Tributary stream restoration
- ❑ Flood mitigation
- ❑ Wetlands and habitat restoration
- ❑ Monitoring
- ❑ Education and training
- ❑ Consideration of changing conditions

Approximately 60 individual recommended actions were developed during the planning process, with a handful of actions stemming from consideration of each management strategy. Actions are listed in Table 6-1. Table 6-1 also presents suggested time frames, responsible parties, and funding sources. Appendix E identifies the priority subwatersheds for each action, whereas Table 6-1 identifies the *overall* high priority actions determined by the PAC. The following three projects have been identified as high priority projects for implementation:

225 Wilbur Avenue

Eroding streambanks, steep slopes, and sharp turns in the Twaalfskill Brook were identified in a section of the brook that runs parallel to Wilbur Avenue near address number 225. Signs of damage from erosion are evident upstream, downstream, and at this location. Streambanks and the stream channel can be stabilized using a number of techniques such as cross vanes in the channel and combinations of rocky and vegetated treatments in the streambanks. These channel and bank treatments must be designed to withstand water velocities and elevated stream power during high discharge events.

> From Objective #1.2, "Reduce streambank and channel erosion along tributary streams," the actions identified are (1) stabilize eroding banks along watercourses in Kingston, Ulster, and Esopus using natural, bioengineered, and hybrid gray/green bank treatments and (2) address downcutting and channel erosion on a case-by-case basis with cross vanes and other base level control techniques.

Tannery Brook parallel to Linderman Avenue beginning at Twin Ponds Drive

Objective #1.3, "Prevent or minimize flood damage along tributary streams" was identified as a high priority objective for the neighborhood bordered by Twin Ponds Drive to the southwest and Washington Avenue to the northeast. Beginning near Twin Ponds Drive, Tannery Brook flows roughly parallel to Linderman Avenue and crosses Loughran Court, Navara Street, and Hewitt Place, approximately 200 feet from the start of each side street. Tannery Brook then becomes piped and

buried and is no longer visible. There has been a great deal of nuisance flooding in this neighborhood. Clogged and undersized culverts were observed along this stream segment as well as natural debris and man-made structures that span or are in the tributary and pose a threat during storm events.

Under Objective #1.3, the following action items could greatly improve conditions within this area:

a. Reconnect tributary streams to their floodplains by pursuing all the actions suggested above (daylighting streams, replacing walls with naturalized streambanks, and stabilizing banks) and by removing berms and any other obstructions
b. Enhance existing floodplains and construct floodplain benches to accommodate floodwaters and provide space for debris flowing downstream in floods
c. Increase bridge and culvert capacities to allow conveyance of floodwaters while minimizing debris clogs
d. Remove outbuildings, tanks, and stored materials from stream corridors

In the short term, option c. in the text box to the left may be most easily implemented as it would require a lesser acreage of disturbance and involve fewer property owners. Option d. may also be relatively easy to implement, whereas options a. and b. will require working with property owners and securing easements for floodplain projects.

Green Infrastructure along 9W Bypass

From Objective #1.4, "Modify stormwater management in tributary subwatershed," action "i. to incorporate green infrastructure and improved stormwater management at and along the Route 9W bypass," has been identified as a high priority action item. This section of 9W is largely void of green infrastructure. The addition of green infrastructure features such as vegetated swales and increased stormwater retention would aid in the management of stormwater from this area. Reducing stormwater runoff would then help reduce nonpoint source pollution and lower the frequency of combined sewer overflows.

Typical Definitions of Green Infrastructure (GI)

EPA: Green stormwater infrastructure includes a wide array of practices at multiple scales that manage wet weather and maintain and restore natural hydrology by infiltrating, evapotranspiring, harvesting, and using stormwater…. On the local scale, green infrastructure consists of site- and neighborhood-specific practices, such as bioretention, trees, green roofs, permeable pavements and cisterns.

American Rivers: GI is an approach to water management that protects, restores, or mimics the natural water cycle…. GI incorporates both the natural environment and engineered systems to provide clean water, conserve ecosystem values and functions, and provide a wide array of benefits to people and wildlife…. On the local level, GI practices include rain gardens, permeable pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting systems.

The Nature Conservancy: GI solutions are planned and managed natural and semi-natural systems which can provide more categories of benefits, when compared to traditional gray infrastructure. GI solutions can enhance or even replace a functionality that is traditionally provided by man-made structures…. GI solutions employ ecosystem services to create more resource efficient systems involving water, air and land use.

1.0 INTRODUCTION AND PLANNING BACKGROUND

1.1 Introduction

In recognition of the importance of water quality on the high quality of life enjoyed in the Kingston area, the City of Kingston commissioned the preparation of a watershed management plan for the tidal section of Rondout Creek. This is the section of the creek downstream of the dam at Eddyville. Milone & MacBroom, Inc. (MMI) was retained to work with the project partners to develop the subject watershed management plan. Resources were provided through the New York State Department of State from 2013 through 2015, with funds provided under Title 11 of the Environmental Protection Fund.

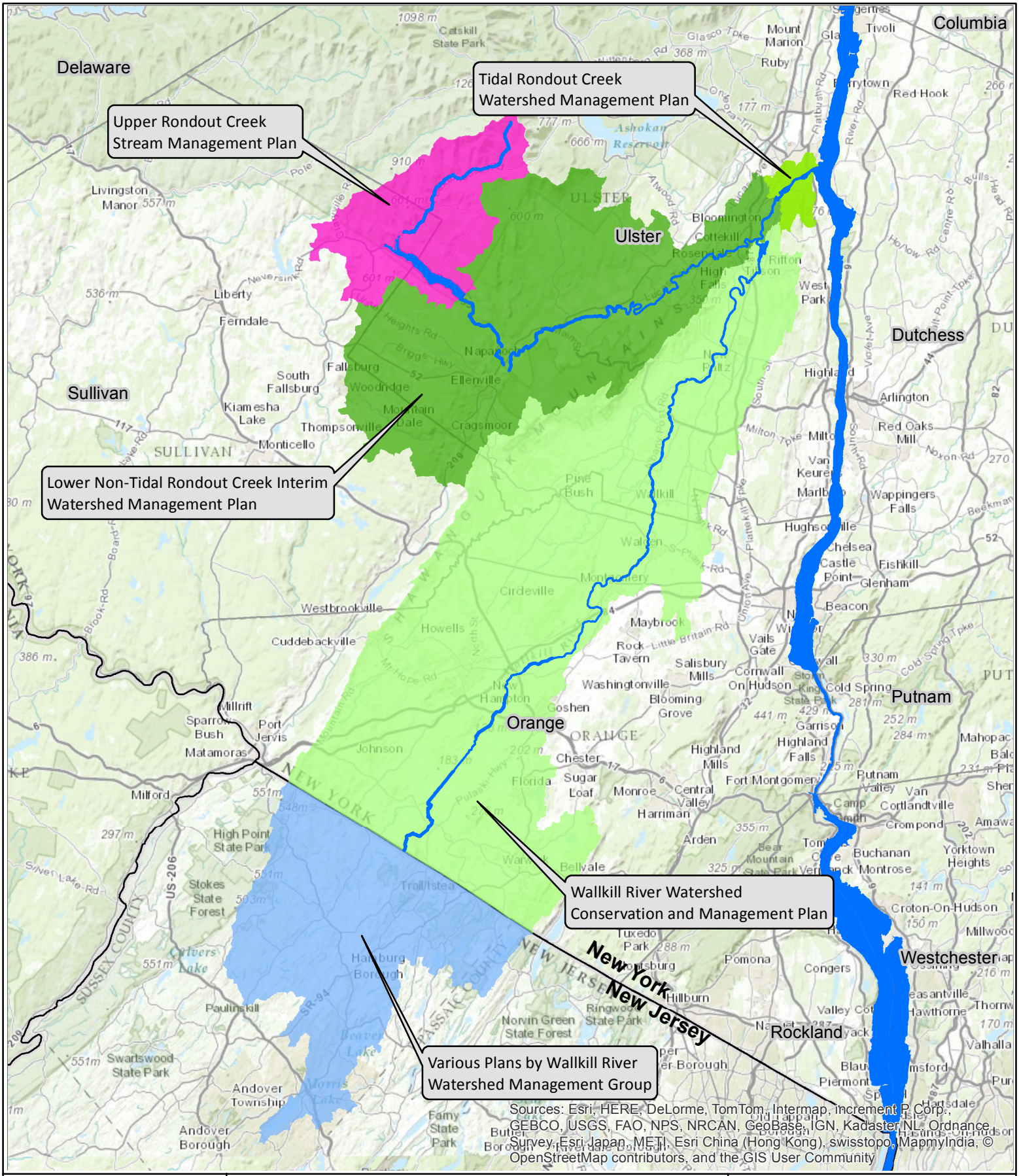
Rondout Creek is one of the largest tributary watersheds to the Hudson River, with an area of approximately 1,199 square miles. The watershed includes the entire Wallkill River subwatershed as well as Rondout Reservoir, which is part of the New York City water supply network. The headwaters of Rondout Creek begin in the town of Shandaken in the eastern Catskills. The river flows south into Rondout Reservoir then continues east and northeast until it reaches the Hudson River along the city of Kingston waterfront, pictured to the right. The watershed of the tidal section of Rondout Creek consists of portions of the city of Kingston, town of Ulster, and town of Esopus.

For watershed planning purposes, the Rondout Creek watershed has been divided into the five separate planning units listed in Table 1-1 and depicted on Figure 1-1. Planning is either underway or complete for all five sections of the watershed.

TABLE 1-1
Status of Rondout Creek Watershed Planning*

Subwatershed	Area (mi^2)	Plan Name or Status
Upper Rondout Creek	95.1	*Upper Rondout Creek Stream Management Plan* (2010)
Lower Nontidal Rondout Creek	309.9	*An Interim Watershed Management Plan for the Lower Nontidal Portion of Rondout Creek* (2010)
Tidal Rondout Creek	11.3	**This watershed management plan**
Wallkill River (New York)	574.1	*Wallkill River Watershed Conservation and Management Plan* (2007)
Wallkill River (New Jersey)	208.4	Various reports and studies prepared by the Wallkill River Watershed Management Group (2008-present)

*Refer to Chapter 3 for detailed descriptions of other planning efforts.



SOURCE(S):
ESRI Topographic Basemap

Figure 1-1: Status of Watershed Planning

LOCATION:
Ulster County, NY

N

Tidal Rondout Creek
Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\Status of Watershed Planning_update.mxd

Map By: CMP
MMI#: 4766-01
Original: 1/15/2013
Revision: 12/19/2016
Scale: 1 inch = 43,796.04 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

With its 11 square miles, the watershed of the tidal portion of Rondout Creek *is only 1% of the entire Rondout Creek-Wallkill River watershed.* The quality of water in the tidal portion of Rondout Creek is affected by activities throughout the 1,199-square-mile watershed stretching from New Jersey to the Catskills and to the Hudson River. The numerous watershed communities collaborate to maintain good water quality and improve it where possible. The City of Kingston, Town of Ulster, and Town of Esopus recognize the unique opportunity to focus on the lands that drain *directly* to the tidal portion of the creek, thereby contributing to improved water quality.

Photo courtesy of the Papakating Creek Watershed Restoration Plan, NJ

1.2 Background

Rondout Creek is a 63-mile tributary to the Hudson River. The river and its watershed can be generally divided into three consecutive sections and their associated watersheds: the upper river, the lower nontidal river, and the tidal creek. The headwaters begin in the town of Shandaken in the eastern Catskills and flow south toward the Rondout Reservoir, which is part of the New York City water supply network. The Wallkill River joins Rondout Creek's lower nontidal section as both rivers are flowing north-northeast toward the Hudson River. While the Wallkill River's watershed is a part of the Rondout Creek watershed, it is often treated as a separate functional unit for planning purposes.

The New York City Department of Environmental Protection (NYCDEP) and the Rondout Neversink Stream Management Program developed the *Upper Rondout Creek Stream Management Plan* in 2010 for the protection of water quality for the subwatersheds that drain into the reservoir. A photograph of the creek is provided to the left, courtesy of that management plan.

The river reach from the reservoir to the Eddyville Dam is considered the lower nontidal portion of Rondout Creek. The Rondout Creek Watershed Council (RCWC), formed in 2007, was created to collaborate with the municipalities along the nontidal portion of the creek and developed an *Interim Watershed Management Plan* in 2010. That plan focuses on water quality and quality of life in this section of the watershed and terminates its study area at the Eddyville Dam.

The third section of the watershed is the tidal portion and is the focus of this watershed management plan. The tidal portion of Rondout Creek begins at the Eddyville Dam and flows in a northeasterly direction for approximately 3.6 miles until it reaches the Hudson River at Kingston.

Rondout Creek is economically and historically significant to the City of Kinston as well as the surrounding communities of Esopus and Ulster because it is the epicenter of the waterfront district. The waterfront district includes museums, marinas, retail ventures, and industrial facilities that are significant to the financial stability of the communities. It is also a mecca for fishing and recreational opportunities such as rowing and kayaking.

In recent years as our rivers and streams have been improved and our appreciation for water resources has grown, a greater awareness has evolved of where and when water quality can be further improved. The tidal section of Rondout Creek is an example. Despite its absence from state-impaired water lists, the creek is a Class C watercourse. These two facts are not incongruous. According to NYSDEC, "the best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes." Stormwater runoff, sewer overflows, and flood events have all caused temporary but persistent impairments to water quality.

In an effort to protect and improve the water quality within the tidal Rondout Creek watershed, the City of Kingston identified the need for a watershed management plan that includes a multijurisdiction approach to watershed planning. Protection and enhancement of water quality within the watershed will improve the quality of life for residents and businesses in the adjacent communities of Ulster and Esopus while helping the City of Kingston meet its goals of maintaining good water quality in its watershed.

Therefore, the overall goal of this plan is to set a framework for the protection and restoration of the tidal portion of Rondout Creek. As such, this management plan addresses strategies associated with stormwater management, land management, point and nonpoint source pollution prevention, and stream and wetland habitat protection. These strategies have one important common goal and intended outcome, which is to identify potential water quality impairments and implement measures to improve the overall water quality within the watershed.

1.3 Overview of Watershed Management

The term "watershed" refers to the area surrounded by high spots, or divides, from which water drains or flows downhill to or past an end point. Surface water movement through a watershed

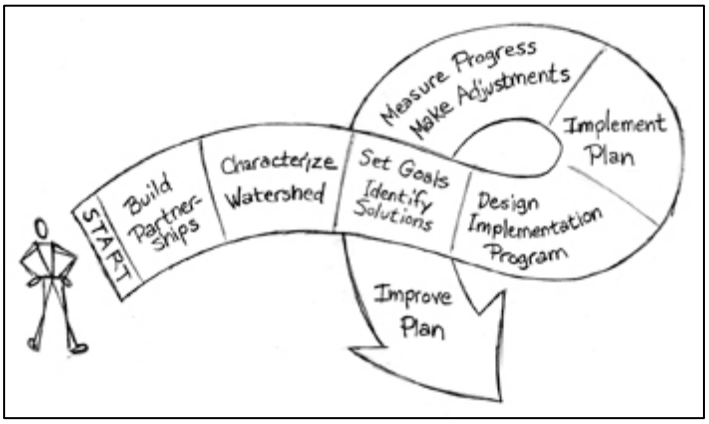
begins with runoff flowing downhill as sheet flow, collection in small rivulets, and joining of small streams. These small streams receive additional runoff downstream and groundwater discharge, eventually merging and forming larger watercourses.

Watersheds are geographic features and therefore do not reflect political boundaries. Effective watershed protection involves a multifaceted approach that encompasses past, present, and future land use; stream and wetland buffers; responsible development through adequate site selection, design, and maintenance; stormwater best management practices; control of nonstormwater discharges; control of destructive and unnatural erosion and sedimentation; and watershed stewardship programs that have the ability to span corporate boundaries and governmental divides.

The process of watershed management typically includes tasks such as:

- ❑ identification of the study area
- ❑ identification and notification of interested individuals, organizations, and public agencies
- ❑ establishment of an advisory or coordinating committee
- ❑ collection of existing data and evaluation of existing natural and cultural features
- ❑ collection of new data as needed
- ❑ identification of watershed and stream issues and problems
- ❑ identification of highest priority issues
- ❑ identification of vision, mission, and/or goals
- ❑ evaluation of alternative solutions to problems
- ❑ research of funding sources and needed regulatory programs
- ❑ development of suggested strategies
- ❑ adoption of a management plan
- ❑ implementation of the plan

Watershed management planning is meant to be iterative, with opportunities for revisiting and improving the management plan after periodic measurements or monitoring to gauge its success. This cyclical pattern is represented by the graphic to the right, courtesy of the U.S. EPA.



Existing resources and materials were used to gather information for the Tidal Rondout Creek Watershed Management Plan, and a list of these resources can be found in the references section. The Tidal Rondout Creek Watershed Management Plan is organized by the following series of chapters:

- ❑ Chapter 1.0 identifies the study area, project stakeholders, watershed vision, and project goals and objectives.

- ❑ Chapter 2.0 presents an inventory of existing conditions based upon available data and information, including the assessment of the watershed.
- ❑ Chapter 3.0 presents the key studies and plans that are most directly relevant to the subject plan.
- ❑ Chapter 4.0 provides a review of plans, policies, and regulations that affect the watershed.
- ❑ Chapter 5.0 describes potential management strategies for identified problems.
- ❑ Chapter 6.0 presents the findings and suggested actions for watershed management objectives.

1.4 Community Involvement

Community stakeholder and public participation is vital to the preparation of a successful watershed management plan. In order to educate the general public on the watershed planning effort, gain community support, and learn from the community, a Project Advisory Committee (PAC) was developed to guide the planning effort. The PAC developed a public participation plan to encourage a meaningful dialog.

Project Advisory Committee

A PAC was convened for the Tidal Rondout Creek Watershed Management Plan process, with representatives from local, county, and state government as well as watershed residents with an interest in maintaining high water quality and ecological health in the Tidal Rondout Creek watershed.

The role of the PAC was to ensure that the watershed management plan development process and the policy recommendations contained therein are clear and appropriate and that as diverse an audience as possible was engaged in developing the plan and its recommendations. Appendix A lists the PAC members and their respective affiliations.

Public Outreach

Appendix B contains a copy of the Community Outreach Plan developed for the watershed planning process. The general guiding principles for public outreach as part of the Tidal Rondout Creek Watershed Management Plan included the following:

- ❑ Opportunity for involvement – Provide multiple opportunities for residents, key stakeholders, government officials, and other impacted parties to participate in the development of specific action steps that will result in better management of the watershed.
- ❑ Involve a broad base of participants – Have an outreach program that is designed to draw in the broadest base of participants as possible while still maintaining a manageable and timely planning process.
- ❑ Convenience and accessibility – Provide avenues of participation that are convenient for a diverse set of stakeholders and accessible to participants of varied means. Achieving this goal requires a mix of opportunities for engagement, from standard public meetings to social media to other means of participation.

- Logical progression – The public outreach program presented the issues facing the watershed, such as flooding and erosion, with supportive data, evidence, and identified potential impacts before offering solutions to these issues. One of the underlying goals of any public outreach campaign was education such that participants were given the opportunity to learn and understand as much as possible about the underlying issues affecting their watershed before they proceed to evaluate potential solutions to these issues.
- Realistic expectations – The goals of the public outreach campaign were as specific as possible so that they could be realistically addressed within a reasonable time frame.
- Target audience – The target audience included all residents of Kingston, Ulster, and Esopus, particularly property owners located in the watershed; business owners, particularly those with businesses located in the watershed; and public agencies and municipal officials. Their understanding of the issues and potential and appropriate remediation/mitigation measures was critical.

With reference to the Community Outreach Plan in Appendix B, the public outreach and participation program for the Tidal Rondout Creek Watershed Management Plan had at its cornerstone several PAC meetings/workshops and three public outreach workshops. Each of these "events" is described in greater detail below in terms of logistics, scheduling, and desired outcomes. These meetings were supplemented by informal communications and additional meetings as needed.

- Event 1 – PAC Meeting/Workshop: The initial PAC meeting took place on January 30, 2013. The purpose was to allow the project team to introduce themselves and to discuss the mechanisms and logistics of developing the plan, generate public involvement, and create implementation strategies.

- Event 2 – PAC Meeting/Workshop: This meeting of April 4, 2013 served to provide a progress report on the development of the plan. Discussion topics focused on reviewing proposed recommendations in light of the previously completed characterization and analysis tasks. The outcome of this meeting included a general consensus on the potential management practices, approaches, and strategies for watershed protection, restoration, and flood damage prevention for the watershed management area, with prioritization of these elements being key.

- Event 3 – Public Outreach Workshop: The first public outreach workshop took place on April 4, 2013 to discuss the watershed management planning efforts and address the concerns of the residents. The goals of this workshop can be best summarized as "introduce," "characterize," and "identify." The "introduce" segment involved an educational component on what is and is not encompassed in watershed management planning as well as an introduction of the project team from MMI and the PAC.

  The "characterize" component involved describing the watershed in terms of its different characteristics such as watershed boundaries, land use and development patterns, infrastructure, and water quality. The "identify" component involved soliciting and defining general goals and expectations from meeting participants, developing a framework of both

the overall "global" issues impacting the watershed (e.g., land development in the floodplain) and more specific issues impacting the watershed at select points (e.g., if a poorly managed farm led to the runoff of manure and agricultural waste products into a water resource).

During this meeting, a survey was distributed to address priority issues and ideal outcomes for the watershed as viewed by attendees. The survey was meant to be completed by the attendees rather than be cast via a wide net to solicit comments from outside the meeting. As such, it was a partial window into concerns for the watershed. The results of the survey are included in Appendix C. The results of the survey showed that stormwater runoff, sanitary sewer inflows and overflows, and water quality within the creek were the main concerns.

Consequently, the highest-ranked ideal outcomes were (1) improved water quality in the creek, (2) pollution prevention, (3) improved stormwater management, and (4) flood mitigation and protection. Future development management, habitat protection and training, education, and stewardship were also ranked relatively highly. Based on the results, it was clear that the respondents were very concerned with ensuring that water quality concerns are addressed in the watershed management plan.

Ecological habitats and land use practices are often important issues in watershed management plans. Although ranked lower than water quality and stormwater management, this plan addresses these important and interrelated issues.

- Event 4 – PAC Meeting/Workshop: This meeting of July 8, 2014 served to provide a progress report on the development of the plan. Chapters 1.0 through 4.0 were reviewed, and comments were received from the PAC.

- Event 5 – Public Outreach Workshop: In contrast to the goals of the first public outreach workshop in Event 3, the goals of the public outreach workshop on August 26, 2014 could be described as "present, summarize, and respond." The "present" component involved an overview of the entire project and the process from the initial PAC meeting through all public outreach efforts to the compilation of the final draft product. The "summarize" component involved a discussion of the plan's objectives, findings, conclusions, and action items. Clarifying how the plan will be implemented in the future was also part of this discussion. Finally, the "respond" component involved gathering feedback from the workshop participants.

- Event 6 – PAC Meeting/Workshop: This meeting served to provide a progress report on the development of the plan. Discussion topics focused on reviewing proposed actions in light

of the previously completed characterization and analysis tasks. The outcome of this meeting included a general consensus on the potential management practices, approaches, and strategies for watershed protection, restoration, and flood damage prevention for the watershed management area, with prioritization of these elements being key.

- Event 7 – Public Outreach Workshop: The goals of the third and final public outreach workshop held on October 22, 2015 were to present the draft watershed management plan and solicit input from the public. A written summary of public input was prepared and input was incorporated into the final plan.

1.5 Vision, Goals, and Objectives

The vision and goals of the watershed management plan were developed through the thorough and effective public outreach process described above. A vision statement clearly describes desired accomplishments, sets the tone of the watershed plan, and is used throughout the planning process all the way through implementation. It should look to the future, motivate partners and the community, and bring together assets and resources. Creating a vision involves taking a critical look at the watershed's unique characteristics and thinking about future goals. The vision statement was written in a way that can be easily translated into a set of goals and objectives[1].

THE VISION FOR THE TIDAL RONDOUT CREEK WATERSHED IS THAT IT BECOMES A HEALTHY NATURALLY SUSTAINABLE STREAM SYSTEM SURROUNDED BY A VIBRANT WATERFRONT COMMUNITY.

The following expectations were developed for the Tidal Rondout Creek watershed:

- Encourage a continued multijurisdictional approach to watershed management.
- Develop management measures to improve and restore water quality.
- Adopt/amend local legislation to be compatible with sound watershed management principles.
- Focus on responsible development through adequate site selection, design, and maintenance.
- Promote watershed education and awareness.

With the watershed vision in mind and in consideration of the expectations listed above, two goals were identified through this planning process to provide a framework for suggested watershed management actions:

[1] Watershed Plans: Protecting and Restoring Water Quality, NYSDOS, 2009

Goal #1

Restore tributary streams and subwatersheds to improve water quality.

This goal focuses on conditions along tributary streams and subwatersheds within the watershed communities of Kingston, Ulster, and Esopus.

Goal #2

Create a vibrant waterfront by improving water quality.

This goal focuses on the main stem of the tidal Rondout Creek abutting Kingston, Ulster, and Esopus.

Because the tributary streams and subwatersheds are directly connected to the main stem of the Tidal Rondout Creek, the two goals support the vision that the Tidal Rondout Creek watershed becomes a healthy naturally sustainable stream system surrounded by a vibrant waterfront community. The following objectives were developed for each goal:

Goal #1 – Restore tributary streams and subwatersheds to improve water quality

- ❑ Restore tributary streams and enhance riparian vegetation along tributary streams.
- ❑ Reduce streambank and channel erosion along tributary streams.
- ❑ Prevent or minimize flood damage along tributary streams.
- ❑ Modify stormwater management in tributary subwatersheds.
- ❑ Manage land use and redevelopment in tributary subwatersheds.
- ❑ Manage disposal of sanitary wastewater in tributary subwatersheds.

Goal #2 – Create a vibrant waterfront by improving water quality

- ❑ Manage land use and redevelopment along the Kingston waterfront.
- ❑ Mitigate tidal flooding in the Kingston, Esopus, and Ulster waterfront areas.
- ❑ Reduce sewer overflows into Rondout Creek.
- ❑ Improve water quality classification of Rondout Creek from C to B.
- ❑ Increase training, education, and stewardship.

These objectives will be discussed throughout the plan, including rationales for their designations as objectives.

2.0 WATERSHED CHARACTERIZATION

A basic understanding of a watershed is an essential beginning to developing a sound management plan. A description of the Tidal Rondout Creek watershed is provided in this section. The information contained in the following sections is based on published documents, information provided by PAC members, and direct observations by MMI.

2.1 Geographic Setting

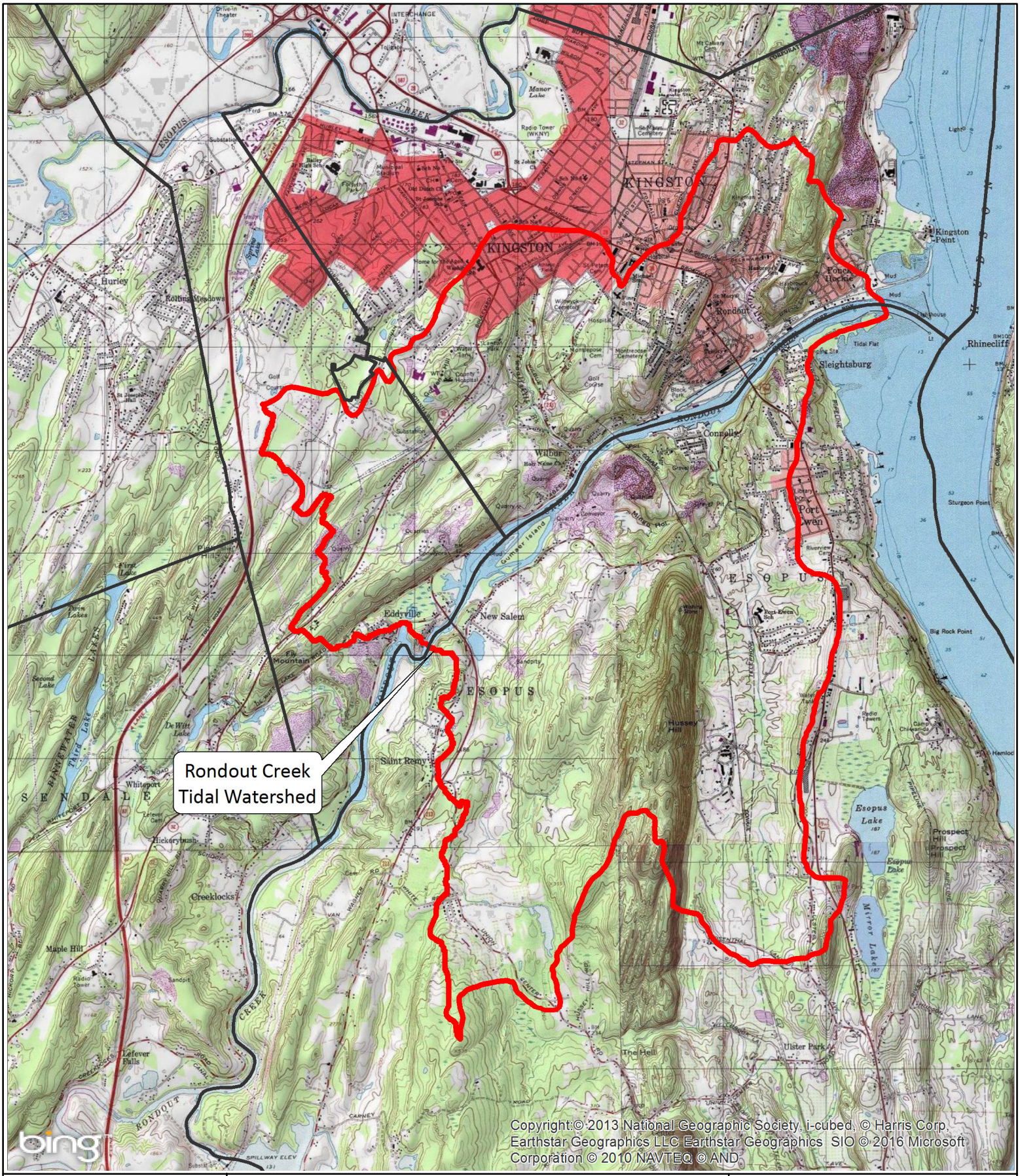
Figure 2-1 shows the Tidal Rondout Creek watershed on a topographic base map with municipal boundaries visible. The upstream (western) edge of the watershed is constrained by the dam at Eddyville, whereas the eastern edge of the watershed is bounded by lands that drain directly to the Hudson River. The watershed is generally split in half by the tidally influenced main stem of Rondout Creek although the portion of the watershed south of the creek in the town of Esopus is slightly larger than the portion of the watershed north of the creek in the city of Kingston and town of Ulster. The 11-square-mile watershed is located entirely within Ulster County and comprises one of the most densely developed parts of the county.

For reference, Ulster County is located in the southern part of the state of New York, south of Albany, and immediately west of the Hudson River. It sits in the state's Mid-Hudson Region of the Hudson Valley. The city of Kingston, town of Esopus, and town of Ulster are all located in the eastern portion of Ulster County, approximately 90 miles north of New York City and 50 miles south of Albany. The New York State Thruway (Interstate 87) traverses the city of Kingston and town of Ulster from northeast to south.

According to the U.S. Census Bureau, the city of Kingston has a total area of 8.5 square miles, of which 7.3 square miles is land and 1.3 square miles (15.03%) is water. The town of Esopus has a total area of 41.9 square miles, of which, 37.2 square miles of it is land and 4.5 square miles of it (11.08%) is water. The town of Ulster has a total area of 28.9 square miles, of which 25.8 square miles of it is land and 2.1 square miles of it (7.20%) is water.

2.2 Community Demographics

The city of Kingston is located north of Rondout Creek along the west bank of the Hudson River. Kingston is commonly known as an early capital of New York State. There are three main historic neighborhoods within the city – the Uptown or "Stockade" area, the Midtown area, and the Rondout area, which contains the West Strand Historic District. The different historic neighborhoods reflect the fact that the city was formed by the consolidation of the Uptown and Rondout areas, with the Midtown area subsequently developed with services linking the two older villages. Kingston's "downtown" is located adjacent to Rondout Creek and includes the redeveloped waterfront district along the Strand.



SOURCE(S): Bing Maps Hybrid	**Figure 2-1: Watershed**	**LOCATION:** Kingston, NY
N	**Tidal Rondout Creek Watershed Management Plan** MXD: P:\4766-01\Design\GIS\Maps\LocationMap_update.mxd	**Map By:** JEP **MMI#:** 4766-01 **Original:** 1/15/2013 **Revision:** 12/20/2016 **Scale:** 1 inch = 4,000 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Census counts for the three watershed municipalities are listed below.

TABLE 2-1
Populations of Watershed Municipalities

Municipality	2000 Census	2010 Census
Kingston	23,455	23,893
Ulster	12,544	12,327
Esopus	9,331	9,041

According to the 2010 Census, approximately 23,893 people reside within the city of Kingston. There are 11,147 housing units located in the city. According to the 2000 Census, the population was 23,455, and the total number of housing units was 10,537. This is a 1.85% increase in population and 4.79% increase in total number of housing units. According to the 2000 U.S. Census data, the median income for a household in the city was $31,594. The 2009-2013 5-year Census estimates report the median household income has increased to $43,680, a 38% increase.

The town of Ulster is located just north and west of the city of Kingston and west of the Hudson River. The Town of Ulster is actively working to provide economic opportunities for the residents while continuing to maintain the rural atmosphere that has come to define many of the upstate New York towns. According to the Town of Ulster Comprehensive Plan (2007) vision statement, "… Residential and business growth will be managed to retain our rural and historic character, a quality environment and an active agricultural community."

According to the 2010 Census, the town of Ulster had a population of 12,327 in 4,961 households. In 2000, the population was 12,544 and 4,850 households. Based on the Comprehensive Plan, the population decrease was partly due to the closing of the IBM Kingston Plant, which had a negative effect on the local economy and housing market in 2000. However, the Comprehensive Plan indicates that as of 2007, both the economic and housing markets in the area were rebounding. The median income for a household in the town was $43,707, and the median income for a family was $51,095. According to 2008-2012 5-year Census estimates, median household income has increased to $52,401 (a 20% increase), and median family income has increased to $61,224 (also a 20% increase).

The town of Esopus is located south of Rondout Creek, along the west bank of the Hudson River. The town has a rich history, and its small town charm has made it a popular retreat for artists and performers from New York City. Beautiful landscapes, historic buildings, orchards, parks, and preserves are just a few of the attributes that add to the overall character of the town.

According to the 2010 Census, Esopus has a population of 9,041 people and 3,959 households. The population of Esopus decreased by 3.11% from the 2000 Census (9,331 people). The total number of households in 2000 was 3,439. The median income for a household in the town was $46,915, and the median income for a family was $55,442 in 2000. According to 2008-2012 5-year Census estimates, median household income has increased to $70,244 (an almost 50% increase), and family income has increased to $85,918 (a 55% increase).

2.3 Subwatershed Delineations

The 11-square-mile watershed was divided into 17 subwatersheds to facilitate appropriate evaluation of water quality management issues at a scale that allows actions to be developed and advanced for consideration. The subwatersheds were delineated and numbered based on the location of tributaries and the natural drainage areas associated with these tributaries. Subwatersheds 4a, 4b, and 4c are all tributaries to the Twaalfskill Brook tributary, hence that labeling. Subwatershed-scale division of a watershed can accomplish this for several reasons:

- ❑ The influence of impervious cover on hydrology, water quality, and biodiversity is readily apparent at the subwatershed level.
- ❑ Subwatershed boundaries tend to be located within fewer political jurisdictions (or only one community) where it is easier to establish clear regulatory authorities and interest the stakeholders in the planning process.
- ❑ The small sizes of subwatersheds allow ranking of issues and prioritization of actions.

The subwatersheds are depicted on Figure 2-2. Table 2-2 provides a summary of subwatershed data including size, length of streams that are tributary to Rondout Creek, and approximate area of water bodies within each of the subwatersheds. Names are informal and were selected to match places located within or near the subwatersheds.

The pages following Table 2-2 provide basic information for each subwatershed, with one or two pages dedicated to each.

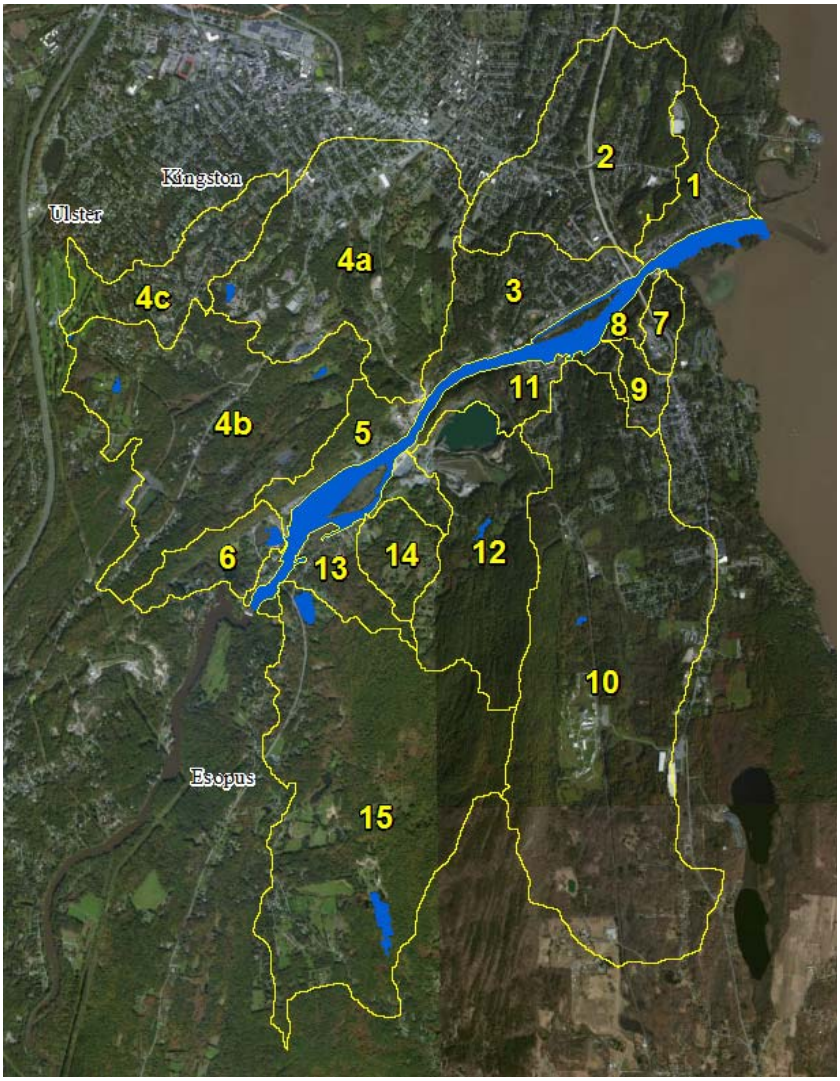


Figure 2-2 – Subwatershed Delineations

TABLE 2-2
Subwatershed Summary

Number	Subwatershed	Size (acres)	Streams (mi)*	Water Bodies (acres)*	Comments
1	Waterfront	141	0.4	0	Drains directly to Rondout Creek in the waterfront area. It may have contained streams in the past but is currently dominated by drainage systems. An open watercourse is located north of Ponckhockie. Field reconnaissance reveals that this watercourse ends in the caverns or a drainage system.
2	Kingston/Rondout	585	0.3	0.25	Believed to have contained streams in the past but is currently dominated by drainage systems. An open watercourse is located on the east side of 9W. Field reconnaissance reveals that this watercourse ends in a drainage system.
3	Downtown West	295	0	0	Includes lower end of Broadway and some of the Rondout area. It may have contained streams in the past but is currently dominated by drainage systems. Minor open watercourses may be located west of Block Park.
4a	Twaalfskill East	789	1.5	2.1	Contains the main stem of Twaalfskill Brook as well as upstream areas.
4b	Twaalfskill West	842	2.3	4.5	Contains a relatively long tributary of Twaalfskill Brook as well as many intermittent streams.
4c	Tannery	257	0.7	2.8	Contains Tannery Brook upstream of the point that the Tannery subwatershed is diverted to the Twaalfskill Brook subwatershed.
5	West Bank	142	0	0	Elongated subwatershed that drains directly to Rondout Creek. Several small intermittent streams may be located in this subwatershed.
6	Eddyville	141	0	6.1	Subwatershed that joins Rondout Creek just below the falls.

TABLE 2-2
Subwatershed Summary

Number	Subwatershed	Size (acres)	Streams (mi)*	Water Bodies (acres)*	Comments
7	Sleightsburg	56	0.25	0	Contains a small stream that flows from south to north under 3rd Street, 2nd Street, and 1st Street and then along Everson Street.
8	Bridge	55	0	0	Does not contain a perennial stream; these are steep sloping areas that drain directly to Rondout Creek.
9	Port Ewen	57	0.5	0.3	Contains a small watercourse that drains the northern section of the Port Ewen village center.
10	Esopus	1,649	2.3	0.9	Contains the longest tributary of Rondout Creek in the town of Esopus, known as Plantasie Kill.
11	Connelly	103	0	0	Does not contain a perennial stream; it drains directly to the Tidal Rondout Creek from the Connelly section of town.
12	Mingo Hollow	502	0.6	1.8	Contains a small tributary stream associated with quarries.
13	East Bank	178	0	0	Drains directly to Rondout Creek in three areas (one on each side of the West Mingo Hollow subwatershed and one near Eddyville
14	West Mingo Hollow	123	0	0.8	Contains a small tributary to Rondout Creek.
15	New Salem	1,264	3.2	19.7	Contains the lake located in New Salem, along with the relatively long stream system (Swarte Kill) that flows into it.
	Totals:	7,179	12.1	39.3	

*Figures are based on GIS analysis and have been adjusted by field reconnaissance observations.

SUBWATERSHED CHARACTERISTICS

SUBWATERSHED 1: Waterfront

"Waterfront" is a subwatershed in Kingston that does not contain a perennial stream; it drains directly to Tidal Rondout Creek in the waterfront area. It may have contained streams in the past, and there is a trace of a watercourse at the northern corner, but the watershed is currently dominated by drainage systems.

The waterfront subwatershed is highly developed and zoned for a mix of uses. It is very close to Rondout Creek and therefore, the priority for water quality management is high. Redevelopment is highly desired in this area.

Tidally-influenced flooding is an exceedingly urgent problem in the Waterfront subwatershed, and the City of Kingston is taking steps to address it.

Subwatershed Summary

Size (Acres)	141
Streams (mi)	0.4
Waterbodies (acres)	Negligible
Hydrology	One open watercourse
Flood characteristics	Zone AE
Soils	Groups A, A/D, C
Wetlands (acres)	1.5
Natural Heritage Areas	Shore of Rondout Creek
Existing Stormwater Systems	Traditional catch basin and piped system
Impaired Water Status	Not Impaired
% Impervious	25.30%
Roads (mi)	3.7
Road/Stream Ratio (refer to Table 2-7)	N/A
Kingston Zoning	R-1, RRR, M-1, R-2, C-2
Land Use	Residential, Commercial, Institutional, Wastewater Treatment Plant
Amount of Open Space	Low
WQ Management Priority	High

SUBWATERSHED 2: Kingston/Rondout

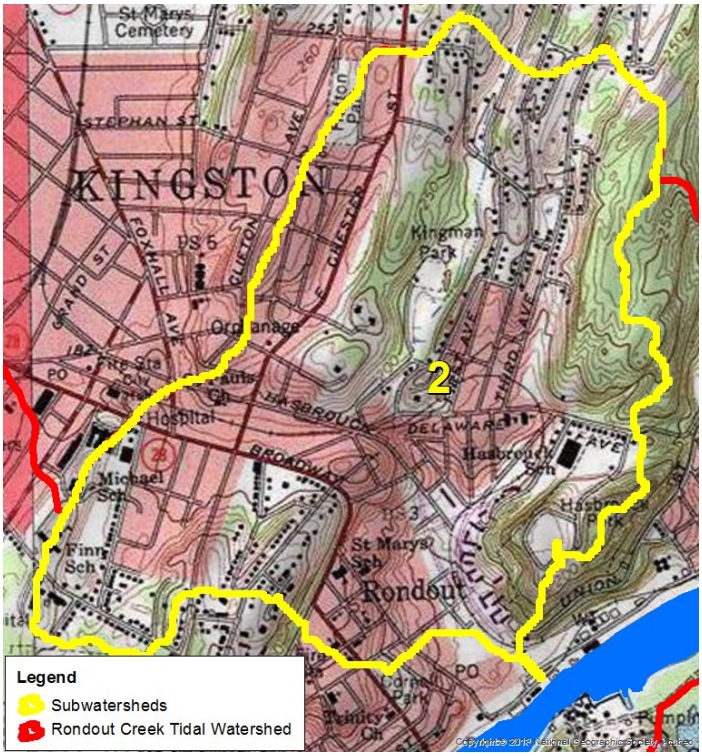
Subwatershed Summary

Size (Acres)	585
Streams (mi)	0.3
Waterbodies (acres)	0.25 (pond)
Hydrology	As described
Flood characteristics	No mapped flood zones
Soils	Groups A, A/D, C, D
Wetlands (acres)	2.2
Natural Heritage Areas	None
Existing Stormwater Systems	Traditional catch basin and piped system
Impaired Water Status	Not Impaired
% Impervious	31.00%
Roads (mi)	3.7
Road/Stream Ratio (refer to Table 2-7)	N/A
Kingston Zoning	RRR, R-1, R-2, R-5, C-2, C-3, O-2, M-1
Land Use	Residential, Commercial, Highway infrastructure
Amount of Open Space	Low
WQ Management Priority	High

"Kingston/Rondout" is a subwatershed in Kingston that is believed to have contained streams in the past, but is currently dominated by drainage systems.

An unnamed tributary starts in the northeast section of the watershed and flows south. It flows through a flat residential areas near Hooker Street and is crossed by several small pedestrian bridges. The tributary continues to flow south and drains into a pond located south of Kingman Park. After this, it may enter drainage systems.

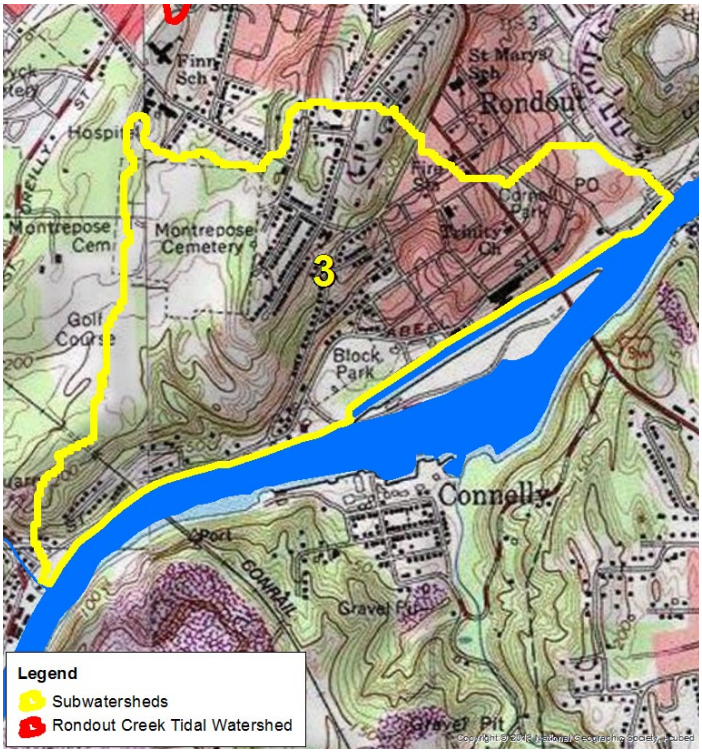
The Kingston/Rondout subwatershed is in close proximity to Rondout Creek and includes a variety of land uses and zoning. The route 9W expressway spur runs through the Kingston/Rondout subwatershed. Due to the developed nature of the watershed along with commercial and industrial uses the priority for water quality management is high.



SUBWATERSHED 3: Downtown West

"Downtown West" is the subwatershed around the lower end of Broadway and some of the downtown Kingston area. It may have contained streams in the past, but is currently dominated by drainage systems.

This subwatershed contains a variety of dense land uses and zoning along with a dense road network. It is very close to Rondout Creek and therefore, the priority for water quality management is high.



Subwatershed Summary

Size (Acres)	295
Streams (mi)	Negligible
Waterbodies (acres)	Negligible
Hydrology	No visible streams
Flood characteristics	Zone AE
Soils	Groups A, A/D, C, D
Wetlands (acres)	2.2
Natural Heritage Areas	Shore of Rondout Creek
Existing Stormwater Systems	Some traditional & some areas unserved
Impaired Water Status	Not Impaired
% Impervious	24.30%
Roads (mi)	7.8
Road/Stream Ratio (refer to Table 2-7)	N/A
Kingston Zoning	RF-R, RRR, R-1, R-2, C-2, R-6
Land Use	Rondout Creek District, Residential, Commercial
Amount of Open Space	Low to Moderate, includes cemetery & golf course
WQ Management Priority	High

SUBWATERSHED 4A: Twaalfskill East

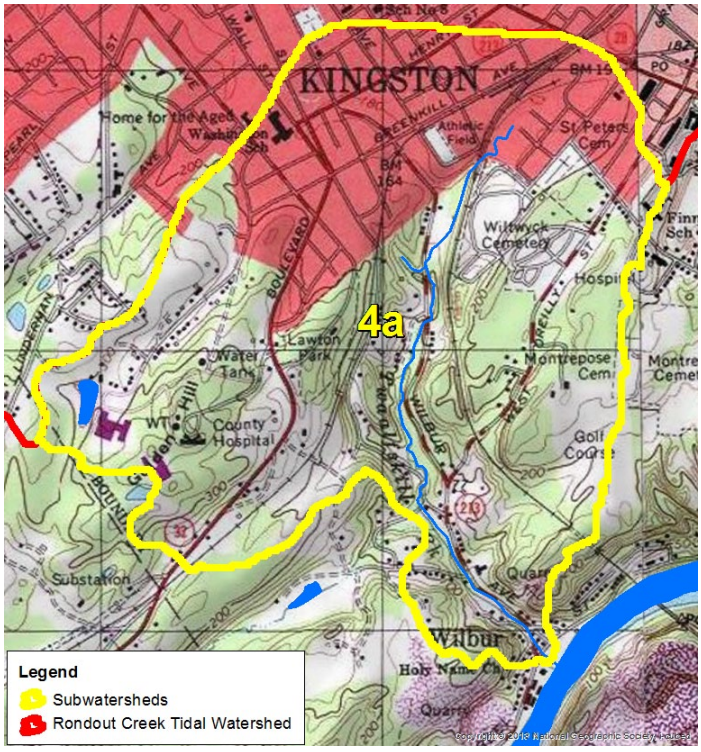
Subwatershed Summary

Size (Acres)	789
Streams (mi)	1.5
Waterbodies (acres)	2.1
Hydrology	Middle and lower sections of brook are free-flowing.
Flood characteristics	Zone AE limited to downstream section of Twaalfskill Brook
Soils	Groups A, A/D, B, C, D
Wetlands (acres)	5
Natural Heritage Areas	Shore of Rondout Creek
Existing Stormwater Systems	Some traditional; some areas unserved
Impaired Water Status	Not Impaired
% Impervious	20.40%
Roads (mi)	13.7
Road/Stream Ratio (refer to Table 2-7)	9.1
Kingston Zoning	C-3, C-2, O-2, R-2, RRR, R-1
Land Use	Commercial, Office, Residential, Institutional
Amount of Open Space	Low to Moderate, includes golf course
WQ Management Priority	High

"Twaalfskill East" is the subwatershed in Kingston that contains the main stem of Twaalfskill Brook.

This subwatershed has a highly variable character, from dense development in the north, to sparse development in the south. Twaalfskill Brook begins in a series of pipes in the northern section of the Tidal Rondout Creek watershed. It flows south and runs parallel to Wall Street. The creek exits the piping and enters a more natural system where it flows mostly south through an area with valley walls on both sides. The creek continues to flow south through residential areas. One section below Brook Street is bordered by a stone wall on the east side. The creek continues south where it flows through a wooded area before discharging into Rondout Creek.

Twaalfskill East is one of the few subwatersheds with an open flowing perennial watercourse. A high priority for water quality management has been given to this area.



SUBWATERSHED 4B: Twaalfskill West

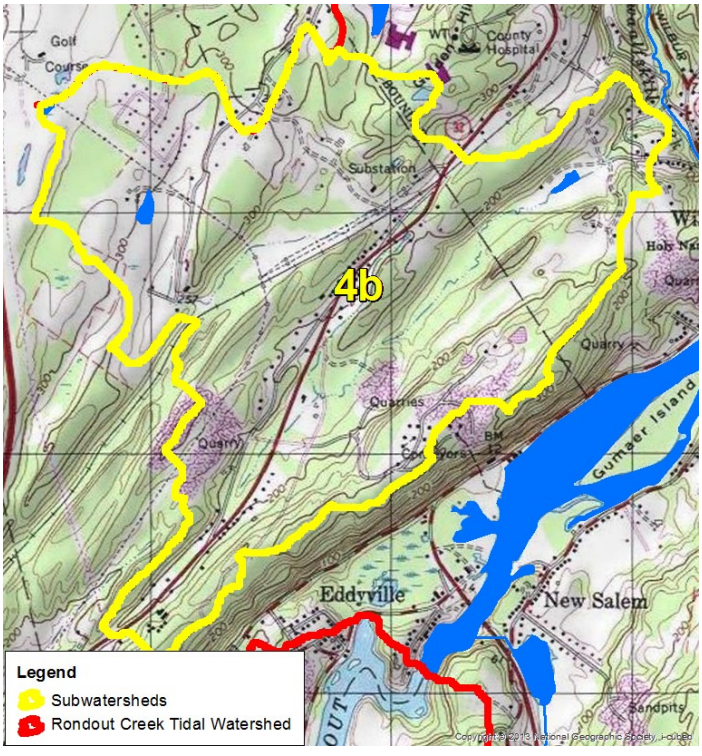
"Twaalfskill West" is the subwatershed in Ulster and Kingston that contains the tributary of Twaalfskill Brook. Like subwatershed 4A, it is one of the few with an open, flowing watercourse.

Starting in the northwest corner of the Tidal Rondout watershed, an unnamed stream flows throughout Ulster and Kingston to join Twaalfskill Brook. The stream begins alongside the Town of Ulster section of Linderman Avenue. It changes direction to flow northeast through a culvert to a rural, very flat, grassy terrain. This area has scattered houses surrounding the stream. The stream moves south through a stone vertical channel where it joins with a small tributary from the north. The stream continues to wind southwest and northeast until it flows into Twaalfskill Brook. The entire course of this stream system is depicted as dashed (intermittent) on the USGS topographic map, although it is believed to be a perennial stream.

This subwatershed includes residential zoning and is not highly developed. Thus, the priority for water quality management is low.

Subwatershed Summary

Size (Acres)	842
Streams (mi)	2.3
Waterbodies (acres)	4.5
Hydrology	Open watercourses
Flood characteristics	No mapped flood zones
Soils	Groups A, A/D, B, C, D
Wetlands (acres)	38.5
Natural Heritage Areas	None
Existing Stormwater Systems	Few traditional systems
Impaired Water Status	Not Impaired
% Impervious	2.80%
Roads (mi)	5
Road/Stream Ratio (refer to Table 2-7)	2.2
Kingston Zoning	RRR, R-1
Ulster Zoning	R-30, R-60
Land Use	Residential
Amount of Open Space	Moderate
WQ Management Priority	Low



SUBWATERSHED 4C: Tannery

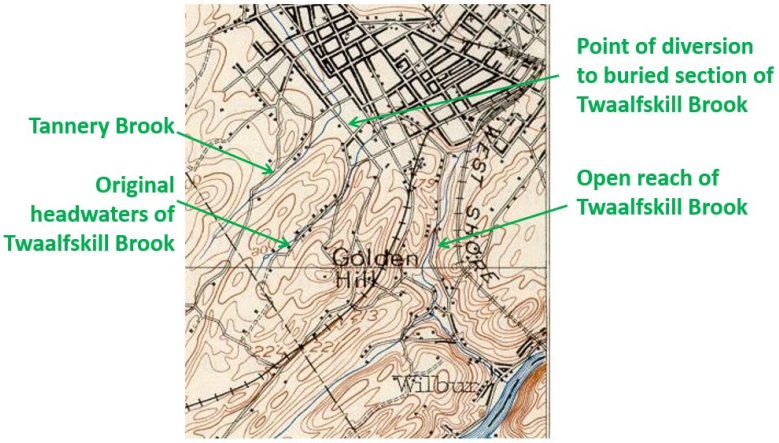
Subwatershed Summary

Size (Acres)	257
Streams (mi)	0.7
Waterbodies (acres)	2.8
Hydrology	Sections of Tannery Brook are open
Flood characteristics	No mapped flood zones
Soils	Groups B, C, D
Wetlands (acres)	0
Natural Heritage Areas	None
Existing Stormwater Systems	Some traditional systems
Impaired Water Status	Not Impaired
% Impervious	13.90%
Roads (mi)	4.4
Road/Stream Ratio (refer to Table 2-7)	6.3
Kingston Zoning	RRR, R-1, O-2
Ulster Zoning	R-30
Land Use	Residential, Limited Office
Amount of Open Space	Moderate
WQ Management Priority	Moderate

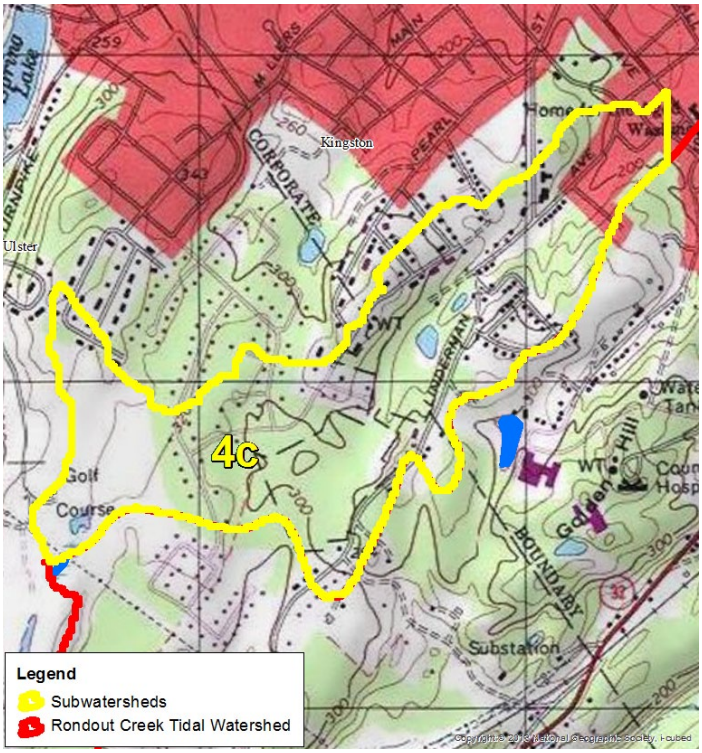
"Tannery" is the subwatershed in Ulster and Kingston that includes Tannery Brook. The natural drainage basin for this subwatershed is the Esopus Creek watershed, but the Tannery subwatershed is diverted to the Twaalfskill Brook subwatershed.

Tannery Brook is a small urban stream that runs parallel to Linderman Avenue from the Town of Ulster toward Washington Avenue in the City of Kingston. The original path of Tannery Brook was through uptown Kingston to Esopus Creek. In 1993, Tannery Brook was diverted under Washington Avenue near Linderman Avenue into a tunnel that carries it to Twaalfskill Creek where it ultimately discharges to Rondout Creek. During high flows, water in Tannery Brook splits, with part of the water flowing into its natural channel and eventually to the outlet at Esopus Creek.

The Tannery Brook subwatershed is moderately developed and consists of residential and limited office use. A golf course is located within this subwatershed. The subwatershed has been given a moderate priority for watershed management.



Topographic map dated 1903



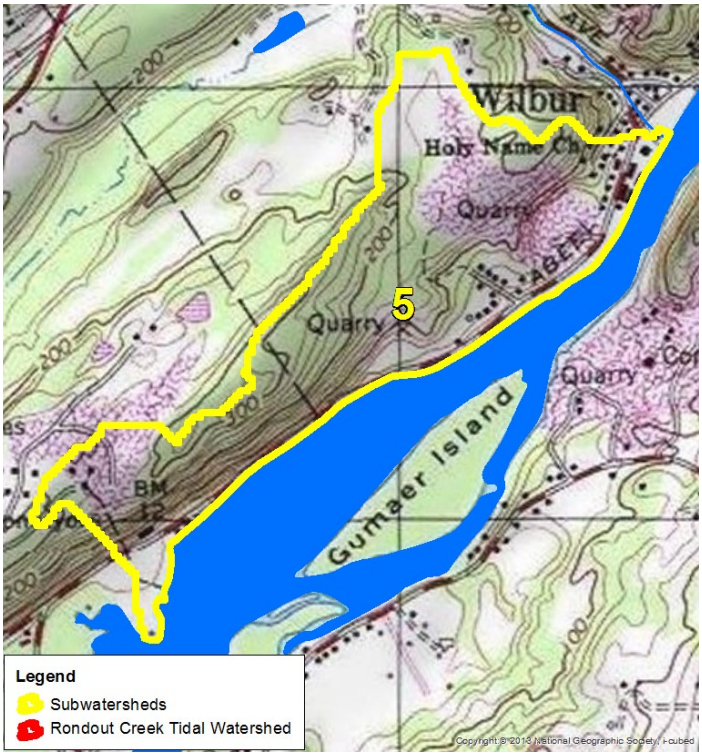
SUBWATERSHED 5: West Bank

"West Bank" is an elongated subwatershed that drains directly to the Tidal Rondout Creek. Several small intermittent streams may be located in this subwatershed.

This subwatershed is moderately developed and zoned for mix uses. It is very close to Rondout Creek and therefore, the priority for water quality management is high.

Subwatershed Summary

Size (Acres)	142
Streams (mi)	Negligible
Waterbodies (acres)	Negligible
Hydrology	No visible streams
Flood characteristics	Zone AE
Soils	Groups A, A/D, B
Wetlands (acres)	0
Natural Heritage Areas	Shore of Rondout Creek
Existing Stormwater Systems	Limited to roadway
Impaired Water Status	Not Impaired
% Impervious	8.80%
Roads (mi)	1.6
Road/Stream Ratio (refer to Table 2-7)	N/A
Kingston Zoning	R-1, C-3, M-2, RR, R-1
Ulster Zoning	R-10
Land Use	Residential, Commercial, Industrial
Amount of Open Space	Low
WQ Management Priority	High



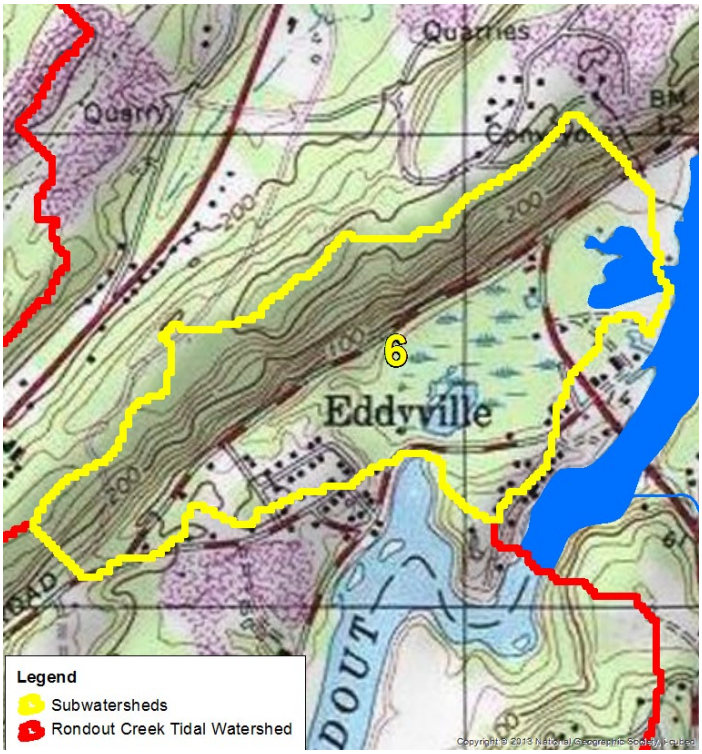
SUBWATERSHED 6: Eddyville

Subwatershed Summary

Size (Acres)	141
Streams (mi)	Negligible
Waterbodies (acres)	6.1
Hydrology	Dominated by large wetland system
Flood characteristics	Zone AE
Soils	Groups A, A/D, B, C
Wetlands (acres)	23.5
Natural Heritage Areas	Shore of Rondout Creek
Existing Stormwater Systems	Few systems
Impaired Water Status	Not Impaired
% Impervious	5.50%
Roads (mi)	1.7
Road/Stream Ratio (refer to Table 2-7)	N/A
Ulster Zoning	R-60, R-10
Land Use	Residential
Amount of Open Space	Moderate
WQ Management Priority	Low

"Eddyville" is the subwatershed that joins the Tidal Rondout Creek just below the falls.

The Eddyville subwatershed is zoned residential and is only lightly developed. Much of the subwatershed is either steep slopes or expansive wetlands. Therefore, it has been given a low priority for needing water quality management due to the low threat of water quality degradation.



SUBWATERSHED 7: Sleightsburg

"Sleightsburg" is the subwatershed in Esopus that contains the small stream that flows from south to north under 3rd Street, 2nd Street, and 1st Street and then along Everson Street in the Front Street/North Broadway Area. The stream is located mainly within and between backyards in this residential area, and enters Rondout Creek northeast of Front Street, just west of the Kingston Oil Terminal.

This subwatershed is zoned residential. However due to its proximity to Rondout Creek and the highly developed nature of the subwatershed, the priority for water quality management is high.

Subwatershed Summary

Size (Acres)	56
Streams (mi)	0.25
Waterbodies (acres)	Nominal
Hydrology	Open watercourse
Flood characteristics	No mapped flood zone
Soils	Groups A, A/D, B, B/D, C
Wetlands (acres)	0
Natural Heritage Areas	Shore of Rondout Creek
Existing Stormwater Systems	Mainly traditional systems
Impaired Water Status	Not Impaired
% Impervious	34.90%
Roads (mi)	1.9
Road/Stream Ratio (refer to Table 2-7)	N/A
Esopus Zoning	R-12
Land Use	Residential
Amount of Open Space	Low
WQ Management Priority	High

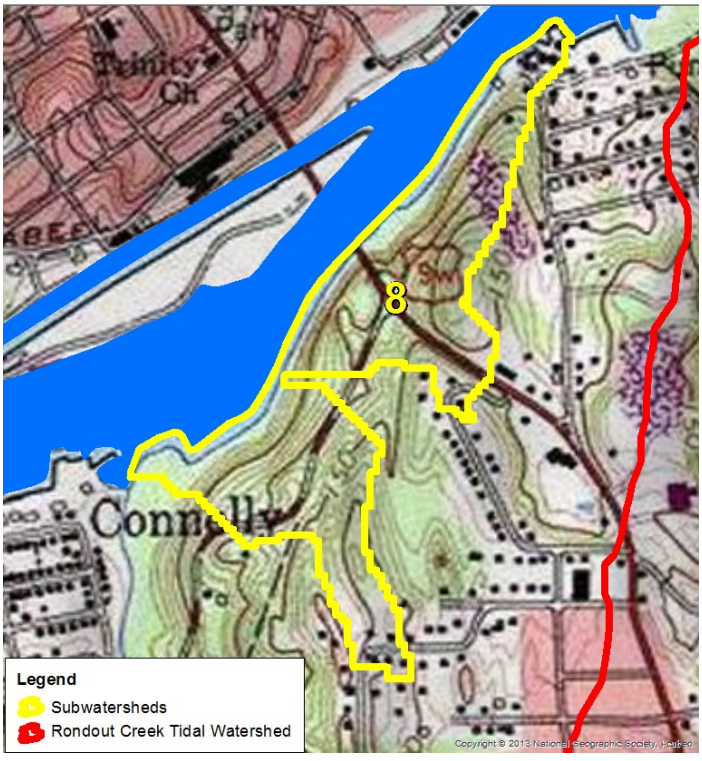
SUBWATERSHED 8: Bridge

Subwatershed Summary

Size (Acres)	55
Streams (mi)	0
Waterbodies (acres)	0
Hydrology	N/A
Flood characteristics	Zone AE
Soils	Groups A, A/D, C
Wetlands (acres)	1.3
Natural Heritage Areas	Shore of Rondout Creek
Existing Stormwater Systems	Few; limited to roadway
Impaired Water Status	Not Impaired
% Impervious	22.00%
Roads (mi)	1.6
Road/Stream Ratio (refer to Table 2-7)	N/A
Other Zoning	R-40, W
Land Use	Residential, Commercial
Amount of Open Space	Low
WQ Management Priority	High

"Bridge" is a subwatershed in Esopus that does not contain a perennial stream; these are steep sloping areas that drain directly to the creek.

This subwatershed is very close to Rondout Creek and therefore, the priority for water quality management is high.



SUBWATERSHED 9: Port Ewen

"Port Ewen" is a subwatershed in Esopus contains a small watercourse that drains the northern section of the Port Ewen village center before flowing through a condominium complex located along Connelly Road.

The Port Ewen subwatershed is moderately developed and is comprised of residential and commercial use. Thus, the priority for water quality management is high.

Subwatershed Summary

Size (Acres)	57
Streams (mi)	0.5
Waterbodies (acres)	0.3
Hydrology	Open watercourse
Flood characteristics	No mapped flood zone
Soils	Groups A, B, B/D, C
Wetlands (acres)	0
Natural Heritage Areas	None
Existing Stormwater Systems	Some traditional systems
Impaired Water Status	Not Impaired
% Impervious	28.40%
Roads (mi)	1.5
Road/Stream Ratio (refer to Table 2-7)	N/A
Esopus Zoning	R-40, GC
Land Use	Residential, Commercial
Amount of Open Space	Low
WQ Management Priority	High

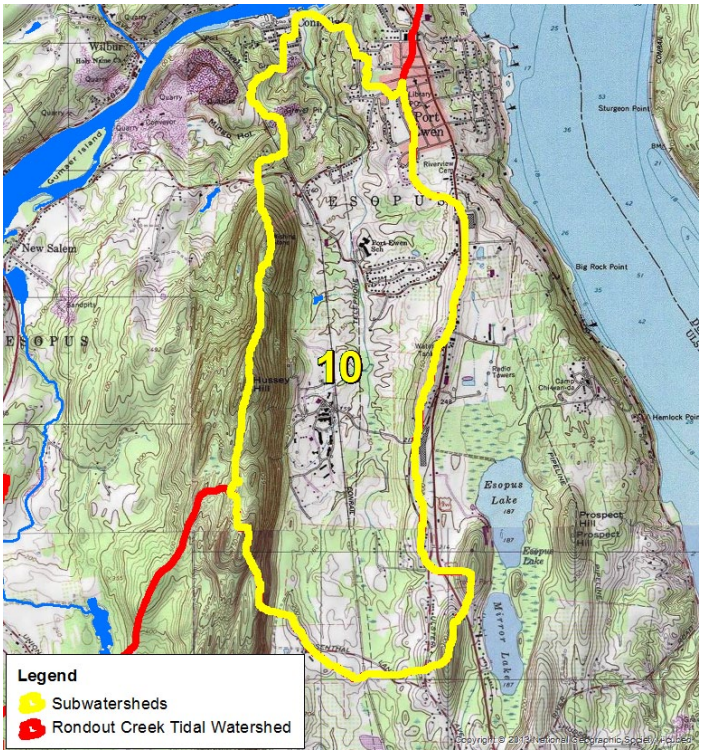
SUBWATERSHED 10: Esopus

Subwatershed Summary

Size (Acres)	1,649
Streams (mi)	2.3
Waterbodies (acres)	0.9
Hydrology	Long open watercourse (Plantasie Kill)
Flood characteristics	Zones A and AE
Bedrock Geology	Middle Ordovician (Mohawkian) and Silurian
Soils	Groups A, A/D, B, B/D, C, D
Wetlands (acres)	44.2
Natural Heritage Areas	None
Stormwater Management	Varies from no management, to swales and ditches, to traditional systems.
Existing Stormwater Systems	Some traditional systems
Impaired Water Status	Not Impaired
% Impervious	7.80%
Roads (mi)	11
Road/Stream Ratio (refer to Table 2-7)	4
Ulster Zoning	R-40, H-1, L-1, R-12, GC
Land Use	Residential, Industrial, Commercial
Amount of Open Space	High
WQ Management Priority	High

"Esopus" is a subwatershed in Esopus that contains the longest tributary of Rondout Creek in that town, the Plantasie Kill.

The Esopus subwatershed is comprised of residential, industrial, commercial, and agricultural uses. Due to the potential for these land uses to have a negative impact on water quality, the priority for water management is high.



SUBWATERSHED 10: Esopus (continued)

Plantasie Kill in the eastern portion of Esopus is the longest tributary to the Tidal Rondout Creek within the town of Esopus. The headwaters to this stream are located near Bruderhof Farmlands at the intersection of Rosenthal Lane and the railroad tracks.

The stream flows north past Fawn Meadows Court and water quality basins at the end of the road that appear to provide treatment for a few residential homes. The stream continues north toward the intersection of Rodman Lane and Anna Lane. This is an older area of town that consists of approximately twelve residential homes. Stormwater conveyance for the area is provided by a series of swales that run along Anna Road.

As the stream continues, it enters the Dyno Nobel Port Ewen Plant property. Dyno Nobel is a leading supplier of industrial explosives and blasting services to the mining, quarrying, seismic and construction industries. The site is located in a valley just east of Hussey Hill and is bordered by wetland areas to the east, northeast, and southeast which drain to several unnamed tributaries.

According to the United State Environmental Protection Agency Region , (http://www.epa.gov/region02/waste/fsdyno.htm), groundwater and soil at the Dyno Nobel site are contaminated. Groundwater contamination consists of volatile organic compounds and selenium; soil is contaminated with volatile organic compounds, explosives and metals. The data indicates there has been no movement of groundwater contamination offsite.

Dyno Nobel is currently in the process of moving most of its operations to another facility in Simsbury, Connecticut and is closing its manufacturing operation. They plan to continue to operate a distribution and a sales and service support center at the Esopus location.

North of the Dyno Nobel facility, the stream continues to flow through a flat rural area then past a nursery to the east. To the west of the stream and nursery, there is a 41 acre light industrial lot for sale by Upstate Commercial Group that has frontage on Mountain View Road. A large residential area is located east of the stream in the area of Rogers Street, Lindorf Street, and Clay Road. A small unnamed tributary of the stream begins at the corner of Rogers Street and Lindorf Street. It flows north through the residential area into a small pond approximately 100 feet north of Roger Street. Once the stream exits the pond, it flows northwest through wooded areas.

As the stream continues northward, it travels through a culvert under Mountain View Road and near the front of Robert R. Graves Elementary School. The surrounding areas of the stream are very flat areas, grass covered and either lightly forested or highly forested. The Highway Department is located directly north of the 41-acre lot for sale on Mountain View Road, to the west of the stream. Within this short reach of the stream subwatershed, land use varies greatly.

The stream continues to flow north of the Graves Elementary School through forested then residential areas, then under Salem Street and through Dutcher Mobile Home Park. The valley walls along this stretch are steep, with base flow much greater than previously. This is due to the many unnamed tributaries that enter the unnamed stream upstream of this point. The stream continues to flow through a residential area but still located in steep terrain. The stream flows alongside Mill Brook Drive for approximately 2,500 feet, then flow under Connelly Road.

Approximately 1,500 feet downstream of Connelly Road, the stream enters Rondout Creek. This densely developed area includes many homes, the Rondout Yacht Basin, and other buildings along 1st Street, 2nd Street, 3rd Street, Plantasia Avenue, Center Street, and Mary's Street.

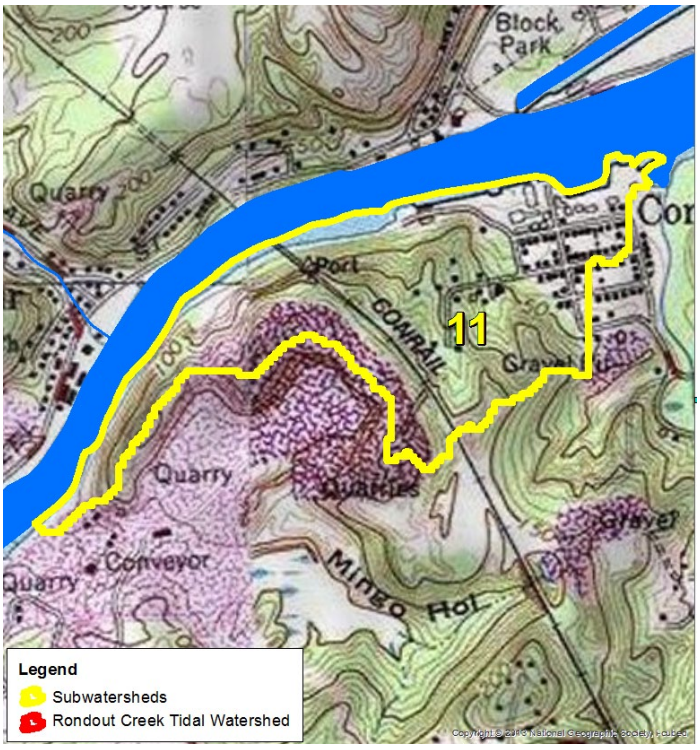
SUBWATERSHED 11: Connelly

Subwatershed Summary

Size (Acres)	103
Streams (mi)	0
Waterbodies (acres)	0
Hydrology	No visible streams
Flood characteristics	Zone AE
Soils	Groups A, A/D, B, C
Wetlands (acres)	2.4
Natural Heritage Areas	Shore of Rondout Creek
Stormwater Management	Varies from no management to traditional
Existing Stormwater Systems	Some traditional systems
Impaired Water Status	Not Impaired
% Impervious	13.70%
Roads (mi)	0.9
Road/Stream Ratio (refer to Table 2-7)	N/A
Esopus Zoning	PUD, WR
Land Use	Planned Unit Development, Commercial
Amount of Open Space	Low
WQ Management Priority	Moderate

"Connelly" is a subwatershed in Esopus that does not contain a perennial stream; it drains directly to the Tidal Rondout Creek from the Connelly section of town.

This subwatershed is zoned Planned Unit Development and commercial. Due to the amount of development and the proximity to Rondout Creek, it has been given a moderate priority for water quality management.



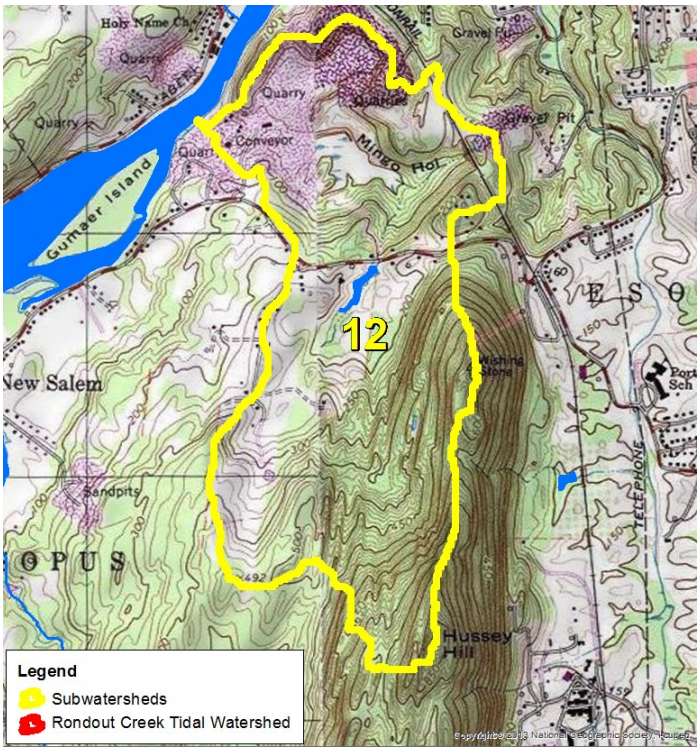
SUBWATERSHED 12: Mingo Hollow

"Mingo Hollow" is a subwatershed in Esopus that contains a small tributary stream associated with quarries. This unnamed stream is located East of Schultz Lane. The stream flows to the northeast under New Salem Road. Once it crosses the road the stream flows to the north and eventually the northwest where it passes through the existing quarry and is believed to enter Rondout Creek.

This subwatershed is zoned residential and contains a large amount of open space. Thus, the priority for water quality management is low.

Subwatershed Summary

Size (Acres)	502
Streams (mi)	0.6
Waterbodies (acres)	1.8
Hydrology	Some open watercourses
Flood characteristics	No mapped flood zones
Soils	Groups A, A/D, B, C, D
Wetlands (acres)	17.1
Natural Heritage Areas	None
Stormwater Management	Minimal
Existing Stormwater Systems	Few systems
Impaired Water Status	Not Impaired
% Impervious	6.00%
Roads (mi)	0.9
Road/Stream Ratio (refer to Table 2-7)	1.6
Esopus Zoning	R-40
Land Use	Residential
Amount of Open Space	High
WQ Management Priority	Low



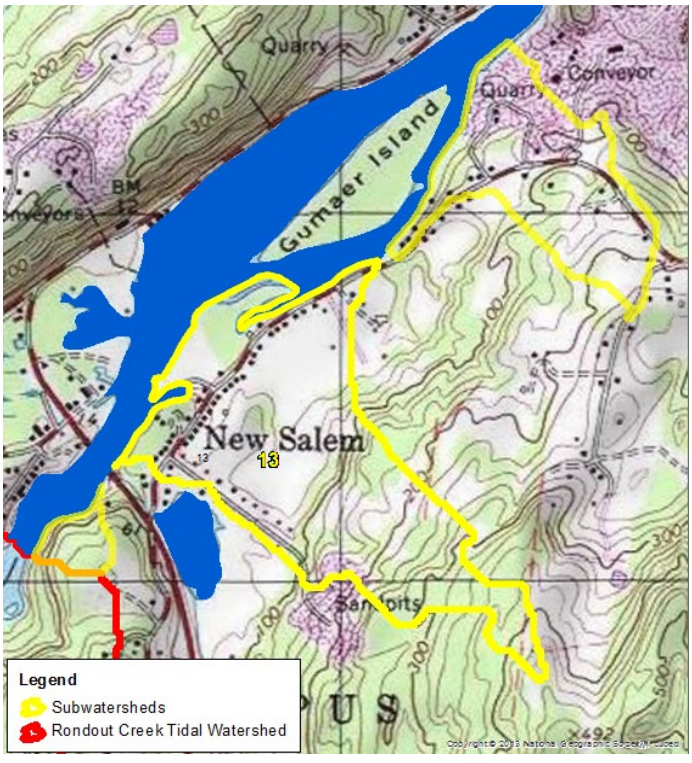
SUBWATERSHED 13: East Bank

Subwatershed Summary

Size (Acres)	178
Streams (mi)	0
Waterbodies (acres)	0
Hydrology	No visible streams
Flood characteristics	Zone AE
Soils	Groups A, A/D, B, C
Wetlands (acres)	9,7
Natural Heritage Areas	Shore of Rondout Creek
Stormwater Management	Limited to roadways
Existing Stormwater Systems	A few traditional
Impaired Water Status	Not Impaired
% Impervious	10.80%
Roads (mi)	1.7
Road/Stream Ratio (refer to Table 2-7)	N/A
Esopus Zoning	R-12
Land Use	Residential
Amount of Open Space	Low
WQ Management Priority	Moderate

"East Bank" is a subwatershed in Esopus that drains directly to the Tidal Rondout Creek in three areas (one on each side of the West Mingo Hollow subwatershed, and one near Eddyville.

The East Bank subwatershed is zoned residential. However, due to the amount of development and the proximity to Rondout Creek it has been given a moderate priority for water quality management.



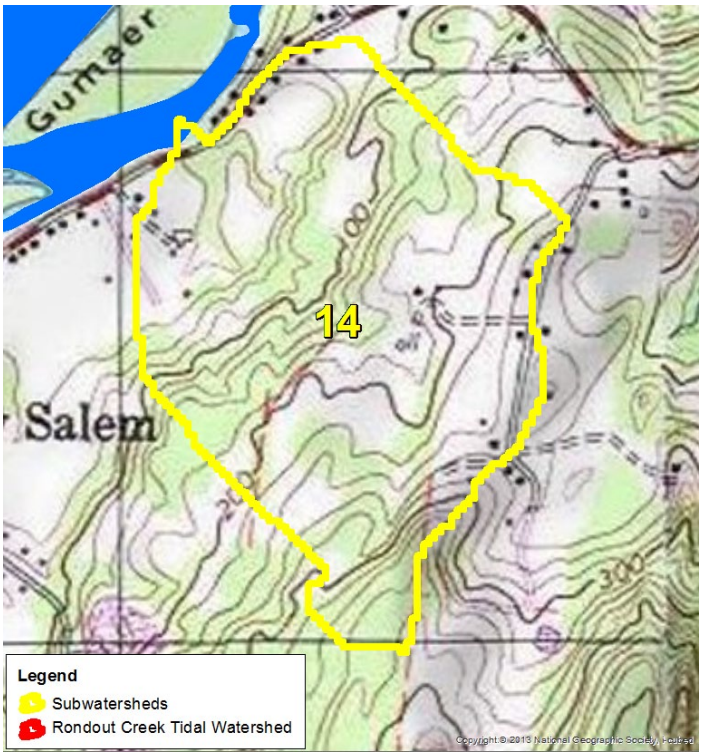
SUBWATERSHED 14: West Mingo Hollow

"West Mingo Hollow" is a subwatershed in Esopus that contains a small tributary to the creek. Several ponds are located near the downstream end of the subwatershed.

This subwatershed is small and is mostly residential and undeveloped. Therefore, the priority for water management is low.

Subwatershed Summary

Size (Acres)	123
Streams (mi)	Negligible
Waterbodies (acres)	0.8 (pond)
Hydrology	Minor watercourse
Flood characteristics	No mapped flood zones
Bedrock Geology	Silurian and Middle Ordovician (Mohawkian)
Soils	Groups A, B, C
Wetlands (acres)	2.8
Natural Heritage Areas	None
Existing Stormwater Systems	Few
Impaired Water Status	Not Impaired
% Impervious	1.40%
Roads (mi)	0.5
Road/Stream Ratio (refer to Table 2-7)	N/A
Other Zoning	R-40
Land Use	Residential
Amount of Open Space	High
WQ Management Priority	Low



SUBWATERSHED 15: New Salem

Subwatershed Summary

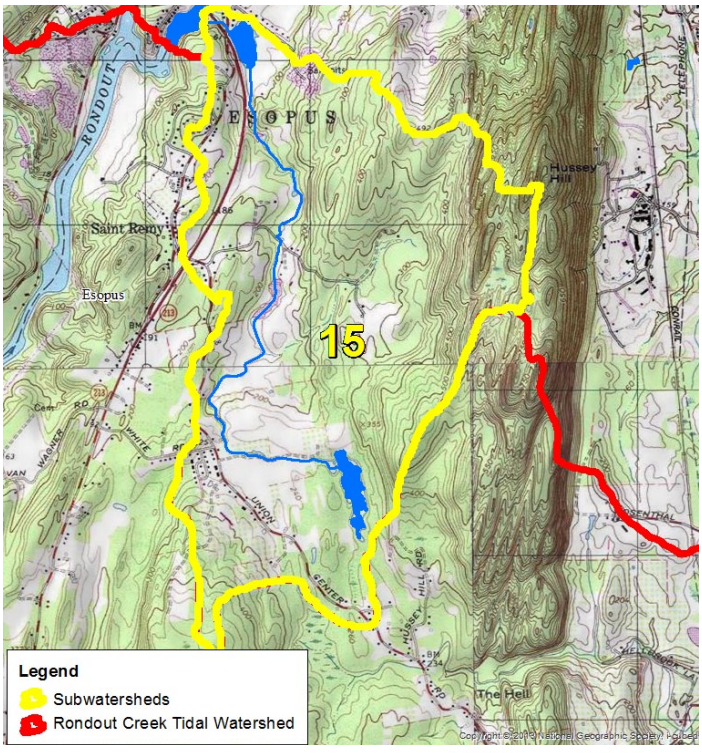
Size (Acres)	1,264
Streams (mi)	3.2
Waterbodies (acres)	19.7
Hydrology	Open watercourses including Swarte Kill
Flood characteristics	Zone A at lake; remainder has no mapped flood zones
Soils	Groups A, A/D, B, C, D
Wetlands (acres)	59.5
Natural Heritage Areas	None
Stormwater Management	Limited to some developed areas of systems
Existing Stormwater Systems	Limited traditional systems
Impaired Water Status	Not Impaired
% Impervious	1.40%
Roads (mi)	4.8
Road/Stream Ratio (refer to Table 2-7)	1.5
Esopus Zoning	R-40
Land Use	Residential
Amount of Open Space	High
WQ Management Priority	Low

"New Salem" is a subwatershed in Esopus that contains the lake located in New Salem, along with the stream that flows into it.

An unnamed pond/lake is located to the northeast of Union Center Road. Swarte Kill leaves the pond/lake from the northwest side and continues to flow west for approximately 2,000 feet through a sparse residential area, where it enters a small unnamed pond. From here the stream flows north through sparse residential areas with relatively flat terrain. It generally flows near and in the same direction as Union Center Road.

After it starts to flow northeast, it enters another small pond flowing under Pokonoie Road through a small round perched culvert. It continues north through two very small ponds alongside Main Street until it enters a lake located in New Salem at the intersection of Main Street and New Salem Road, a residential area. To the northwest, the stream exits over a stone masonry spillway and approximately 500 feet downstream this unnamed stream enters Rondout Creek.

This subwatershed is zoned residential and contains a large amount of open space. Thus, the priority for water management is low.



2.4 Land Use

A significant component of watershed management involves identifying land use within the watershed that directly impacts the overall health of a system. The Tidal Rondout Creek watershed includes approximately 7,203 acres of land, of which 4,146 acres are located within the town of Esopus, 2,134 acres are within the city of Kingston, and 923 acres are located within the town of Ulster.

Land use in the Tidal Rondout Creek watershed is highly variable. Low to high density residential development, commercial land uses, industrial land uses, and numerous institutional land uses are found in the Kingston portion of the watershed. Water-dependent uses are located along the tidal main stem of the creek.

The Town of Esopus offers a mirror image to some degree, with residential, commercial, industrial, institutional, and water-dependent land uses in the watershed. However, overall density tends to be lower in Esopus, and there are significant sections of undeveloped land in the town. Unlike Kingston and Esopus, the portion of the watershed in the town of Ulster is mainly low density residential with few commercial and industrial land uses.

While there are several locations of open space in the watershed such as golf courses and parks, the three watershed communities are generally lacking significant tracts of permanently protected open space. Consider the following information from the *Ulster County Open Space Plan*:

TABLE 2-3
Permanently Protected Open Space*

Municipality	Total Acreage	Protected Open Space Acreage	Percent of Land in Protected Open Space
Kingston	5,625	381	7%
Esopus	26,868	1,444	5%
Ulster	18,774	504	3%

*Figures are townwide; figures for the watershed have not been compiled.

Table 2-4 contains information about land use within each of the Tidal Rondout Creek subwatersheds.

Seven subwatersheds are located within the city of Kingston, which is the most developed portion of the Tidal Rondout Creek watershed. The Waterfront and Kingston subwatersheds are located in the eastern portion of the city and have the highest percentages of high density development. This can be attributed to the fact that Rondout Creek has historically been an important commercial waterway.

Table 2-4
Land Use by Subwatershed

Subwatershed		Size (acres)	Open Water	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Deciduous Forest	Evergreen Forest	Mixed Forest	Shrub / Scrub	Grassland / Herbaceous	Pasture / Hay	Cultivated Crops	Woody Wetlands	Emergent Herbaceous Wetlands	Total
4c	Tannery Brook	257	0.00%	59.88%	13.76%	0.87%	0.00%	0.00%	10.56%	1.64%	5.02%	0.52%	0.00%	0.00%	0.00%	8.39%	0.00%	100.64%
4b	Twaalfskill Brook West	842	1.48%	11.25%	2.75%	0.11%	0.00%	0.74%	30.72%	7.87%	27.73%	0.40%	0.00%	0.34%	0.45%	16.38%	0.00%	100.21%
4a	Twaalfskill Brook East	789	0.17%	30.86%	18.86%	10.29%	2.93%	0.00%	16.69%	3.21%	12.01%	0.14%	0.00%	0.00%	0.00%	4.93%	0.00%	100.09%
3	Kingston	585	0.00%	33.49%	32.01%	15.59%	4.60%	0.27%	12.05%	1.06%	0.49%	0.00%	0.00%	0.53%	0.00%	0.00%	0.00%	100.10%
7	Sleightsburg	56	0.00%	36.93%	23.03%	20.65%	9.93%	2.38%	8.34%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	101.27%
9	Port Ewen	57	0.00%	38.63%	39.80%	6.24%	2.73%	0.00%	13.66%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	101.05%
10	Esopus	1649	0.00%	13.24%	8.23%	2.71%	1.20%	0.07%	40.86%	1.39%	8.77%	0.59%	0.36%	6.96%	2.72%	13.07%	0.07%	100.25%
12	Mingo Hollow	502	1.33%	4.39%	1.77%	2.30%	3.77%	12.05%	24.85%	7.09%	35.13%	0.00%	0.00%	4.34%	0.97%	2.70%	0.00%	100.70%
14	West Mingo Hollow	123	0.00%	10.49%	0.36%	0.00%	0.00%	0.00%	19.89%	1.63%	41.95%	0.00%	0.00%	18.98%	4.16%	2.89%	0.00%	100.35%
15	New Salem	1264	1.04%	6.84%	1.09%	0.00%	0.00%	0.00%	36.79%	1.11%	36.74%	0.00%	0.00%	5.35%	2.39%	8.64%	0.00%	99.99%
6	Eddyville	141	4.10%	19.56%	4.26%	1.58%	0.00%	0.00%	28.86%	1.58%	21.61%	0.00%	0.00%	0.00%	1.42%	13.25%	3.63%	99.84%
13	East Bank	178	0.25%	9.87%	5.50%	2.62%	6.50%	2.12%	23.24%	0.50%	34.11%	0.00%	0.00%	2.00%	0.12%	14.87%	0.00%	101.70%
11	Connelly	103	1.30%	19.65%	9.07%	9.50%	2.16%	8.64%	29.80%	0.00%	7.34%	0.00%	0.00%	0.00%	5.83%	0.86%	5.83%	99.97%
8	Bridge	55	3.23%	21.03%	31.54%	2.02%	4.45%	0.00%	26.28%	7.68%	0.00%	0.00%	0.00%	0.00%	0.00%	0.40%	5.26%	101.90%
5	West Bank	142	0.78%	15.35%	8.14%	5.79%	0.00%	0.00%	30.23%	0.31%	19.89%	0.00%	0.00%	0.00%	8.46%	11.59%	0.00%	100.55%
3	Downtown West	295	0.60%	46.51%	22.31%	12.74%	1.88%	0.00%	11.01%	0.00%	4.37%	0.00%	0.00%	0.00%	0.00%	0.00%	0.30%	99.74%
1	Waterfront	141	0.16%	18.93%	22.40%	20.82%	1.73%	5.68%	21.92%	0.47%	2.68%	0.00%	0.00%	3.79%	0.00%	0.00%	1.73%	100.31%

Land use information was obtained from the 2006 National Land Cover Database: Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, PE&RS, Vol. 77(9):858-864.

Consequently, the city is currently focusing on redevelopment of the waterfront as outlined in their *Local Waterfront Revitalization Plan* (2007). The purpose of the plan is to, "promote economic development and revitalization of the City's local waterfront revitalization area while assuring the protection and beneficial use of coastal resources therein." Much of the older industry along Rondout Creek consisted of scrap yards, marinas, and vacant factories. However, a group of restaurants, art spaces, and museums has begun populating this area.

High density development is also located in the adjacent subwatersheds of Downtown West, Twaalfskill East, and West Bank. However, the extensive steep slopes in these three subwatersheds tend to be less developed. A few homes near Sass Park located between steep slopes and Rondout Creek are pictured to the upper right. Within these subwatersheds, pockets of low density development can be found, such as the scattered residences along the Twaalfskill Brook corridor, pictured to the lower right.

Nine subwatersheds are located within the town of Esopus. The subwatersheds identified as East Bank, Bridge, and Sleightsburg have the highest percentage of high density development and are located in the northern portion of the town adjacent to Rondout Creek. The majority of commercial and residential development is located in these areas and includes large commercial and industrial facilities such as CSX, Transportation Inc. Gravel Pit, Callanan Road Improvement, Kingston Oil Supply Corporation, and several marinas.

The remaining subwatersheds are located in the southern and western portions of Esopus and have high percentages of undeveloped land and forested areas. Bruderhof Farmlands and the Dyno Nobel facility (pictured to the left) are located in the southern portion of town within the Esopus subwatershed.

Parts of four subwatersheds are located within the town of Ulster. Land within this area consists largely of low density residential and vacant land as pictured to the right. Much of the vacant land consists of heavily wooded areas. There are also some commercial marinas located on the north side of Rondout Creek.

2.5 Geology and Soils

The geologic history of a region provides the land forms upon which drainage patterns and watersheds are established and subsequently evolve. Likewise, the type of bedrock and surficial materials present dictate land form, stream characteristics, and background water quality in these surface water features.

Figure 2-3 shows the bedrock formations in the Tidal Rondout Creek watershed. The bedrock structure exerts strong influence on the orientation of Rondout Creek, with the contact between the gray argillaceous calcareous formation and the gray shales aligned with the creek. The Quassaic Quartzite is relatively resistant to erosion and forms the ridge in Esopus, separating some of the larger subwatersheds (10 to the east and 12 and 15 to the west of the ridge). The three calcareous/limestone formations were responsible for the historic underground quarrying in Kingston. The "Kingston Caves" are identified on the map.

Surficial geology in the Catskills region is a reflection of multiple glacial cycles. The majority of surficial deposits in the Tidal Rondout Creek watershed consist of glacial till. Till is an unsorted, unstratified mixture of clay, silt, sand, gravel, and boulders deposited directly by glaciers. Stratified materials deposited by glacial meltwater are often found along present-day streams that have largely inherited glacial streams. Geologic mapping (Figure 2-4) depicts glacial till, kame deposits, lacustrine delta, lacustrine sand, lacustrine silt and clay, recent alluvium, and bedrock.

Soil types are typically influenced by bedrock and surficial geology as well as topography and hydrology. The Tidal Rondout Creek watershed can be classified by a handful of different soil types, with the primary being Bath-Nassau-Rock outcrop complex, Plainfield-Rock outcrop complex, Nassau-Bath-Rock outcrop complex, Bath-Nassau complex, and Riverhead fine sandy loam.

Figure 2-5 depicts the generalized soil types in the Tidal Rondout Creek watershed based on hydrologic drainage classes A, B, C, and D. These hydrologic soil groups are typically employed in the computation of runoff by the "Curve Number" method, which has implications for computing runoff to design stormwater drainage and infiltration systems.

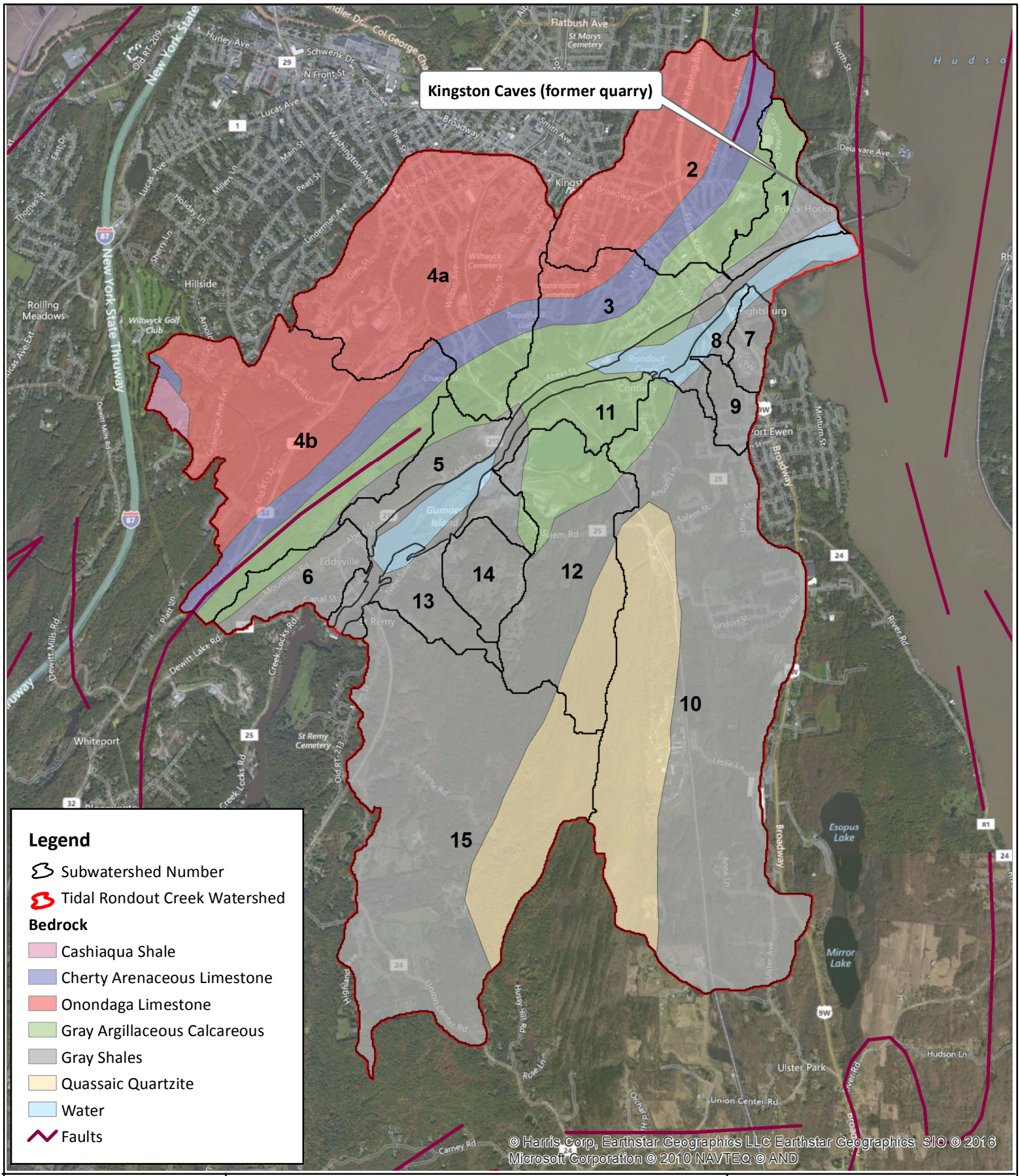
Hydrologic Soil Groups

Group A - Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well-drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B - Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well-drained or well-drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C - Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D - Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.



SOURCE(S):
Bing Maps Hybrid
NYS Museum/NYS Geological Survey-Lower Hudson Sheet Bedrock Geology

Figure 2-3: Bedrock

LOCATION:
Kingston, NY

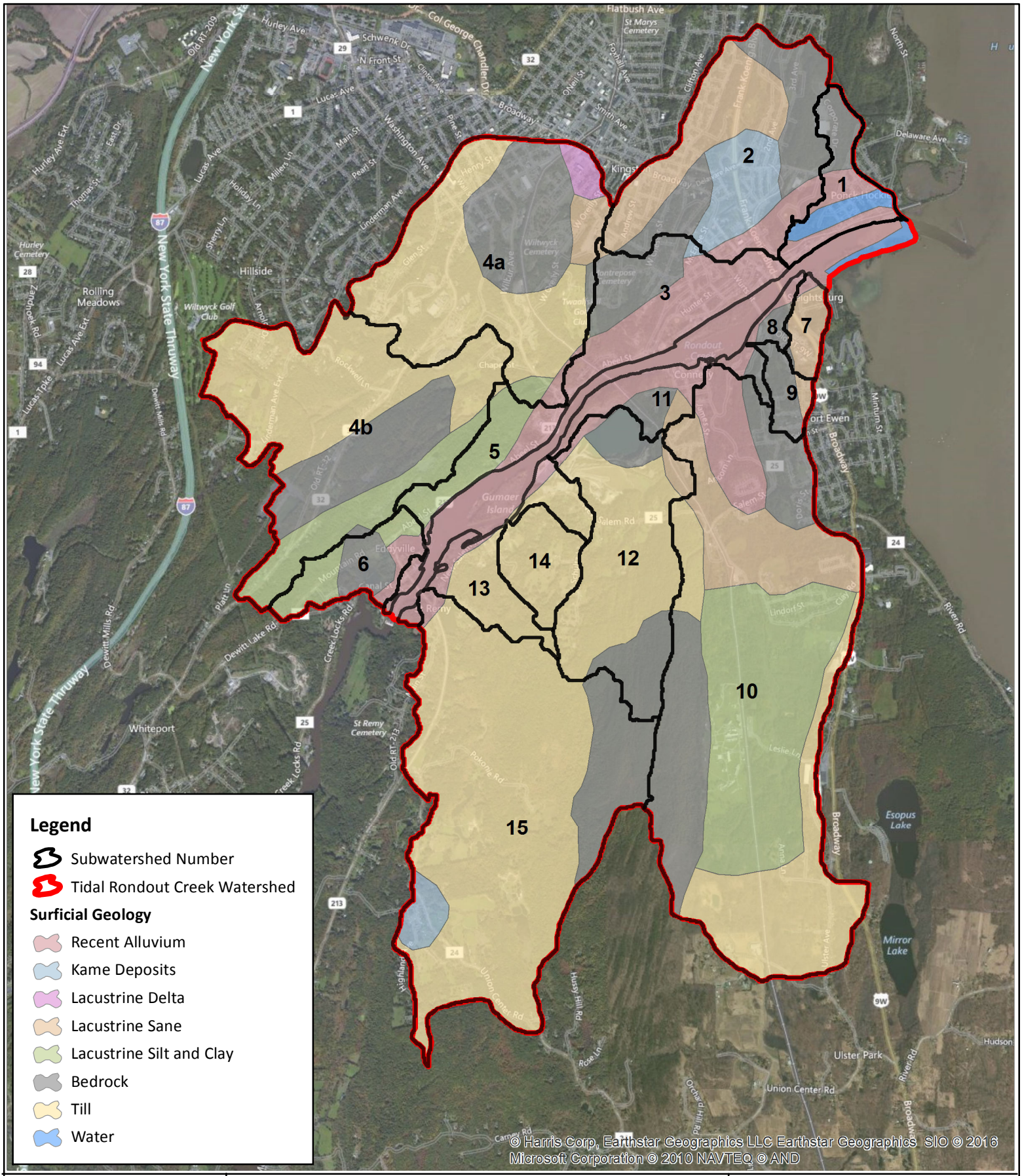
N

Tidal Rondout Creek Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\Bedrock_update.mxd

Map By: CMP
MMI#: 4766-01
Original: 1/15/2013
Revision: 12/20/2016
Scale: 1 inch = 3,500 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com



SOURCE(S):

Bing Maps Hybrid
NYS Museum/NYS Geological Survey-Lower Hudson Sheet Surficial Geology

Figure 2-4: Surficial Geology

LOCATION:

Kingston, NY

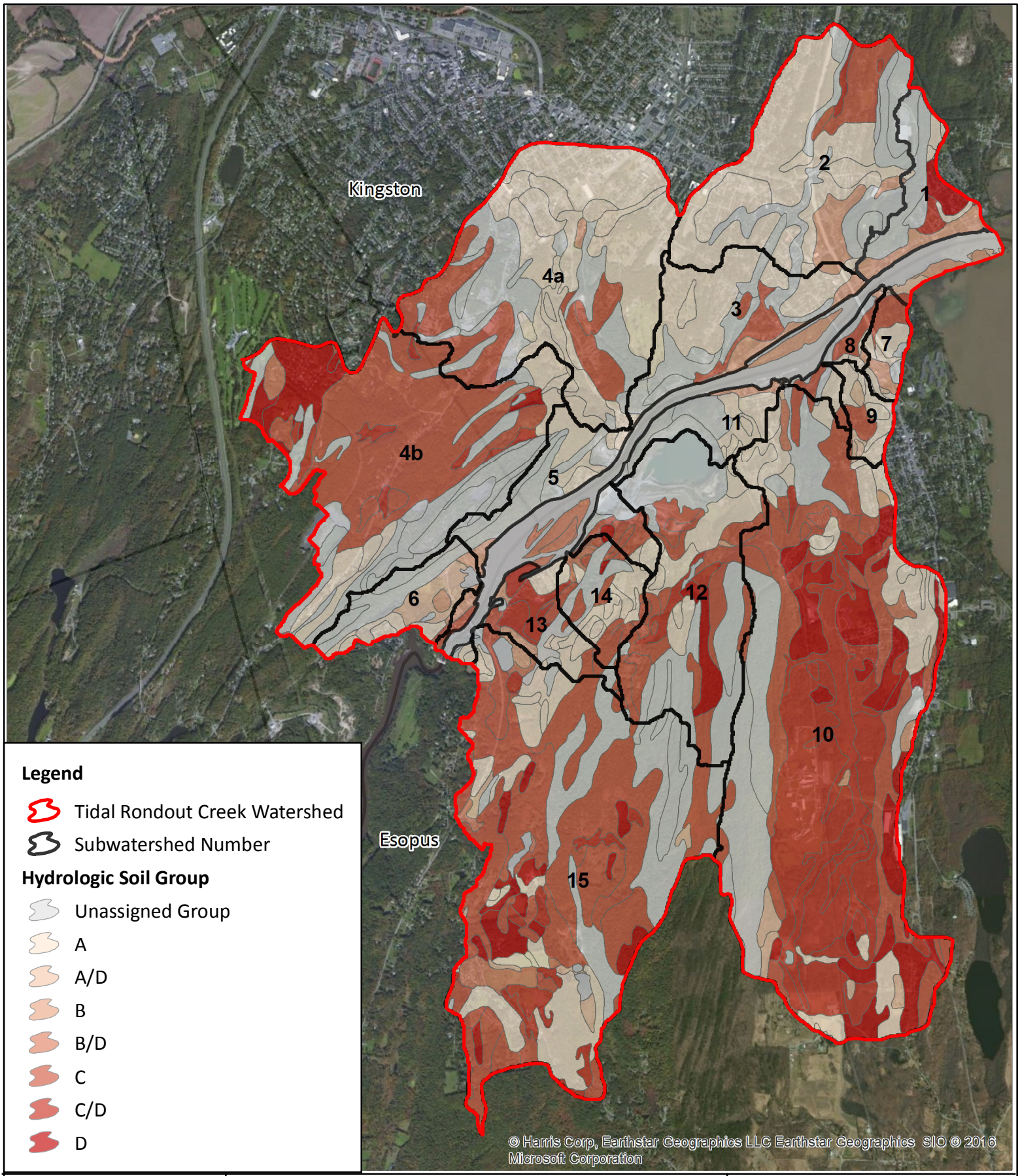
N

Tidal Rondout Creek Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\SurficialGeology_update.mxd

Map By: CMP
MMI#: 4766-01
Original: 1/15/2013
Revision: 12/20/2016
Scale: 1 inch = 3,500 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com



SOURCE(S):

Bing Aerial Imagery
NRCS Soil Survey

Figure 2-5: Soil Types

LOCATION:

Kingston, NY

N

Tidal Rondout Creek Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\Soils_update.mxd

Map By: CMP
MMI#: 4766-01
Original: 1/15/2013
Revision: 12/19/2016
Scale: 1 inch = 3,273.48 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

2.6 Stormwater

The regulatory programs focused on stormwater management are discussed in Chapter 5.0 within the context of the policy and regulatory framework for management of the Tidal Rondout Creek watershed. However, understanding stormwater management practices in the field is often as important for developing meaningful watershed management actions.

Stormwater management in the Tidal Rondout Creek watershed is highly variable. Traditional stormwater management systems with catch basins (pictured to the upper right) and piped conveyance networks are found in all three of the watershed municipalities. In densely developed areas, these types of systems are found throughout the roadway networks. In some of the less developed areas, they are found only along the major roadways. For the most part, these piped systems are directed to stormwater outfalls located along Rondout Creek, along tributary streams in the subwatersheds, or in wetlands.

In limited cases, piped stormwater systems are directed to water quality or detention basins such as the basin pictured to the lower right in the town of Esopus. This is more common in areas of newer development.

Many parts of the Tidal Rondout Creek watershed are lacking traditional stormwater systems and instead rely on roadside ditches and swales for conveyance of stormwater. In some cases, these swales are paved, but often they are bare ground or vegetated (often depending on the seasonal conditions). Examples of roadside ditches and swales from the town of Esopus are pictured below.

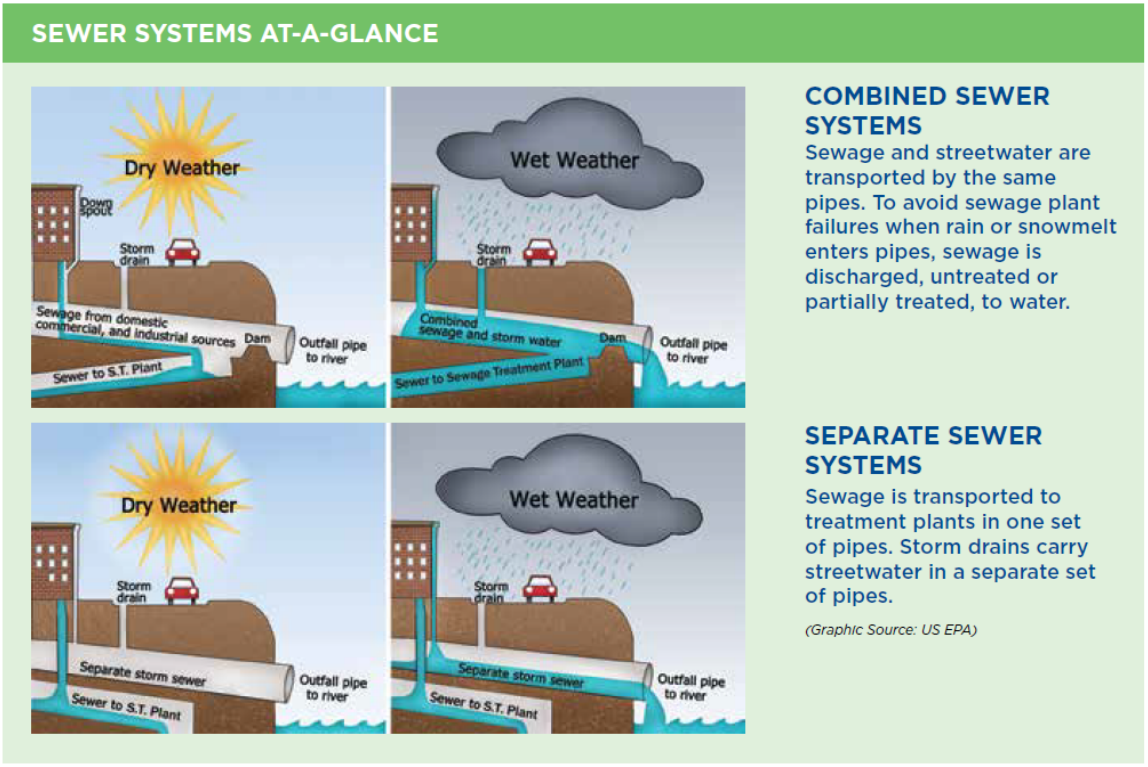
In some instances, traditional catch basin systems and swale or ditch systems are found in close proximity, often working together to convey stormwater off roads and away from developed land.

Stormwater management at small infill projects such as new single-lot developments appears to

be somewhat site specific in the Tidal Rondout Creek watershed. For example, a riprap swale (pictured to the right) was observed leading from a new home to a street that runs parallel to Twaalfskill Brook. Presumably, stormwater from this lot will combine with stormwater from the road and discharge to the brook.

Finally, there are many areas in the Tidal Rondout Creek watershed that lack stormwater management systems. Stormwater in these locations will flow overland toward the nearest receiving watercourse such as Rondout Creek or its tributary streams.

A specific concern in the Kingston portion of the Tidal Rondout Creek watershed is the presence of combined sewer overflows (CSOs). Four such overflow discharge points are located in Kingston, and they directly impact Rondout Creek and the Hudson River when they overflow during heavy rain events. A graphic that illustrates the cause of overflows **(courtesy of Riverkeeper)** is presented below.



Elimination of CSOs is an action that supports the goals and objectives of this plan. CSO elimination is a topic that is raised in the various management strategies discussed in Chapter 5.0.

2.7 Hydrology and Flooding

New York has a humid continental climate. Within Ulster County, average annual precipitation totals 46 inches, and temperature averages 49°F. Weather in New York is heavily influenced by two continental air masses: a warm, humid one from the southwest and a cold, dry one from the northwest.

Surface water hydrology is the quantitative study of the presence, form, and movement of water in and through a drainage basin. The primary independent variables affecting runoff are precipitation, watershed area, surficial geology, and slope. Dependent variables that change over short and intermediate time spans include vegetative cover, land use, wetland and floodplain water storage, reservoir size and volume, water diversion for irrigation or municipal use, and beaver dams.

For the purpose of studying sediment transport and flooding, the primary interest is in peak stream flows due to intense precipitation, sometimes in combination with snow melt. It is the peak flood flows that shape and form the river channels, scour the banks, and carry the majority of sediment. Subsequent storm runoff events, perhaps up to the mean annual flood, also convey sediment and tend to dominate the formation of the inner channel dimensions, bars, pools, and riffles. Monthly mean stream flow rates are a good indicator of seasonal flow patterns that affect water supply, habitat, and recreation.

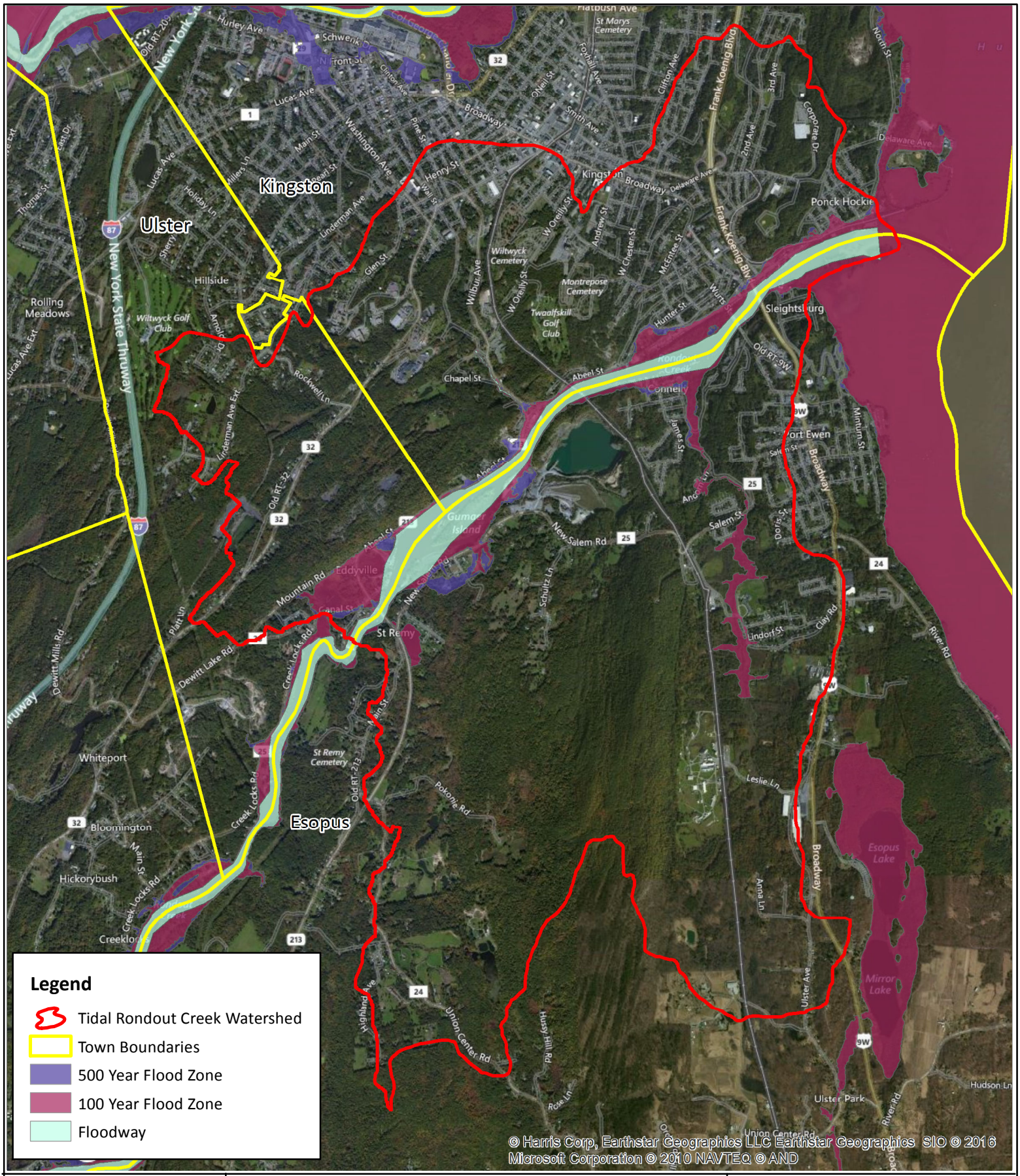
Consideration of floods is essential in the context of watershed planning. Floods are a significant cause of water quality impairment in many watersheds. Floodwaters mobilize pollutants from developed land including petroleum products, chemicals, and sanitary wastewater. Floodwaters can disengage tanks, equipment, and vehicles and carry them downstream to sensitive watercourses. Reduction of flood damage is one of the most important aspects of protecting water quality.

A watershed's peak stream flow rates can be obtained or estimated using several different techniques, including direct measurement, use of gauge data in nearby watersheds, or statistical analysis (such as the United States Geological Survey [USGS] *StreamStats* program). Some of these methods were employed for Rondout Creek. A discussion is included in Appendix D.

The Federal Emergency Management Agency (FEMA) provides a community's basic flood risk information in the Flood Insurance Study (FIS) and the Flood Insurance Rate Map (FIRM). FEMA's delineation of flood risk is divided into Special Flood Hazard Areas (SFHAs) [areas that are colloquially known as 100-year floodplains but more accurately described as places that are at risk from the 1% annual chance flood] and 500-year flood zones [places that are at risk from the 0.2% annual chance flood].

The current FIS for Ulster County became effective on September 25, 2009 and was then updated December 12, 2011 with minor corrections. The FIS covers all jurisdictions in the county, inclusive of the city of Kingston, town of Esopus, and town of Ulster.

Figure 2-6 depicts the FEMA flood risk mapping for Tidal Rondout Creek and several tributary streams.



SOURCE(S):
Bing Maps Hybrid

Figure 2-6: FEMA Mapping

LOCATION:
Kingston, NY

N

Tidal Rondout Creek
Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\FEMA_update.mxd

Map By: JEP
MMI#: 4766-01
Original: 1/15/2013
Revision: 12/20/2016
Scale: 1 inch = 3,350 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

A SFHA is delineated along Rondout Creek, merging with the SFHA of the Hudson River. Within the Tidal Rondout Creek watershed, the FIS includes analysis and flood risk mapping of only three tributary streams: "Tributary One" to Rondout Creek (Plantasie Kill), which is located in subwatershed 10 in Esopus; "Tributary Two" to Rondout Creek, which is also located in subwatershed 15 in Esopus (Swarte Kill); and Twaalfskill Brook, which is located in subwatershed 4a in Kingston.

FEMA flood zone mapping within the SFHA varies. Plantasie Kill includes flood zones A (a SFHA *without* a flood elevation determined) and AE (a SFHA *with* a flood elevation determined). Swarte Kill includes only flood zone A. Twaalfskill Brook includes flood zone AE but only upstream a short distance to Brook Street, beyond which there is no FEMA mapping.

Although the very limited delineation of SFHAs along tributary streams in the watershed may imply to some that vast areas in the watershed do not have floodplains, the fact is that all watercourses are lined with floodplains and therefore present flood risk. Furthermore, there is risk of flooding at the ground surface above streams that have long ago been relegated to underground culverts and tunnels. And with streets and developed land in these flood risk zones, water quality impairment is possible during floods.

Members of the PAC and the public have described many instances of flood damage and resulting pollution. For example, stormwater flowing down steep slopes in Kingston has resulted in physical damage and its associated pollution. Water-borne diesel pollution reportedly occurred during Hurricane Irene in 2011.

While swiftly flowing floodwaters are of concern, flood inundation also mobilizes pollutants. The wastewater treatment plant in Kingston has been flooded many times, putting water quality at risk of pollution from sanitary wastewater. Another manner in which floods can cause pollution from sanitary wastewater is when floodwaters enter stormwater collection systems and cause overflows of combined sewer systems downstream.

Tidally-influenced flooding of Rondout Creek (pictured to the right) and the effect of sea level rise are important considerations of the subject watershed management plan. Chapter 3 will review these issues in the context of the *Kingston Climate Action Plan* and *Planning for Rising Waters.*

2.8 Water Quality

Priority Water Bodies and Impaired Waters

In order to fulfill requirements of the Federal Clean Water Act, the NYSDEC must provide periodic assessments of the quality of the water resources in the state and their ability to support specific uses. These assessments reflect monitoring and water quality information drawn from a number of programs and sources both within and outside NYSDEC. This

information has been compiled by the Division of Water and merged into an inventory database of all water bodies in New York State. The database is used to record current water quality information, characterize known and/or suspected water quality problems and issues, and track progress toward their resolution.

This inventory of water quality information is the division's "Waterbody Inventory/Priority Waterbodies List" (WI/PWL). The Lower Hudson River Basin WI/PWL was last published in August 2008. **Rondout Creek was listed as having "no known impact."**

The New York State Section 303(d) Lists of Impaired Waters (2012, 2013, 2014) identify waters that do not support appropriate uses and that may require development of a Total Maximum Daily Load (TMDL). **Rondout Creek and its tributaries *are not listed* in these inventories.**

Water Quality Standards and Classifications

The NYSDEC Water Quality Standards and Classifications program is responsible for setting ambient water quality standards and guidance values for surface water and groundwaters. The program is also responsible for the classification of surface waters for their best usage. All waters in New York State are assigned a letter classification that denotes their best uses. Letter classes such as A, B, C, and D are assigned to fresh surface waters. Table 2-5 lists the water quality classifications for Tidal Rondout Creek and associated tributaries.

The best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation although other factors may limit the use for these purposes (6NYCRR Part 701.8).

TABLE 2-5
Water Quality Classes and Standards for Tidal Rondout Creek

Name	Description	Class	Standards
Rondout Creek	From mouth to dam at Eddyville, N.Y. Enters Hudson River at Kingston	C	C
Tidal Rondout Creek	Tributaries of the Tidal Rondout Creek	C	C
Tributary of Rondout River or Creek	"Enters from south approximately 1.3 miles above mouth of Rondout River."	C	C
Tributary of Rondout River or Creek	"Enters Rondout River from south near and below Eddyville dam."	C	C

Over time, the City of Kingston would like to see measureable improvements in water quality within Rondout Creek that could lead to an improved water quality designation. Specifically, the city would like to achieve a Class B designation within Rondout Creek.

The best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival (6NYCRR Part 701.7).

Water Quality Testing

City of Kingston Monitoring, 2006-2007

The City of Kingston's 2010 CSO Long-Term Control Plan (LTCP) includes the results of the city's 2006 and 2007 water quality monitoring associated with the city's CSOs. According to the plan, "six sites were sampled in 2006 and five sites were sampled in 2007. The sampling included measurements of dissolved oxygen, fecal coliform, total suspended solids (2007 only) and visual observation of floatables in the creek." The results of the sampling indicated that Fecal Coliform is a parameter of concern. However, no information was provided on the occurrence of overflows during these sampling events. Therefore, there is no direct indication that the high fecal bacteria readings are related to combined sewer system overflows although this is suspected.

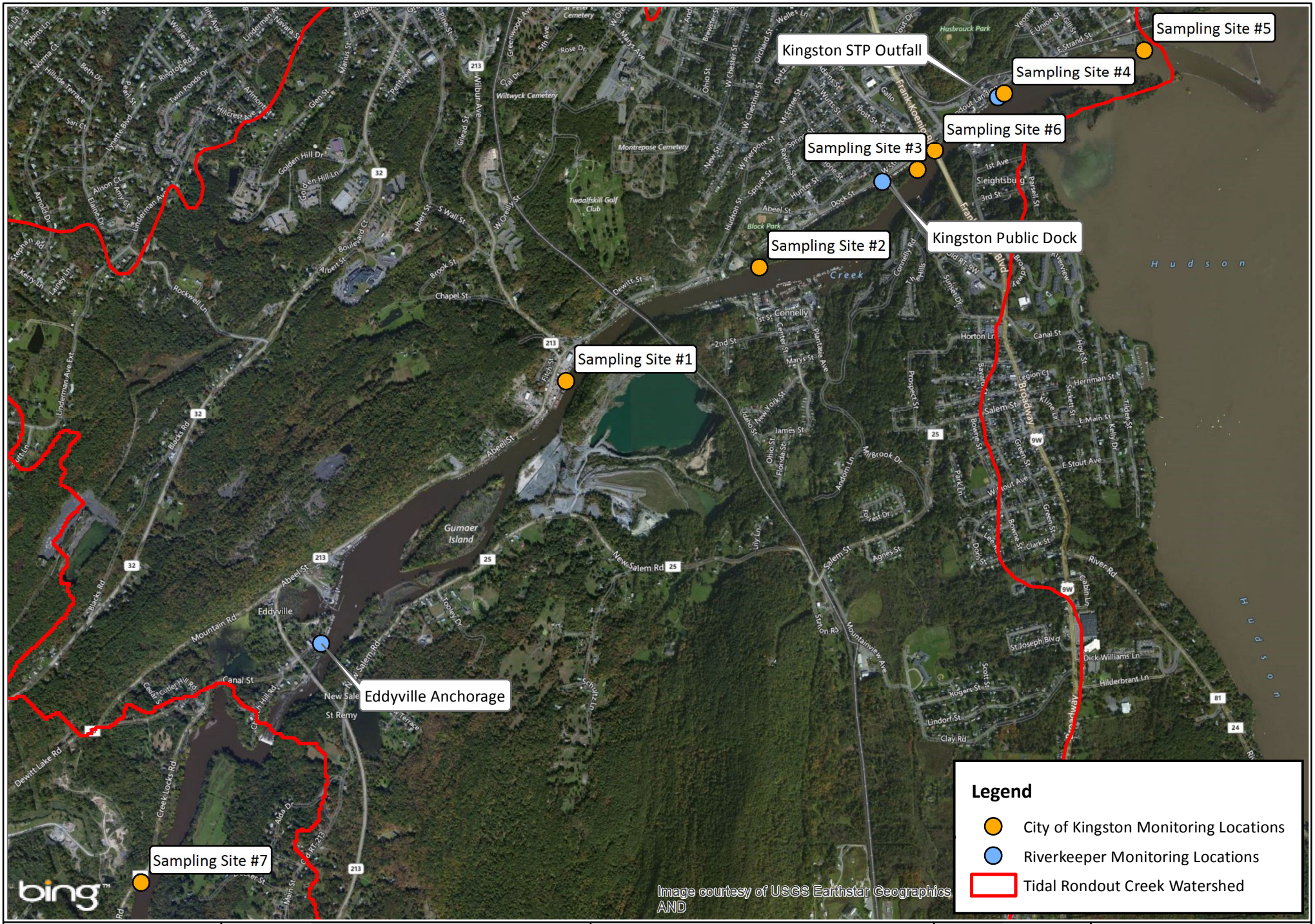
2014 Water Quality Study

As part of the approved LTCP for the City of Kingston, Malcolm Pirnie, Inc. (the water division of ARCADIS) was retained to perform sampling in the tidal section of Rondout Creek. Seven sites were sampled for total coliform, total suspended solids, dissolved oxygen, and temperature between May 2014 and October 2014. Within the sampling period, approximately 175 samples were collected and analyzed for the aforementioned parameters. Six of the seven sampling locations are located in the tidal section of Rondout Creek and the last located upstream of the Eddyville Dam representing upstream source point and nonpoint contamination. The sampling locations can be seen on Figure 2-7. CSOs were identified for the Post Construction Monitoring program including installation of flow meters at the outfalls. As a result of the monitoring, it was determined that Rondout Creek is not impaired or precluded from meeting Water Quality Standards (WQS) set by NYSDEC.

To make this determination, several factors were assessed based on the WQS set by NYSDEC. Standards considered in analysis of samples were:

- The fecal coliform standard for both Class B and C designations states that the geometric mean of no less than five examinations shall be less than 200 colony-forming units per 100 milliliter (CFU/100mL).
- The applicable standard for both total suspended solids (TSS) and settleable solids states that "None from sewage, industrial wastes, or other wastes that will cause deposition or impair the water for their best usages."
- The applicable dissolved oxygen (DO) standard "For non-trout waters, the minimum daily average shall not be less than 5.0 mg/L, and at no time shall the DO concentration be less than 4.0 mg/L."
- In nontrout waters, the water temperature at the surface of a stream shall not be raised to more than 90 degrees Fahrenheit at any point.

Water quality was collected during dry and wet conditions to assess the potential impact from CSOs. Samples were conducted five times per month at seven locations. The dry-weather sample events were conducted weekly no earlier than 48 to 72 hours post rainfall event.



SOURCE(S): BING Aerial Imagery	N **Figure 2-7: Existing Monitoring Locations** MXD: P:\4766-01\Design\GIS\Maps\Existing Water Quality_update.mxd	**Tidal Rondout Creek Watershed Management Plan** **LOCATION: Kingston, NY**	**Map By:** CMP **MMI#:** 4766-01 **Original:** 6/15/2015 **Revision:** 12/20/2016 **Scale:** 1 in = 2,000 ft	MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

Wet-weather sampling occurred within 4 to 8 hours of the start of a precipitation event. Sampling of the water body was performed from a boat using a GPS unit to ensure consistent sampling location. As requested by NYSDEC in the approval for the city's LTCP, SMARTCOVER-S units were installed at the four CSO locations to monitor flow.

A total of four dry-weather sampling events occurred each month from May through September of 2014 along with four wet-weather sampling events from May through October. Rainfall that occurred prior to the wet-weather sampling ranged from 0.27 to 1.4 inches providing a range of discharges to observe possible coliform and TSS. To compare the results of the seven sampling locations to the WQS, geomeans (geometric means) were calculated by averaging in the duplicate samples and taking the geomean of the averaged values. Overall, the geomean values from the collected samples did not exceed the WQS over the 5-month monitoring period.

Settleable solids and TSS were sampled during both wet- and dry-weather events. Calculated monthly arithmetic means for settleable solids remained at 0.1 mL/L with the exception of a single month for site 7. Values for TSS remained fairly low ranging between 1.8 and 9.2 mg/L. Both outcomes of sampling for settleable solids and TSS indicate that these parameters do not cause deposition or impair the waters for their intended use.

Temperature and DO measurements were taken at the same time as the bacteria samples. Temperature measurements ranged depending on the season and time of day, but all remained within the WQS. DO measurements remained within the WQS as well.

In summary, a total of 20 dry-weather events and four wet-weather events were sampled at the seven locations identified in Figure 2-7. Dry-weather samples were collected to develop an understanding of the typical or background water quality parameters in contrast to the wet-weather samples, which would determine the water quality impacts that rain events had on Rondout Creek. In conclusion, water quality in Rondout Creek assessed in the study did not exceed the WQS set by NYSDEC under a range of weather conditions.

Riverkeeper

Riverkeeper is an environmental nonprofit organization dedicated to the protection of the Hudson River and its tributaries as well as the watersheds that provide New York City with its drinking water. Water quality testing locations are located throughout the counties that surround the Hudson River. Within the limits of the watershed in the city of Kingston and towns of Esopus and Ulster, there are three water sampling sites as shown on Figure 2-7 and described below. One additional site of interest is located at Kingston Point Beach, a short distance outside the watershed.

- Ulster Eddyville Anchorage – This site at Rondout Creek is heavily used for boating, kayaking, rafting, swimming, and fishing.
- Kingston Sewage Treatment Plant Outfall – The sewage treatment plant discharges into Rondout Creek here. Rondout Creek is heavily used for boating, team rowing, kayaking, and fishing.

- ❑ Kingston Public Dock – The town docks of Kingston and West Strand Park host a marina, recreational boating, fishing, and kayaking on Rondout Creek. There is a CSO at the site.
- ❑ Kingston Point Beach – This official beach has swimming, fishing from the shoreline, kayaking, and recreational boating in the vicinity.

The measurements taken at each site include *enterococcus* count, temperature, salinity, chlorophyll, turbidity, oxygen, and rainfall on the day of, prior day, 2 days prior, 3 days prior, and 5 days prior to when the sample was taken. Based on the *enterococcus* count, a commonly used indicator of water quality and sewage contamination presented as colony-forming units per 100 ml of water, each sample is ranked as acceptable, possible risk, or unacceptable. Sampling results from May 2008 through September 2013 are listed in Table 2-6.

TABLE 2-6
Riverkeeper Sampling Results

Testing Location	Acceptable	Possible Risk	Unacceptable
Kingston Point Beach	78.38%	5.41%	16.22%
Kingston Public Dock	40.54%	16.22%	43.24%
Kingston Sewage Treatment Plant Outfall	23.08%	25.64%	51.28%
Ulster Eddyville Anchorage	70.59%	2.94%	26.47%

The Riverkeeper sampling results indicate that water quality in the vicinity of the Kingston Sewage Treatment Plant (STP) outfall and Kingston Public Dock appear to be the most adversely affected by adjacent land uses, stormwater, and CSOs.

Subsequent to the provision of data for 2008-2013, Riverkeeper published its report entitled *How's the Water 2014 – Water Quality Monitoring, Fecal Contamination, and Achieving a Swimmable Hudson River.* The report summarized water quality data gathered from 2008 through 2013 at 74 locations in the Hudson River estuary watershed, and was available for most of the duration of the development of this watershed management plan. Some of the findings were notable:

While focusing on sewage, the Riverkeeper report notes that it is just one of the pollutants in the Hudson River estuary and its tributaries. Other pollutants include PCBs, nutrients, heavy metals, pharmaceuticals and personal care products, pesticides, etc.

- ❑ The Kingston STP outfall site is one of the top 10 sites – of all sites sampled along tidal waters – with the highest failure of the Environmental Protection Agency's (EPA) proposed Beach Action Value (BAV) [equal to the an *entero* count of 60] with a failure rate of 53% of samples.
- ❑ Of the top ten sites with the highest BAV failure rates along tributaries, half are located in the larger Rondout Creek watershed. All five sites are located along the Wallkill River.
- ❑ The sample site on Rondout Creek below Rondout Reservoir is one of the top ten with the lowest failure rate.

Riverkeeper's sampling found that 23% of samples at Eddyville would have closed swimming areas if managed according to EPA guidelines. At the Kingston Public Dock, 44% of samples would have closed swimming areas, and at the STP outfall, a total of 53% would have closed swimming areas. The geometric mean score and statistical threshold value score (measures of water quality over time) for all three of these sites would have resulted in beach advisories and potential actions to improve water quality.

Riverkeeper's 2015 report *How's the Water 2015 – Fecal Contamination in the Hudson River and its Tributaries* provided addition data. A copy is included as Appendix G. The report continued to support Riverkeeper's conclusions. The Riverkeeper action agenda is concise and clear:

- Improve monitoring, modeling and public notification so the public is informed about risks associated with contamination, and water quality is properly assessed so investments can be prioritized.
- Invest in clean water including sewage infrastructure; watershed protection plan implementation; green infrastructure; and management of animal feeding operations, farms and septic systems.
- Enforce the Clean Water Act by verifying impairments identified by citizen water sampling, tightening pollution discharge permit conditions and enforcing compliance, and prioritizing projects to reduce pollution.
- Develop new science-based tools to better understand pollution sources, wastewater contaminants, and their impacts on human and environmental health.

How's the Water 2015 – Fecal Contamination in the Hudson River and its Tributaries
Findings at a Glance (paraphrased)

Contamination Varies: At Hudson River sites sampled, contamination varies from location to location and over time. Sites vary in frequency and degree of contamination.
Rain Increases Contamination: At river sites sampled, the failure rate against EPA's Beach Action Value (BAV) is 12% after dry periods but 35% after rain. The increase in contamination is most pronounced near communities with combined sewers, in tidal tributaries, and urban near-shore areas.
Contamination is Greater in Tributaries: At river sites sampled, the failure rate against EPA's BAV is 18% in the mid-channel and near-shore areas tested, but twice that (36%) in and at the mouths of tidal tributaries.
Contamination Levels Differ by Tributary: At non-tidal tributary sites, the frequency and degree of contamination is greater than in the river, including the tidal portions of its tributaries. The frequency and degree of contamination vary among tributaries.
Rain Increases Contamination in Tributaries: At non-tidal tributary sites, the failure rate against EPA's BAV is 59% after dry periods but 85% after rain.

Summary

In summary, the city's water quality studies have found that water quality parameters in Rondout Creek did not exceed the WQS set by NYSDEC whereas the monitoring results summarized in the Riverkeeper report demonstrate that water quality in Rondout Creek stands to benefit from improvements that reduce pollution in runoff, combined sewer overflows, and other activities that degrade water quality.

These conclusions are not mutually exclusive nor do they directly contrast with the lack of Rondout Creek appearing on the Section 303(d) Lists of Impaired Waters. The bottom line is that there is room for improvement in the water quality found in Rondout Creek despite its absence from the impaired water inventories over the last few years.

2.9 Wetland Habitats and Natural Heritage Areas

State-regulated freshwater wetlands data was accessed and reviewed using the Environmental Resource Mapper found on the NYSDEC webpage http://www.dec.ny.gov/imsmaps/ERM/viewer.htm. According to the mapper, state-regulated freshwater wetlands are located within the Tidal Rondout Creek watershed. Most of these wetlands are mapped in the Eddyville subwatershed, Twaalfskill West subwatershed, and in the rural headwaters of the Esopus and New Salem subwatersheds where Plantasie Kill and Swarte Kill have their headwaters.

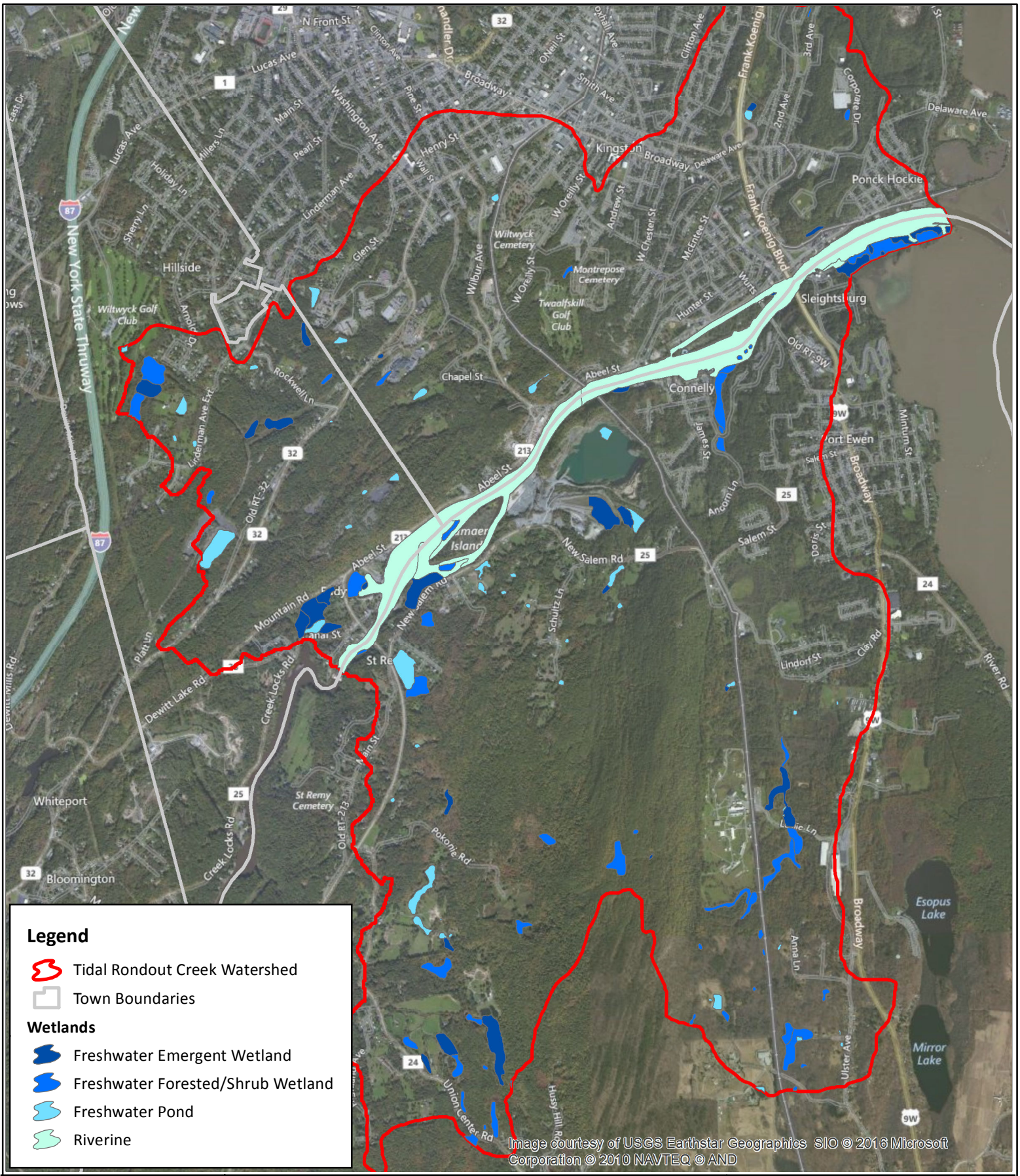
Figure 2-8 depicts emergent, forested/shrub, and open water (pond) wetlands. Some of these are illustrated in the freshwater wetland zones depicted by Environmental Resource Mapper as well. Similar to the NYSDEC mapped wetlands, most of these wetlands are mapped in the Esopus, New Salem, Eddyville, and Twaalfskill West subwatersheds. These are the subwatersheds with the most undeveloped and rural land.

The New York Natural Heritage data was accessed and reviewed using the same Environmental Resource Mapper found on the NYSDEC webpage. According to the mapper, there are known and/or documented rare animals and/or plants within the Tidal Rondout Creek watershed. These are oriented mainly along Rondout Creek.

2.10 Bureau of Fisheries Annual Report

The NYSDEC Division of Fish, Wildlife and Marine Resources, Bureau of Fisheries delivers a diverse program and annually conducts a wide array of activities to accomplish its mission to "conserve and enhance New York State's abundant and diverse populations of freshwater fishes while providing the public with quality recreational angling opportunities." This report provides a summary of significant activities completed during fiscal year 2009-2010 by Bureau of Fisheries staff located in nine regional offices, two research stations, 12 fish hatcheries, and one fish disease laboratory as well as the DEC Central Office in Albany.

Electrofishing surveys were conducted to sample the black bass populations in the tidal portion of Rondout Creek during late October 2009. The survey purpose was to help assess the Hudson River black bass population's response to a fall 2006 regulation change that increased the minimum size limit for bass from 12 inches up to 15 inches. In the tidal Rondout Creek, 182 largemouth bass and five smallmouth bass were collected in 2 hours of electrofishing. Nearly 45% of the bass collected were over 15 inches. Over the next several years, the fishery was to be monitored in a variety of ways to assess the effectiveness of the new size regulation.



SOURCE(S):

Bing Maps Hybrid
National Wetlands Inventory-
New York Wetlands Layer

Figure 2-8: Wetlands Map

LOCATION:

Kingston, NY

N

Tidal Rondout Creek
Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\Wetlands_updates.mxd

Map By: CMP
MMI#: 4766-01
Original: 1/15/2013
Revision: 12/20/2016
Scale: 1 inch = 3,000 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Gillnets were set in Rondout Reservoir with the objective of documenting the status of the trout population in the reservoir. This reservoir is currently stocked with brown trout yearlings and lake trout yearlings, with wild fish of both species also present. Of the 67 brown trout collected, 55 (82%) were of hatchery origin, indicating that the stocking policy contributes substantially to the brown trout population. All 18 of the lake trout collected were wild, indicating that the lake trout stocking policy may no longer be making a significant contribution to the fishery.

The NYSDEC Fish Disease Control Center maintains a fish health program for the DEC hatchery system. Fish samples were collected from Rondout Creek and other watercourses as part of a mercury sampling program. The sections sampled were located downstream of NYCDEP reservoirs. The fish samples were analyzed for mercury, and approximately half of the samples were analyzed for PCBs and selected pesticides. All results were below actionable levels.

The above sources of information indicate that fisheries health is good in the overall Rondout Creek watershed and specifically in the Tidal Rondout Creek.

2.11 Impervious Surfaces

A breakdown of imperviousness and road densities for individual subwatersheds is presented in Table 2-7.

TABLE 2-7
Subwatershed Development and Road Density Summary

Number	Subwatershed Name	% Impervious	Streams (mi)	Roads (mi)	Road/Stream Ratio
1	Waterfront	25.3%	0.4	3.7	9.3
2	Kingston	31.0%	0.3	17.9	59.7
3	Downtown West	24.3%	0*	7.8	N/A
4a	Twaalfskill Brook East	20.4%	1.5	13.7	9.1
4b	Twaalfskill Brook West	2.8%	2.3	5	2.2
4c	Tannery Brook	13.9%	0.7	4.4	6.3
5	West Bank	8.8%	0*	1.6	N/A
6	Eddyville	5.5%	0*	1.7	N/A
7	Sleightsburg	34.9%	0.25	1.9	7.6
8	Bridge	22.0%	0*	1.6	N/A
9	Port Ewen	28.4%	0.5	1.5	3.0
10	Esopus	7.8%	2.3	11.1	4.8
11	Connelly	13.7%	0*	0.9	N/A
12	Mingo Hollow	6.0%	0.6	0.9	1.6
13	East Bank	10.8%	0*	1.7	N/A
14	West Mingo Hollow	1.4%	0*	0.5	N/A
15	New Salem	1.4%	3.2	4.8	1.5
	Total:	11.0%	12.1	80.6	6.7

*Very limited stream segments may be present.

These impervious surface figures are based on the land uses listed in Table 2-4 as follows:

- The percent impervious cover for the low, medium, and high intensity development land uses was assumed to be 45%, 55%, and 88%, respectively, based on an analysis of National Land Cover Database (NLDC) land cover mapping[2].
- A figure of 12% was assumed for developed open space.
- The remaining land uses in Table 2-4 were assumed to have minimal impervious surfaces although this plan recognizes that roads are located in most of the subwatersheds, and they are impervious.

As a point of reference, the *Interim Watershed Management Plan for Lower Nontidal Rondout Creek* notes that the overall degree of imperviousness in the entire Rondout Creek watershed is 9%. The same document estimates that the average imperviousness in the tidal Rondout Creek watershed is 14.7% to 18.5%. This range is consistent with the figures listed in Table 2-7.

Higher road densities are generally associated with subwatersheds with higher percentages of development. Higher ratios of roads to streams will translate to increased potential for altered hydrology and polluted runoff thereby influencing water and habitat quality in nearby water resources. Certainly, the higher ratios for Kingston, Waterfront, Tannery Brook, Twaalfskill Brook East, and Sleightsburg indicate higher percentages of development as these watersheds drain urban to suburban areas. However, many of the subwatersheds do not contain streams or only contain limited daylighted sections. Thus, the road/stream ratio is a somewhat challenging indicator to utilize when evaluating many of the subwatersheds in the overall Tidal Rondout Creek watershed.

2.12 Assessment of Critical Watershed Areas

Several methods are available for ranking watershed areas with regard to focusing future water quality protection efforts. Such ranking systems are useful for identifying what are often known as "critical" watershed areas. A critical area is generally described as that area necessary for the protection of a resource such as water quality, endangered habitat, or other environmental indicators. It is important to understand that any particular subwatershed need not be subject to the full suite of management strategies promoted in this plan. Nevertheless, a rank for each subwatershed will help decision makers prioritize future management in the watershed.

Most practitioners in the field of environmental science agree that watersheds with 10% to 25% impervious surfaces are considered to have impacted stream quality whereas greater than 25% impervious surfaces are considered nonsupporting of aquatic life.

Rather than focus on selecting a quantitative ranking system for the active watersheds, a qualitative system was applied. This allows for more flexibility. Quantitative ranking systems are reserved for larger watersheds where decision making must be applied uniformly across many communities and where abundant information on existing water quality is available.

[2] Land use information was obtained from the 2006 National Land Cover Database: Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, PE&RS, Vol. 77(9):858-864.

The factors considered herein include percent developed land and impervious surfaces, land use, zoning, relative amount of open space, distance from the tidal part of Rondout Creek, and water quality based upon available data. Table 2-8 on the following page presents the analysis.

Commentary regarding the ranking of each subwatershed is provided in the narrative below.

- Waterfront – The waterfront subwatershed is highly developed and zoned for mixed uses. It is very close to Rondout Creek without much open space, and therefore the priority for water quality management is high.

- Kingston – The Kingston subwatershed is in close proximity to Rondout Creek and includes a variety of land uses and zoning plus the Route 9W bypass. Due to the developed nature of the subwatershed (the second highest percent of imperviousness of all subwatersheds) along with very little open space and a short segment of open watercourse, the priority for water quality management is high.

- Downtown West – This subwatershed contains a variety of dense land uses and zoning along with a dense road network. It is very close to Rondout Creek and is believed to contain short stream segments; therefore, the priority for water quality management is high.

- Twallsfkill Brook East – This subwatershed contains a variety of dense land uses and zoning along with a dense road network. A golf course is partly located within this subwatershed. The brook is a central feature of this subwatershed, and it flows past roads and residences. A high priority for water quality management has been given to this area.

- Twallsfskill Brook West – This subwatershed includes residential zoning and is not highly developed. Thus, the priority for water quality management is low. However, streams are present in this subwatershed, and steps should be taken to prevent additional development that could reduce water quality.

- Tannery Brook – The Tannery Brook subwatershed is moderately developed and consists of residential and limited office use. A golf course is partly located within this subwatershed. The subwatershed has been given a moderate priority for watershed management.

- West Bank – This subwatershed is moderately developed and zoned for mixed uses. It is very close to Rondout Creek but only 8% impervious with land that has development constraints such as steep slopes; therefore, the priority for water quality management is moderate.

- Eddyville – The Eddyville subwatershed is zoned residential and is only lightly developed. Therefore, it has been given a low priority for water quality management.

TABLE 2-8
Subwatershed Prioritization for Management

#	Subwatershed	% Impervious	Zoning	Land Use	Amount of Open Space	Prioritization for WQ Management
1	Waterfront	25.3%	R-1, RRR, M-1, R-2, C-2	Residential, Commercial, Industrial	Low	High
2	Kingston	31.0%	RRR, R-1, R-2, R-5, C-2, C-3, O-2, M-1	Residential, Commercial, Residential, Industrial	Low	High
3	Downtown West	24.3%	RF-R, RRR, R-1, R-2, C-2, R-6	Rondout Creek District, Residential, Commercial	Low	High
4a	Twaalfskill East	20.4%	C-3, C-2, O-2, R-2, RRR, R-1	Commercial, Office, Residential	Low	High
4b	Twaalfskill West	2.8%	Kingston: RRR, R-1; Ulster: R-30, R-60	Residential	Moderate	Low
4c	Tannery Brook	13.9%	Kingston: RRR, R-1, O-2 Ulster: R-30	Residential, Limited Office	Moderate	Moderate
5	West Bank	8.8%	Kingston: R-1, C-3, M-2, RR, R-1; Ulster: R-10	Residential, Commercial, Industrial	Low	Moderate
6	Eddyville	5.5%	R-60, R-10	Residential	Moderate	Low
7	Sleightsburg	34.9%	R-12	Residential	Low	High
8	Bridge	22.0%	R-40, W	Residential, Commercial	Low	High
9	Port Ewen	28.4%	R-40, GC	Residential, Commercial	Low	High
10	Esopus	7.8%	R-40, H-1, L-1, R-12, GC	Residential, Industrial, Commercial	High	High
11	Connelly	13.7%	PUD, WR	Planned Development Unit, Commercial	Low	Moderate
12	Mingo Hollow	6.0%	R-40	Residential	High	Low
13	East Bank	10.8%	R-12	Residential	Low	Moderate
14	West Mingo Hollow	1.4%	R-40	Residential	High	Low
15	New Salem	1.4%	R-40	Residential	High	Low

1. R-1 = One Family Residence
2. R-2 = Two Family Residence
3. R-3 = Three Family Residence
4. R-4 = Two Story Residence
5. R-5 = Three Story Residence
6. R-6 = Multiple Residence
7. RFR = Rondout Creek District
8. RRR = One Family Residence
9. C-1 = Shopping Center
10. C-2 = Central Commercial
11. C-3 = General Commercial
12. M-1 = Light Manufacturing
13. M-2 = General Manufacturing
14. O-2 = Limited Office
15. R-T = Rondout District
16. R-10 = Residence 10,000 SF
17. R-30 = Residence 30,000 SF
18. R-60 = Residence 60,000 SF
19. R-12, R-40 = Residential
20. H-1, L-1 = Industrial
21. PUD = Planned Unit Dev.
22. W = Commercial
23. GC = Commercial

- Sleightsburg – This subwatershed is zoned residential. However, due to its proximity to Rondout Creek, the highly developed nature of the subwatershed, and the presence of a tributary stream, the priority for water quality management is high.

- Bridge – This subwatershed is highly developed and zoned for mixed uses. It is very close to Rondout Creek, and therefore, the priority for water quality management is high.

- Port Ewen – The Port Ewen subwatershed is moderately developed and is comprised of residential and commercial use. A short stream segment is present. Thus, the priority for water quality management is high.

- Esopus – Due to its large size, the Esopus subwatershed is comprised of a wide variety of residential, industrial, commercial, and agricultural uses. The Dyno Nobel facility is also located within this subwatershed. Due to the potential for these land uses to have a negative impact on water quality, coupled with the presence of the Plantasie Kill that flows through the entire subwatershed and provides a direct pathway to Rondout Creek, the priority for water quality management is high.

- Connelly – This subwatershed is zoned Planned Unit Development and commercial. Due to the moderate amount of development and the proximity to Rondout Creek, it has been given a moderate priority for water quality management.

- Mingo Hollow – This subwatershed is zoned residential and contains a large amount of open space. Thus, the priority for water quality management is low. However, a stream is present in this subwatershed, and steps should be taken to prevent additional development that could reduce water quality.

- East Bank – The East Bank subwatershed is zoned residential. Due to the moderate amount of development and the proximity to Rondout Creek, it has been given a moderate priority for water quality management.

- West Mingo Hollow – This subwatershed is small and is mostly residential. Several farm ponds are located near its terminus. The priority for water management is low.

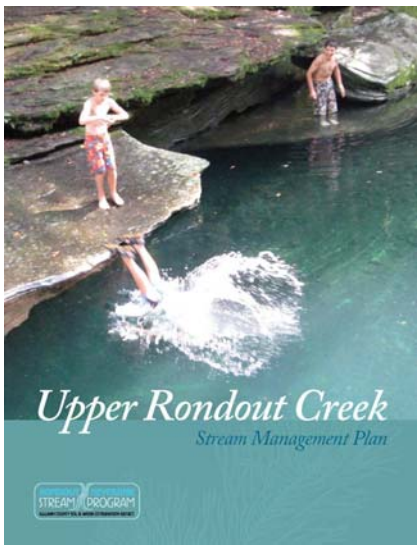
- New Salem – This large subwatershed is zoned residential and contains a large amount of open space. Thus, the priority for water management is low. However, the Swarte Kill stream system is present in this subwatershed and steps should be taken to prevent additional development that could reduce water quality.

3.0 KEY NONREGULATORY STUDIES, REPORTS, AND PLANS

Numerous studies, reports, designs, and plans have been prepared over the years to address issues in and around the Rondout Creek watershed. Some of these were briefly described in Chapters 1.0 and 2.0 within the context of the project background and watershed description. The following descriptions provide insight to watershed processes and helped inform the management strategies of this plan.

3.1 Upstream Watershed Management Plans

Upper Rondout Creek Stream Management Plan



The Upper Rondout Creek Stream Management Plan (2010) was written by the Rondout Neversink Stream Program, a part of Sullivan County Soil and Water Conservation District. This plan was adopted in November 2010 by the Towns of Neversink and Denning. The document is a guide for local residents, municipalities, interested organizations, and agencies.

The Upper Rondout Creek flows from the headwaters near Shandaken, running about 13 miles before entering the Rondout Reservoir in Neversink. Some of the water from the reservoir is utilized for public water supply and does not flow downstream to the lower sections of Rondout Creek. The watershed is approximately 48 square miles and falls primarily in the towns of Denning in Ulster County and Neversink in Sullivan County. The stream management plan summarizes multiple aspects of the watershed such as land use and land cover, wildlife and fisheries, hydrology, riparian community, and water quality and provides recommendations for improving water quality.

The Rondout main stem and one tributary were organized into 18 Management Units defined using physical stream characteristics, historical channel alignments, location of bridges and road infrastructure, and valley characteristics. The units are ranked by the level of effort suggested for the respective management activities. There are four categories of actions:

- Preservation – indicates that conditions are stable and healthy and should be protected as a reference model to guide management of other units.
- Passive restoration – indicates that there may be some instability of the channel bed, but it appears that the stream will recover from disturbance through self-correction and reestablish its stability without intervention and that the appropriate management is to monitor the reach to track its evolution.
- Assisted restoration – indicates that there is sufficient channel instability to warrant active management but that major channel work is not necessary, and management can be effective at the site scale.

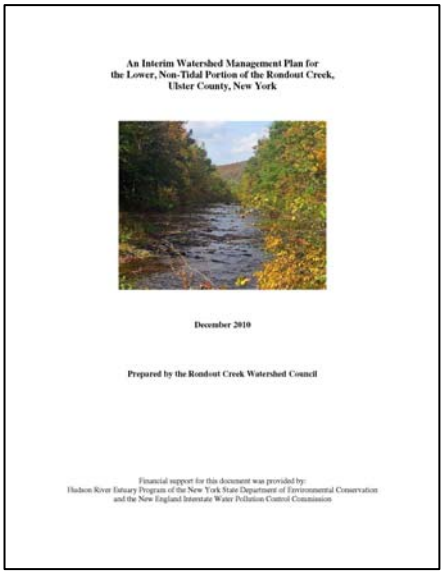
- ❑ Full restoration – indicates that significant instability problems are present that will require intervention such as channel work to reestablish its effectiveness in transporting sediment.

Most of the management units were found to require assisted restoration while two were earmarked for passive restoration, two for full restoration, and one unit (Unit 1) was earmarked for preservation. The Management Unit recommendations include specific projects in categories of stream morphology, riparian vegetation, infrastructure, aquatic habitat, flood-related threats, water quality, and further assessment. Multiple stream restoration projects were proposed to address sediment-related water quality impairment.

The Upper Rondout Creek Stream Management Plan identified a few priority recommendations. These include early detections and rapid response to invasive species, selective stream gravel management, identification of locations with potential water quality impairments, stream stability management, watershed assessment of major Rondout Creek tributaries, debris management, knotweed-free areas and spread prevention, flood hazard education sessions, flood response technical resources, and stream stewardship educational workshops.

The significance of the stream management plan and its recommendations in relation to Tidal Rondout Creek stems from the concept that the watersheds are connected. Therefore, impacts in the Upper Rondout Creek watershed will have water quality consequences downstream in the tidal section of Rondout Creek. Taking a holistic approach to the Rondout Creek watershed planning will be an effective means of protecting water quality.

Interim Watershed Management Plan for Lower Nontidal Rondout Creek


An Interim Watershed Management Plan for the Lower, Non-Tidal Portion of the Rondout Creek, Ulster County, New York

December 2010

Prepared by the Rondout Creek Watershed Council

Financial support for this document was provided by: Hudson River Estuary Program of the New York State Department of Environmental Conservation and the New England Interstate Water Pollution Control Commission

The Rondout Creek Watershed Council (RCWC) developed a watershed management plan in 2010 for the lower nontidal portion of Rondout Creek in cooperation with local municipalities. The plan states that, "the Lower Nontidal Rondout Creek maintains fairly good water quality, but numerous point and non-point sources of pollution in the watershed may threaten the health of the river, as many areas are showing slight signs of human impact." The plan also states that water quality is "moderately impacted" below the confluence of the Wallkill River and the hydroelectric dam at Sturgeon Pool.

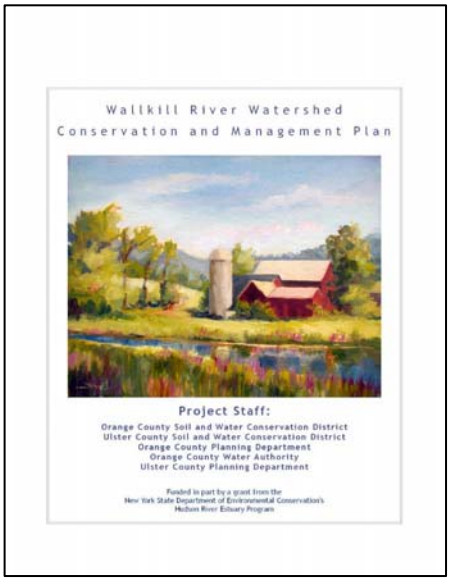
Although the lower nontidal watershed management plan predates the Riverkeeper report described in Chapter 2.0, the water quality data provided by Riverkeeper is consistent with the statement in the watershed management plan that water quality is moderately impacted. The potential sources of pollution identified are both nonpoint sources and point sources.

The lower nontidal watershed management plan organizes most of its actions under four goals – stormwater management, floodplain management, agriculture/forestry, and outreach/education. The plan generally recommends controlling nonpoint sources with improved stormwater management, low impact development, and use of green infrastructure. A selection of specific recommendations includes:

- ❑ Pursue MS4-specified actions in communities where they are not required.
- ❑ Assess water quality upstream and downstream of the State Pollutant Discharge Elimination System (SPDES) discharges.
- ❑ Manage stormwater through green infrastructure practices.
- ❑ Preserve undeveloped land.
- ❑ Ensure zero increase in runoff from developed sites.
- ❑ Limit development in floodplains.
- ❑ Create and restore buffers of vegetation along streams.
- ❑ Protect large and contiguous tracts of habitats.
- ❑ Support forestry and agricultural programs.
- ❑ Develop a watershed awareness and marketing campaign.
- ❑ Develop educational and volunteer programs.

The effective implementation of the recommendations in the *Interim Watershed Management Plan for Lower Nontidal Rondout Creek* will have a direct positive impact on the water quality within the Tidal Rondout Creek.

Wallkill River Watershed Conservation and Management Plan



The Wallkill River is a tributary of the Hudson River that commences at Lake Mohawk in Sparta, New Jersey. The River generally flows in a northeast direction into New York and drains into Rondout Creek near Tillson, about 7 miles upstream from the mouth of the Hudson River.

The *Wallkill River Watershed Conservation and Management Plan* was prepared by the Orange County and Ulster County Soil and Water Conservation Districts, Planning Departments and the Orange County Water Authority. The purpose of the plan was to identify issues within the Wallkill watershed and develop recommendations and strategies to improve overall water quality. While water quality managers felt that problem sources were fairly well understood and significant resources were already being targeted to nonpoint source control programs, it was recognized that preparation of a comprehensive management plan for the Wallkill watershed held the potential to direct existing resources more efficiently and increase the likelihood of securing additional resources.

According to the plan, "land use within the watershed is extremely diverse, ranging from agriculture and forestland to extensive commercial and residential development." The potential sources of pollution identified are both nonpoint sources and point sources, with a focus on

improved agricultural and stormwater management. A summary of a selection of recommendations from the plan includes:

- ❑ Streambank stabilization
- ❑ Flood mitigation
- ❑ Promote riparian buffers
- ❑ Adopt regulations to protect riparian areas from encroachment.
- ❑ Explore stormwater retrofit opportunities.
- ❑ Incorporate low impact development into the site plan approval process.
- ❑ Utilize overlay zones to protect water resources.
- ❑ Increase protections for steep slopes.

Because the Wallkill River and Rondout Creek watersheds are connected, improvements to the Wallkill River watershed will ultimately have a positive impact on water quality within Rondout Creek. Therefore, the benefits associated with the implementation of the *Wallkill River Watershed Conservation and Management Plan* will extend well beyond the Wallkill watershed to the tidal Rondout Creek.

Watershed Planning in New Jersey's Wallkill River Watershed

The Wallkill River Watershed Management Group (WRWMG), through grant funding provided by the New Jersey Department of Environmental Protection (NJDEP) and under the fiscal guidance of the Sussex County Municipal Utilities Authority (SCMUA), has been working for the last 10 years to develop various watershed management plans for the Wallkill River watershed in New Jersey.

In August 2008, the WRWMG submitted to NJDEP two separate but intertwined Watershed Restoration Plans for the Papakating Creek and Clove Acres Lake watersheds that represented the successful culmination of two individual grant projects. Together, these plans offer a comprehensive strategy which includes numerous specific projects, watershed tasks, and implementation themes that, once implemented, will serve to reduce annual pollutant loads, meet state and federally mandated standards, and restore water quality.

Both watershed plans were formally accepted and approved by NJDEP in January 2009, and as a result, the NJDEP awarded $1.4 million in grant funding to the WRWMG/SCMUA to begin the implementation of both plans. The WRWMG has developed a work plan that focuses on the following four major areas of effort:

- ❑ Stormwater Pollutant Loading Reduction
- ❑ Agricultural Best Management Practices (e.g., stream fencing, manure management, active conservation plans)
- ❑ Streambank Stabilization and Riparian Buffer Restoration
- ❑ Monitoring and reporting of stewardship initiatives by other community organizations regarding implementation projects

Despite the distance from New Jersey to Ulster County, the benefits associated with the implementation of the WRWMG watershed management plans will extend well beyond the Wallkill watershed to the tidal Rondout Creek.

3.2 Hazard Mitigation and Flood Mitigation Plans

Multi-Jurisdictional Natural Hazard Mitigation Plan

The Ulster County Multi-Jurisdictional Natural Hazard Mitigation Plan was adopted in 2009. The plan identifies hazards that threaten the county and provides ways to reduce future damages associated with these hazards. The purpose of hazard mitigation planning is to identify policies, actions, and tools for implementation that will, over time, work to reduce hazard risks and the potential for future losses.

In order to reduce the possibility of damage and losses due to flooding caused by floods, hurricanes, and nor'easters, the county plans to (1) limit uses in floodways to those tolerant of occasional flooding, including but not limited to agriculture, outdoor recreation, and natural resource areas; (2) continue to implement best management practices for floodplain areas; (3) identify and document repetitively flooded properties; explore mitigation opportunities for repetitively flooded properties, and if necessary, carry out acquisition, relocation, elevation, and floodproofing measures to protect these properties; and (4) develop specific mitigation solutions for floodprone road systems (roads, bridges, intersections, drainage, etc.) under the leadership of the county Department of Public Works.

The City of Kingston developed the following list of implementation strategies that pertain to locations in the Tidal Rondout Creek watershed:

- ❑ Drainage improvements on three sections of Linderman Avenue, replace culvert, stabilize streambank, and work with Twin Ponds development to address issues and mitigate flooding downstream from the development [this is believed to be the Tannery Brook subwatershed].
- ❑ Replace existing stormwater pipe and culvert along the Jacobs Valley storm sewer line near Wiltwyck Cemetery and alleviate flooding at the Broadway underpass and Susan Street area that occurs during any significant rainfall [this is believed to be the Twaalfskill Brook subwatershed].
- ❑ Stream stabilization at Twaalfskill Creek adjacent to Wilbur Avenue and Chapel Street to prevent reoccurrence of erosion that causes road to slide into creek and threatens water and sewer lines [Twaalfskill Brook subwatershed].

Because flood mitigation has direct benefits to water quality, Kingston's hazard mitigation plan strategies are supportive of this watershed management plan.

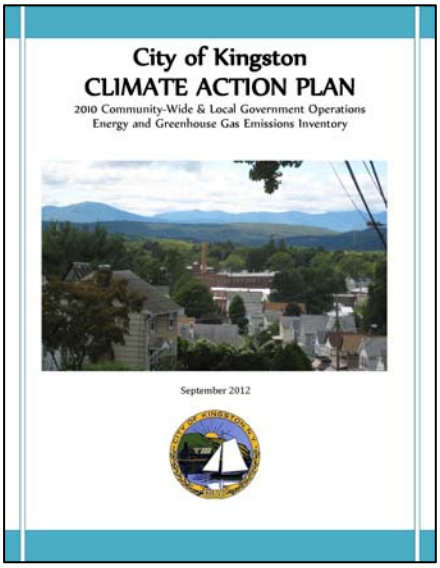
The Town of Ulster developed a list of mitigation strategies, but all of the strategies for the Town of Ulster are in the Esopus Creek watershed, outside the Tidal Rondout Creek watershed that is the subject of this watershed management plan. The Town of Esopus did not participate in the development of the hazard mitigation plan.

NYCDEP Local Flood Analysis (LFA) Program

The NYCDEP's LFA program was unveiled in 2013-2014 to provide funding to NYCDEP watershed communities for flood mitigation studies that identify specific projects that will protect water quality through flood mitigation. Numerous LFAs are under development as of 2015 in the Rondout, Neversink, East Branch Delaware River, and West Branch Delaware River watersheds[3]. When completed, these LFAs will identify flood mitigation projects that reduce the mobilization of pollutants during floods. This will prevent these pollutants from traveling to Rondout Reservoir and ultimately will help protect the Tidal Rondout Creek.

3.3 Climate Action and Adaptation Plans

The City of Kingston Climate Action Plan



The City of Kingston Climate Action Plan was developed to advance the city's efforts with regard to mitigating carbon emissions and adapting to climate change. The plan made several recommendations regarding measures that can be employed to reduce greenhouse gas emissions, enhance operational and energy efficiencies, reduce energy costs, support local job growth, and adapt to a changing climate while improving quality of life. The policies of the plan are being incorporated by reference into the Kingston Comprehensive Plan and include recommendations for government operations, facilities, equipment, and decision-making considerations.

One particular policy of the Climate Action Plan is directly applicable to watershed management:

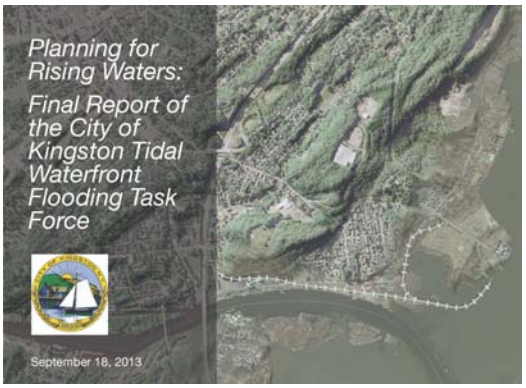
- ❑ Adopt a local "green infrastructure" ordinance promoting the use of rain gardens, vegetated swales, green roofs, and porous pavement that recharge groundwater systems or retain water on site to the maximum practical extent instead of detaining and conveying stormwater off site.

Planning for Rising Waters: Final Report of the City of Kingston Tidal Waterfront Flooding Task Force

The Kingston Tidal Waterfront Flooding Task Force was created in October 2012 to assess local risks and develop strategies to create a more vibrant waterfront and to address waterfront flooding and sea level rise. In September 2013, the Task Force finalized its recommendations in the report titled *Planning for Rising Waters: Final Report of the City of Kingston Tidal Waterfront Flooding Task Force*. The following themes were used in the development of its report:

[3] The reservoirs of Neversink River, East Branch Delaware River, and West Branch Delaware River are connected to the Rondout Reservoir via a series of aqueducts.

"(1) Recognize waterfront history and preserve a sense of community and a 'sense of place,' (2) Promote a waterfront economy and economic revitalization, (3) Prioritize health and safety, (4) Secure infrastructure, and (5) Promote the implementation of Kingston's Climate Action Plan, including reduction of greenhouse gas emissions through green architecture and infrastructure."



The following recommendations are taken directly from the report and are significant to effective watershed management planning. Various aspects of the selected recommendations are discussed further in Chapter 6.0 with respect to long-term strategies:

- ❑ Ensure that all relevant city staff and elected and appointed officials are fully trained in and expected to incorporate impacts of flooding and sea level rise into their daily work.
- ❑ Ensure that zoning designations consider the increasing risk and vulnerability from flooding and sea level rise.
- ❑ Require that proposals for new development of any kind in the Flood Hazard Overlay District take flood risk into account.
- ❑ Reduce stormwater, upland flooding, and combined sewer overflows through green infrastructure and best stormwater management practices.
- ❑ Evaluate the use of natural buffers and green shoreline infrastructure to reduce flood risk and erosion and conserve natural resource functions.
- ❑ Ensure that local street networks, utilities, and other infrastructure function and remain connected as the city implements adaptation strategies to sea level rise.
- ❑ Ensure opportunities exist for open space and recreation over the long term.
- ❑ Develop a plan to mitigate both near- and long-term risk to the wastewater treatment facility.
- ❑ Study the feasibility of using policy, zoning and building codes to achieve creative, water-dependent and water-enhanced uses that are resilient, including elevated, amphibious, or floating structures, wharves, berms, and elevated rights of way.
- ❑ Develop a Kingston Waterfront Long-Term Resiliency Plan.

It is important to emphasize that flooding presents many safety hazards to people and property and can cause extensive damage. Therefore, recommendations in *Planning for Rising Waters* will directly improve water quality within Tidal Rondout Creek.

4.0 REGULATORY AND COMMUNITY PLANS AND POLICIES

4.1 Federal and State Policies and Regulations

Clean Water Act (CWA)

The CWA (Water Pollution Prevention and Control, U.S. C Title 33 Section 1251) requires states to classify waters according to their best uses and to adopt water quality standards that support those uses (for example, Rondout Creek is Class C). Section 404 of the CWA requires that anyone proposing to deposit dredged or fill material into waters of the United States, including wetlands, must receive authorization for such activities. The U.S. Army Corps of Engineers (USACE) has been assigned responsibility for administering the Section 404 permitting process.

New York State Department of State (NYSDOS) Division of Coastal Resources

The Division of Coastal Resources helps protect and enhance coastal and inland water resources and encourages appropriate land use. The Division also works in partnership with local governments in preparation of Local Waterfront Revitalization Programs that serve as comprehensive land and water use plans as well as intermunicipal watershed management plans, such as this plan, that identify problems and threats to water quality and opportunities for achieving long-lasting improvements in water quality and establishes priorities for action. Financial assistance for the preparation and implementation of such programs and plans is available through the Environmental Protection Fund (EPF).

New York State Department of Agriculture and Markets

The Department of Agriculture and Markets provides administrative support to the state Soil and Water Conservation Committee (SWCC), which in turn provides guidance to the county Soil and Water Conservation Districts (SWCD). The SWCD offers technical assistance with services that include, but are not limited to, watershed management, nonpoint source pollution control, and nutrient management plans. In addition, the Department of Agriculture and Markets oversees many aspects of farming that cannot be regulated by municipalities.

New York State Department of Health (NYSDOH)

The DOH monitors impacts of nonpoint source pollution through water quality monitoring and reporting programs. New York Public Health Law contains statutes regulating the protection of public water supplies from contamination due to source and nonpoint source pollution.

New York State Department of Environmental Conservation (NYSDEC)

The NYSDEC works to reduce water pollution through technical assistance for prevention, education, and monitoring. The NYSDEC also provides financial assistance to local governments for a variety of water quality projects. The NYSDEC has extensive regulatory authority through its administration of the New York State Environmental Conservation Law (ECL).

Municipal Separate Storm Sewer Systems (MS4)

According to the federal law commonly known as Stormwater Phase II, permits are required for stormwater discharges from Municipal Separate Storm Sewer Systems (MS4) in urbanized areas and those additionally designated by NYSDEC. Owners or operators of such MS4s must be authorized in accordance with the State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges from Municipal Separate Storm Sewer Systems. A SPDES permit requires the development of a stormwater management plan that incorporates the following methods designed to reduce the discharge of pollutants:

Kingston, Esopus, and Ulster each holds an SPDES General Permit for MS4 facilities and is therefore subject to compliance with the Stormwater Phase II rule.

- ❑ Public Education and Outreach – Educate all property owners, especially those within the MS4 boundaries, on the importance of incorporating responsible stormwater management practices.

- ❑ Public Involvement/Participation – Encourage public participation in the development and implementation of the stormwater management plan.

- ❑ Illicit Discharge Detection and Elimination – Identify and eliminate illicit discharges into the MS4 systems. Outfall mapping is a key component of this measure.

- ❑ Construction Site Runoff Control – Develop, implement, and enforce an erosion and sediment control program for construction activities that disturb greater than or equal to 1 acre of land.

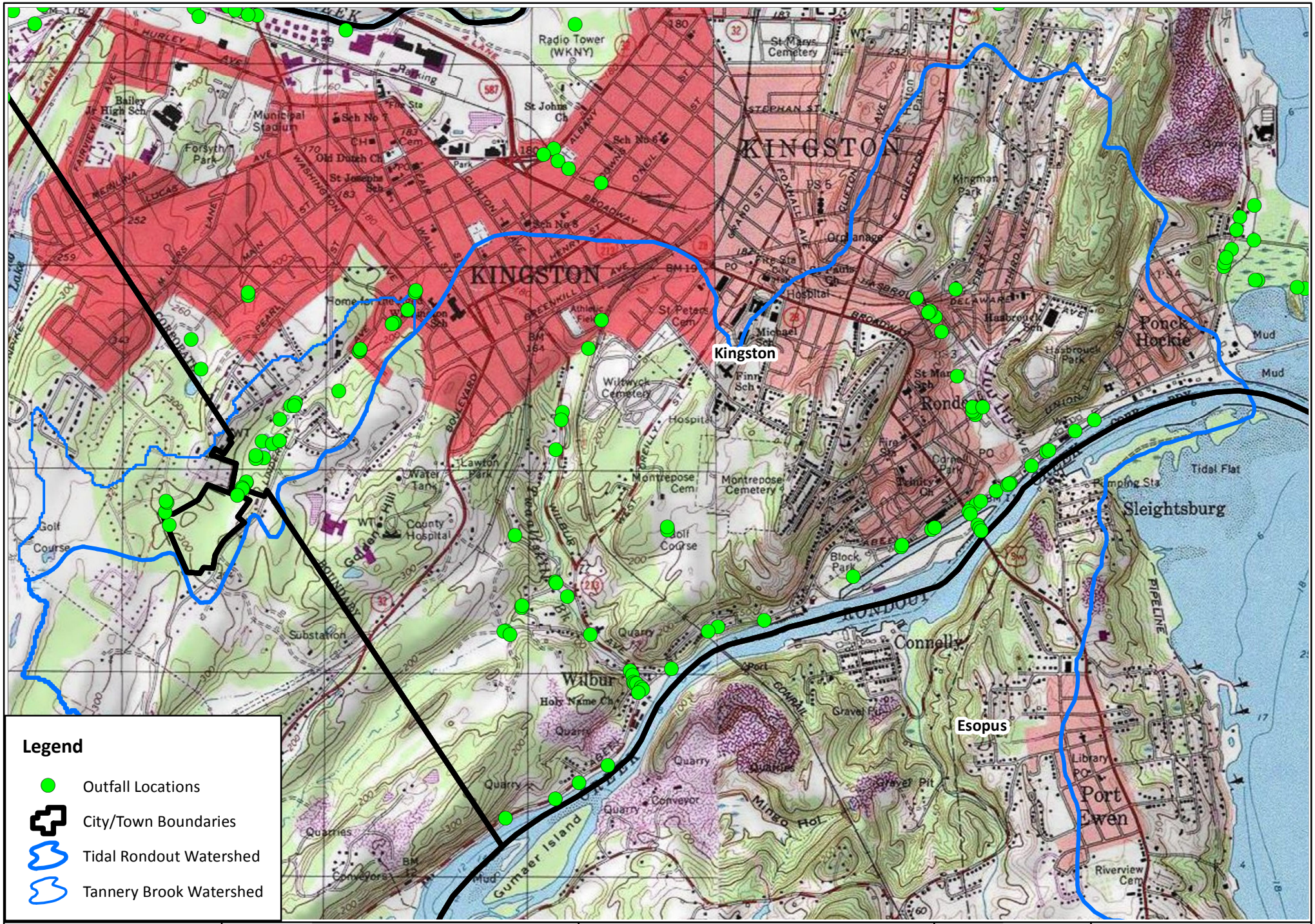
- ❑ Post Construction Stormwater Management – Develop, implement, and enforce a plan that addresses stormwater runoff from new development and redevelopment projects and incorporates enforceable mechanisms. Applicable controls could include preventative actions (e.g., protecting sensitive areas) or the use of structural controls (e.g., grassed swales or porous pavement).

- ❑ Pollution Prevention/Good Housekeeping for Municipal Operations – Limit the amount of pollutant runoff from municipal operations.

A map of stormwater outfalls is included as Figure 4-1.

NYSDEC Stormwater Management Design Manual

The 2015 *New York State Stormwater Design Manual* provides a general overview on designing and siting stormwater management systems in order to comply with state stormwater standards. The purpose of the stormwater management manual is to:



SOURCE(S):
Base Map: Copyright:© 2013 National Geographic Society, i-cubed

N

MXD: P:\4766-01\Design\GIS\Maps\Kingston Outfall_update.mxd

Figure 4-1: Stormwater Outfalls in Kingston, NY

Tidal Rondout Creek Watershed Management Plan

LOCATION: Kingston, New York

Map By:	JCS
MMI#:	4766-01
Original:	6/23/2016
Revision:	12/20/2016
Scale:	1 in = 2,000 ft

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

- ❑ Protect the waters of the State of New York from the adverse impacts of stormwater runoff
- ❑ Provide design standards on the most effective stormwater management approaches including:
  - o Incorporation of green infrastructure achieved by infiltration, groundwater recharge, reuse, recycle, and evaporation/evapotranspiration through the use of green infrastructure techniques as a standard practice.
  - o Design and implementation of standard stormwater management practices (SMPs).
  - o Implementation of a good operation, inspection, and maintenance program.
- ❑ Improve the quality of green infrastructure and SMPs constructed in the state, specifically in regard to their performance, longevity, safety, ease of maintenance, community acceptance, and environmental benefit.

4.2 County Plans and Policies

Ulster County Open Space Plan

The Ulster County Open Space Plan was adopted in 2007 and recommends a proactive regional approach to open space preservation. One important aspect of the plan is the need for a holistic "big picture" approach to watershed management and protection, which is best accomplished through the coordination and participation of various stakeholders such as municipal, local and state governments, environmental groups, and community participants. As noted in Section 2.4, there is very little permanently protected open space located in Kingston, Ulster, and Esopus.

The Ulster County Open Space Plan identifies the following seven resource strategies: (1) identify, permanently protect, and manage critical open space resources and systems; (2) protect and manage water resources; (3) enhance the viability and protection of working landscapes; (4) protect the county's valuable landforms and natural features; (5) develop priority biodiversity areas and ensure that land use decisions incorporate habitat protection and species diversity; (6) promote stewardship of historic and cultural resources; and (7) create, preserve, enhance and provide managed access to parks, hiking trails, active and passive recreational facilities and historic resources.

With regard to water resource protection, the main goal is to "ensure that the water resources of Ulster County meet their highest and best use categories and are available for water supply purposes through the coordination of planning, management, maintenance, stewardship, monitoring, and enforcement of existing laws and developing polices related to riparian corridors, drainage areas, wetlands, and vernal pools."

The plan notes that the implementation of sediment and erosion controls, streambank stabilization, steep slope protection, MS4 stormwater programs, and development of agricultural management plans are all methods that can be utilized to protect and improve water quality in a watershed.

Therefore, in an effort to ensure that water quality in Ulster County meets New York State requirements and is safe and accessible for recreational purposes, the following goals and recommendations were identified:

Goal: Utilize the EPA's Watershed Approach Framework to prioritize and manage water resources

- ❑ Work with all 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 and river corridors.

Goal: Protect Water Quality

- ❑ Update the county's water quality storage.
- ❑ Implement and continuously update the countywide stormwater program for the management of stormwater systems, monitoring of discharges, and cleanup of pollution as necessary to comply with federal statutes.
- ❑ Utilize "Best Management Practices" and a Multiple Barrier Approach to protect water resources from encroaching development.
- ❑ Identify and map important surface and groundwater sources and recharge areas for all aquifers.
- ❑ Develop policies that guide development away from floodprone and aquifer recharge areas and provide for open space and aquifer friendly activities for these areas.
- ❑ Encourage communities to adopt clearing and grading and other land use regulations to protect water quality.

Goal: Protect Waterways

- ❑ Utilize funding and programmatic goals from stream and corridor management regulations to protect riparian areas.
- ❑ Encourage the establishment of wetland mitigation policies at a county level.
- ❑ Encourage a coordinated approach that recognizes state, federal, and local responsibilities for wetland and vernal pool protection.
- ❑ Continue to upgrade and refine the wetland database at local and regional levels.
- ❑ Support state legislation to designate the Esopus Creek, Sawkill, Wallkill, and other Hudson River watershed tributaries as inland waterways.

Goal: Ensure Safe and adequate drinking water resources

- ❑ Update the necessary code with specific reference to protecting existing and potential public water supply systems.
- ❑ Work with local governments to update watershed protection requirements for surface water sources under Public Health Law.

- ❑ Ensure safe and adequate drinking water resources by protecting aquifers, aquifer recharge areas, and well heads by encouraging towns to create an overlay district that regulates development over aquifers and recharge areas.
- ❑ Encourage municipalities to include priority growth areas in their comprehensive plans using factors such as municipal water and sewer areas and their potential for extension, transportation crossroads, existing patterns of development, and absence of critical open space resources.

While the implementation of the various recommendations listed above is critical to the protection of water resources and critical watersheds within Ulster County, it is important to note that this is best accomplished on a regional scale with the support of local governments.

Ulster County Department of the Environment – Environmental Plan

The Ulster County Department of the Environment is charged with the coordination of environmental programs associated with various Ulster County departments and agencies including the Health Department, Planning Department, Information Services, Public Works, Soil and Water Conservation District, and the Cornell Cooperative Extension of Ulster County.

The Environmental Department, in collaboration with the above-referenced departments, prepared an Environmental Plan in 2008, which prioritized environmental projects within Ulster County. The Environmental Plan was updated in 2011. The purpose of the plan was to (1) identify the projects on which the Department of the Environment will focus, (2) outline the set of objectives for each project, and (3) list action items, deliverables, and deadlines related to those projects.

The 2008 Environmental Plan discusses the need to successfully administer the DEC Stormwater Management Program in an effort to protect water resources and prevent flood damage. The following objectives were identified relative to stormwater management: (1) coordinate with the Ulster County Department of Public Works Stormwater Management Program to ensure that the county is meeting the regulatory requirements of the DEC Stormwater Management Program and (2) support municipalities with their permit compliance by providing information, technical support and, where applicable, staff support.

The 2008 Environmental Plan also outlined the following objectives associated with natural resource planning: (1) update the Natural Resource Inventory GIS database. Explore ways to make the information more accessible to local land use decision makers; (2) act as a technical resource for partners engaged in Natural Resource Planning. Represent and advocate for the county in funding and projects; and (3) support the Open Space plan by providing data necessary to prioritize acquisition and research guidance for interpreting the data.

The 2011 annual update provided a summary of the department's progress and accomplishments from January to December 2011 with respect to Department Operations and Development, Stormwater Compliance, Sustainability Initiatives, and Natural Resources. The following is a summary of the achievements relative to stormwater compliance and natural resource activities as they most directly relate to watershed management.

Stormwater Accomplishments

- ❑ 175 county employees completed triennial training on stormwater best practices, illicit discharge detection and elimination, and good housekeeping practices.
- ❑ MS4 presentation was prepared by staff.
- ❑ Continuation of stormwater outfall monitoring (37% of the county's outfalls were monitored in 2011).
- ❑ Completed and presented the 2010-2011 stormwater annual report to the Environmental Management Council.
- ❑ Designed and installed a demonstration rain garden near the department's 17 Pear Street building.
- ❑ Hosted a municipal training workshop, "Rain Gardens: a tool for Municipal Stormwater Management."
- ❑ Developed an educational brochure on rain gardens for public outreach.
- ❑ Ulster County Advisory Committee met to discuss Non-toxic Pest Management.
- ❑ Submitted two environmental projects to the Hudson River Estuary Program for inclusion on the Green Infrastructure website (Rain Gardens and Ulster County Park permeable paver trail extension).
- ❑ Reviewed and updated database of DEC spill cases within Ulster County.
- ❑ Developed written guidelines for paint selection in order to implement the low/no Volatile Organic Compounds (VOC) paint policy.

Natural Resource Accomplishments

- ❑ Continued to be active in the Ashokan Release Working Group (ARWG) regarding NYCDEP's releases from the Ashokan Reservoir. Staff reviewed surveys, conducted inspections, and attended public meetings.
- ❑ Continued to work with the Lower Esopus Watershed Partnership (LEWP) to help it produce maps, collect data, and provide technical review of materials for its recently released draft Stream Management Plan. Additionally, our staff reviewed, provided information, and supplied some images for "A Journey through the Lower Esopus Creek," a 50-page booklet produced by LEWP. Staff also provided data, mapping assistance, and suggestions to LEWP and its designer for its "Recreational Access to the Lower Esopus Creek" map, which was also printed in 2011.
- ❑ Participated in environmental aspects related to the Greater Catskill Flood Remediation and Buyout Program (GCFRBP).
- ❑ Launched UC REConnect, an online recreation map.
- ❑ Produced the Ulster County tourism guide outdoor recreation map.
- ❑ Continued to be consistently involved with the Ashokan Watershed Stream Management Program (AWSMP) Project Advisory Committee.
- ❑ Attended NYSDEC floodplain management meetings.
- ❑ Attended meetings regarding various watercourses in the county, including those convened by the Rondout Creek Watershed Council and the Rondout/Neversink Stream Management Program.
- ❑ Participated in workshops related to the Emerald Ash Borer (EAB) infestation.

- ❑ Continues to work with the County Attorney's Office, the UC Agricultural Society, and the UC Soil & Water Conservation District to establish a plant materials center at the Ulster County Fairground in New Paltz. This planting area will provide plant material to be used to stabilize eroding banks across the county.

The 2011 update also includes a list of goals for the year 2012 as outlined below:

Stormwater & Pollution Prevention Goals

- ❑ Seek and apply for at least one stormwater-related grant.
- ❑ Explore more formal intermunicipal stormwater collaboration.
- ❑ Update the county's Stormwater Management Plan.
- ❑ Host two workshops for municipalities on regulatory stormwater management issues.
- ❑ Monitor 20% of the county's stormwater outfalls in 2012 for illicit discharges.

Natural Resource Goals

- ❑ Seek and apply for at least one natural resource-related grant.
- ❑ Continue to work collaboratively with Planning, Information Services, Health, and Public Works Departments to acquire, map, disseminate, and analyze natural resource data for surficial and groundwater aquifers, in particular, and potentially for other datasets as well which are pertinent to the Natural Resource Inventory (NRI).
- ❑ Work to ensure that Ulster County remains a proactive partner in helping our communities prepare for and ultimately recover from the effects of the EAB infestation.

Stormwater management and natural resource protection are significant factors in watershed management planning. Therefore, the accomplishments and ongoing efforts referenced in the 2011 Environmental Plan update will ultimately assist in improving water quality within Ulster County and specifically the Tidal Rondout Creek watershed.

4.3 City of Kingston Plans, Policies, and Regulations

Local Waterfront Revitalization Plan (LWRP)

The City of Kingston LWRP was approved in 1992. The purpose of the LWRP was to promote economic development and revitalization of the city's local waterfront revitalization area while assuring the protection and beneficial use of coastal resources therein.

Section II provides an inventory and analysis of various aspects of the City of Kingston including but not limited to water quality, erosion, flooding, existing land use, sanitary sewer, and storm drainage. These aspects specifically relate to the overall water quality of Rondout Creek and are therefore discussed further in the following text.

- ❑ Water Quality: Rondout Creek is classified as Class C water quality, which means the water may not be acceptable for primary body contact (swimming, bathing) or consumption. Restrictions regarding disposal into Class C water are particularly important since

deterioration of water quality below this level would have a detrimental impact on the stream's ability to support certain species of fish and other forms of wildlife.

- Erosion: Erosion along Rondout Creek is significant and occurs due to failing bulkheads and a lack of appropriate shoreline stabilization. Eroding shorelines can increase turbidity thereby reducing water quality. This is an important aspect, and measures should be taken to ensure that erosion concerns are addressed to prevent further degradation of the water quality in Rondout Creek.

- Flooding: The plan specifically states that, "the area most affected by periodic flooding is adjacent to Rondout Creek. Flooding occurs along the entire Rondout Creek Waterfront, especially during storms when the tide is in and storm drainage outlets are covered. Stormwater backs up and flows out inlets and manholes."

- Land Use: Land use in the vicinity of Rondout Creek consists of a variety of uses such as commercial, residential, industrial, institutional, and forested areas.

- Sanitary Sewer: According to the LWRP, "the City of Kingston is served by municipal sanitary and storm sewers in the majority of its area. The sewage treatment plant currently has a capacity of 4.8 MGD and improvements are currently underway to increase this to 6.0 MGD. In addition, the City conducts a federally mandated pre-treatment program to monitor specific users for discharge of pollutants into the sanitary system. Most of the Kingston waterfront along the Rondout is serviced by sanitary sewers. The City is continually upgrading the sanitary sewer system and has been concentrating on renewal areas such as the Rondout, West Strand, and Ponckhockie neighborhoods. Originally a combined sanitary and storm system was built in Kingston. The City is now in the process of separating these two lines. Currently, pollutants are discharged into the Rondout Creek during heavy rainstorms when storm runoff generates flows which exceed the capacity of the sewage treatment plant. Continued separation of these two systems will reduce frequency of this discharge and eventually eliminate it."

- The plan indicates that improvement to the city's storm drainage will occur concurrently with sanitary sewer improvements. Areas within the city that are not connected to storm drains use natural drainage channels and runoff patterns.

The LWRP discusses the need to upgrade certain deficient infrastructure elements in the Rondout, West Strand, and Ponckhockie neighborhoods and along the Hudson River. The two improvements referenced in the plan include (1) the need to separate the combined sewers and (2) the need to repair failing bulkheads.

Section III of the plan includes a summary and explanation of NYS Coastal Policies. A summary of the policies related to effective watershed management planning and success are listed below:

Fish and Wildlife Policies

- Policy 7A – Significant coastal fish and wildlife habitats as identified on the coastal area map shall be protected, preserved, and where practical, restored so as to maintain their viability as habitats.
- Policy 7A – The Rondout Creek habitat shall be protected, preserved, and where practical, restored so as to maintain its viability as a habitat.
- Policy 7B – The locally important habitat at Kingston Point Park, also known as K.E.4, shall be protected, preserved and, where practicable, restored so as to maintain its viability as a habitat.
- Policy 8 – Protect fish and wildlife resources in the coastal area from the introduction of hazardous wastes and other pollutants that accumulate in the food chain or that cause significant sublethal or lethal effects on those resources.
- Policy 13 – The construction or reconstruction of erosion protection structures shall be undertaken only if they have a reasonable probability of controlling erosion for at least 30 years as demonstrated in design and construction standards and/or assured maintenance or replacement programs.
- Policy 13A – Bulkheads shall be reconstructed along Rondout Creek.
- Policy 14 – Activities and development including the construction or reconstruction of erosion protection structures shall be undertaken so that there will be no measurable increase in erosion or flooding at the site of such activities or development at other locations.
- Policy 15 – Mining, excavation, or dredging in coastal waters shall not significantly interfere with the natural coastal processes that supply beach materials to and adjacent to such waters and shall be undertaken in a manner that will not cause an increase in erosion of such land.
- Policy 16 – Public funds shall only be used for erosion protective structures where necessary to protect human life and new development that requires a location within or adjacent to an erosion hazard area to be able to function or existing development and only where the public benefits outweigh the long-term monetary and other costs including the potential for increasing erosion and adverse effects on natural protective features.
- Policy 17 – Whenever possible, use nonstructural measures to minimize damage to natural resources and property from flooding and erosion. Such measures shall include (1) the setback of buildings and structures, (2) the planting of vegetation and the installation of sand fencing and drainage, (3) the reshaping of bluffs, and (4) the floodproofing of buildings or their elevation above the base flood level.

Water and Air Resources Policies

- Policy 30 – Municipal, industrial, and commercial discharge of pollutants including but not limited to toxic and hazardous substances into coastal waters will conform to state and national water quality standards.
- Policy 30A – Watercourses and the atmosphere should be kept clean and pollution abated where it now exists.
- Policy 31 – State coastal area policies and purposes of approved local waterfront revitalization programs will be considered while reviewing coastal water classifications and while modifying water quality standards; however, those waters already overburdened with contaminants will be recognized as being a development constraint.

- Policy 33 – Best management practices will be used to ensure the control of stormwater runoff and combined sewer overflows draining into coastal waters.
- Policy 33A – Eliminate combined storm and sanitary sewers where feasible.
- Policy 33B – Work toward upgrading combined storm and sanitary sewers where separate systems are infeasible.
- Policy 34 – Discharge of waste materials from vessels into coastal waters will be limited so as to protect significant fish and wildlife habitats, recreational areas, and water supply areas.
- Policy 34A – Marinas shall be required to make sewage discharge facilities accessible for use by the general public.
- Policy 35 – Dredging and dredge spoil disposal in coastal waters will be undertaken in a manner that meets existing state dredging permit requirements and protects significant fish and wildlife habitats, scenic resources, natural protective features, important agricultural lands, and wetlands.
- Policy 36 – Activities related to the shipment and storage of petroleum and other hazardous materials will be conducted in a manner that will prevent or at least minimize spills into coastal waters; all practicable efforts will be undertaken to expedite the cleanup of such discharges, and restoration for damages will be required when these spills occur.
- Policy 36A – All tanks and tank farms shall be contained by land berms or structures to prevent petroleum or other stored products from entering other public or private lands or bodies of water or drainage courses or systems.
- Policy 37 – Best management practices will be utilized to minimize the nonpoint discharge of excess nutrients, organics, and eroded soils into coastal waters.
- Policy 38 – The quality and quantity of surface water and groundwater supplies will be conserved and protected particularly where such waters constitute the primary or sole source of water supply.
- Policy 39 – The transport, storage, treatment, and disposal of solid wastes, particularly hazardous wastes within coastal areas, will be conducted in such a manner so as to protect groundwater and surface water supplies, significant fish and wildlife habitats, recreation areas, important agricultural land, and scenic resources.
- Policy 40 – Effluent discharge from major stem electric generating and industrial facilities into coastal waters will not be unduly injurious to fish and wildlife and shall conform to state water quality standards.
- Policy 44 – Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas.

Section IV identifies several projects along Kingston's waterfront where water-dependent commercial and industrial development will be encouraged. Specifically, redevelopment along the waterfront of the Wilbur, Rondout, and Ponckhockie neighborhoods is recommended. Water dependent and enhanced recreational areas are also proposed along the Hudson River waterfront.

Overall, the redevelopment of the waterfront area described in the LWRP has the potential to greatly improve water quality within Rondout Creek through the replacement of failing bulkheads, the implementation of appropriate stormwater management practices, and an increased awareness regarding land use activities.

Comprehensive Plan

The city Comprehensive Plan was being updated during the development of this watershed management plan, and was adopted in 2016 after this watershed management plan was substantially complete. The Vision for this plan (provided in the box to the right) is centered on the development of the core neighborhoods into vibrant, diverse, mixed-use centers. The Rondout area is specifically mentioned in the Vision. Among the key principles that guided the Comprehensive Plan development, four stand out in the context of watershed management:

- ❑ It is preferable to focus future development on lands in existing developed areas (in-fill) and in obsolete heavy commercial and industrial areas (brownfields) rather than on virgin undeveloped land (greenfields).
- ❑ Land use planning must not only consider existing physically and environmentally constrained land but also land that may be constrained in the future due to rising sea level and global climate change.
- ❑ Conservation of open space and sensitive habitat is as crucial as development of those areas that are well suited to use of land.
- ❑ Sustainable approaches to stormwater management (green infrastructure like green roofs, rain gardens, porous pavement, and landscaped swales) are preferable as being more efficient and less prone to failure.

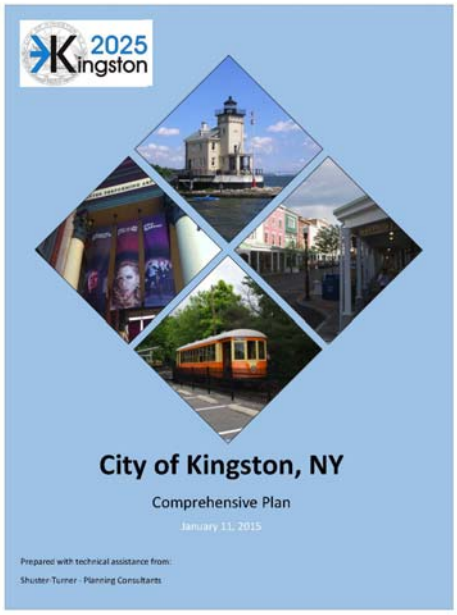
Kingston 2025 Vision

In 2025, Kingston will be a City of Neighborhoods - vibrant neighborhoods diverse in land use and diverse in population. Development will be focused around four cores at the Stockade District; **at the Rondout**; at a future Hudson Landing Core; and at a new core in Midtown centered at the existing Ulster Performing Arts Center. These cores will be comprised of mixed-use centers with multifamily residential incorporated with ground floor retail; pedestrian and bicycle friendly streets; active use of sidewalks; traditional architecture and historic identity. These nodes will be connected not only by a network of streets supporting slow speed/high capacity vehicular travel, but by a network of on-road and off-road bicycle paths, and by public transit ranging from shuttle bus to trolley. Extending outward from the cores, lower densities of mostly well-maintained and predominantly owner-occupied two-family and single-family residential neighborhoods will dominate, with occasional neighborhood corner stores and well-designed townhouses and multifamily residential interspersed. Remote or environmentally-sensitive areas will remain as open space, agriculture, forestry or used for clustered, very low density residential. Employment opportunities will be diverse from County government, historic tourism and specialty retail in Uptown; to arts and new media in Midtown; **to cultural, water-related, restaurant and entertainment uses in the Rondout**; and to clean, green industry along existing active rail lines and within the Kingston Business Park.

The following is a selection of strategies outlined in the Comprehensive Plan that directly relate to the principals of effective watershed management within the Rondout Creek watershed:

- ❑ Strategy 3.3.1: Enact a Hillside Protection Zoning Provision. The varied terrain in parts of Kingston, such as the different elevations along Wilbur Avenue, require revised standards for building on slopes. Steep slope zoning regulations reduce runoff, soil loss, and erosion on sensitive slopes by limiting the impacts of development on steep slopes. Construction on steep slopes greater than 15% and less than 25% should be minimized, and construction on slopes of 25% or greater should be avoided.

- Strategy 3.3.3: Enact Surface Water Protection Regulations. In order to protect water quality and various water-dependent habitats, the city should consider the creation of a buffer requirement around surface water resources including streams, wetlands, and vernal pools. Currently, NYSDEC requires a 100-foot buffer around NYSDEC-regulated wetlands, but other resources do not require such protection. A 50- to 100-foot buffer should be considered with dense vegetation requirements, particularly if a proposed use has an increased likelihood of impacting water quality.



- Strategy 3.3.4: Undertake sea level rise and flooding assessment of the Esopus Creek. To make the lands surrounding the creek more resilient to future storm intensity increases projected by global climate change studies like those taken for the Rondout are needed.

- Strategy 3.3.5: Develop and adopt a Natural Resources Inventory and Open Space Plan. The City of Kingston Conservation Advisory Council has begun the process of inventorying sensitive natural features such as habitats, flood zones, surface waters, geology, agricultural lands, forests, soils, and ecologically sensitive areas. The city should develop an Open Space Plan that provides recommendations for priority areas for open space preservation through public purchase, purchase by institutional land trust, or through low impact uses such as parks and low intensity agriculture.

- Strategy 7.1.1: Develop a plan to mitigate both near- and long-term risks to the wastewater treatment facility. This plan should consider the life cycle of plant components, the value of the property for other uses, and innovative approaches (e.g., distributed systems and shared municipal services) that may effectively meet the wastewater treatment needs for the city and surrounding communities over the long term. The plan should address the issues arising from the partial interconnection of the storm and sanitary sewer systems that lead to the inability to properly treat higher volumes during large storm events (combined sewer overflows). The treatment plant location within the current 100-year flood zone and the implication of increasing sea level elevation must be considered as well.

- Strategy 7.1.2: Implement and improve the Long-Term Control Plan so that combined sewer overflows are reduced.

- Strategy 7.1.3: Reduce stormwater, erosion, upland flooding and combined sewer overflows through green infrastructure, low impact development, and best stormwater management practices. Green infrastructure including large forests, meadows, wetlands, floodplains, and riparian buffers should be retained where feasible in order to naturally

store, infiltrate, and treat stormwater runoff. Implementation of low impact development practices incorporate a number of less intrusive measures to allow precipitation to infiltrate into the ground instead of running off into storm or combined sewers. These measures include street trees, rain gardens, bioswales, green roofs, and on-site storage of stormwater.

- ❑ Strategy 7.1.4: Promote natural vegetation, swales, rain gardens, and similarly environmental conscious landscape practices. The zoning ordinance should be revised to require such practices in connection with industrial, commercial, and multifamily development (i.e., exempting single-family and two-family homes). Natural vegetation is especially important as it requires less watering and pesticides for its care.

- ❑ Strategy 10.1.2: Evaluate the use of natural buffers and green shoreline infrastructure to reduce flood risk and erosion and conserve natural resource functions. Such shoreline infrastructure as wetland biomass, reef balls, and green spikes in riprap can be used to attenuate damaging wave action and prevent erosion.

- ❑ Strategy 10.1.3: Require that any proposed new private structures or major renovations with proposed ground floor elevations lower than 13 feet above 2014 mean sea level be constructed to FEMA standards for construction in flood zones. Current (2014) 100-year flood elevation is 8.2 feet. New York State building code standards require at least 2 feet of freeboard above 100-year flood elevations. High range projections for sea level rise in 2060 and mid-range projections for 2100 are for 3 feet. To safeguard persons and property from future flooding loss, the city should require that any significant new private real property be constructed in a manner that conforms to current requirements for construction in flood zones. Examples of requirements applicable to construction within flood zones may include such safeguards as not constructing on fill, requiring construction on pilings, prohibiting residential occupancy to elevations above flood elevations, and requiring breakaway walls.

- ❑ Strategy 10.1.4: Require that any proposed new public structures or infrastructure or major renovations be constructed to withstand flood elevations of 14 feet above 2014 mean sea level. Current (2014) 100-year flood elevation is 8.2 feet. High range projections for sea level rise for 2100 are for 5 to 6 feet. Long-term planning for public infrastructure and facilities should be designed and located in a manner that will not subject them to future flood risk based on high range projections.

- ❑ Strategy 10.2.2: Promote appropriate private redevelopment of Island Dock, as governed by sound planning for sea level rise, along with construction of a new passive/interpretive park at its eastern tip. Create Island Dock Park located on the east tip of Island Dock in conjunction and in cooperation with the private redevelopment of Island Dock. Island Dock is completely within the 100-year flood zone. Any private redevelopment must be done in a manner consistent with recommendations for future sea level rise. Contingent upon the findings of the recommended Long-Term Resiliency Plan, the best approach for adaptation may be for the city to purchase the island for open space purposes of flood storage and wave attenuation. If used for maritime purposes, including cruise ship dockage or marina,

the improvements should be built in a manner that will adapt to rising sea level and storm surge.

The goals and strategies of the Comprehensive Plan such as preservation of open space, improved public infrastructure, and the implementation of low impact development are critical aspects of watershed management and will greatly assist the city in improving water quality.

Open Space Plan/Natural Resources Inventory

The City of Kingston has taken steps to develop an open space plan with natural resources inventory through the publication of a *Preliminary Review of Open Space and Natural Resources* (draft, December 2013) and the report *Natural Areas and Wildlife in Your Community – A Habitat Summary Prepared for the City of Kingston* (May 2014).

The *Preliminary Review of Open Space and Natural Resources* describes the types of open space in Kingston and lists the city's parks. The document describes the greenbelts and corridors of the city and includes a map, "Significant Habitats in Selected Areas of the City of Kingston." The map depicts pockets of open space and the wetland and upland habitats in discrete areas that are located in subwatersheds 1, 2, 3, 4a, 4b, and 5. In fact, this map (along with the map series in the report *Natural Areas and Wildlife in Your Community – A Habitat Summary Prepared for the City of Kingston*) depicts small discontinuous watercourses in subwatersheds 1, 2, and 3, thereby indicating that not all streams in these subwatersheds are buried in culverts.

Subdivision Regulations

The City of Kingston manages land use through the Subdivision Regulations, which were updated in 2005. The purpose of the subdivision regulations is to guide and protect the community's physical, social, and aesthetic development. The purpose of the subdivision regulations is to ensure the following:

- That land to be subdivided shall be of such a character that it can be used safely for building purposes without danger to health or peril from fire, flood, or other menace.
- Subdivisions shall conform to the Official Map of the city and shall be in harmony with such portions of the Master Plan as may be in existence from time to time.
- All required improvements shall conform to the city specifications.

The following items that can affect water quality are required in new subdivisions except as waived by the Planning Board: paved streets, curbs or gutters, sidewalks, drainage facilities, and sanitary sewers. Paved widths shall be 80, 60, and 50 feet for major streets, collector streets, and minor streets, respectively. Streets shall be graded and improved with pavements, curbs and gutters, sidewalks, drainage facilities, water mains, sewers, street lights and signs, street trees, fire alarm signal devices, and fire hydrants, except where waivers may be requested, and the Planning Board may waive, subject to appropriate conditions, such improvements as it considers may be omitted without jeopardy to the public health, safety, and general welfare.

The regulations also require that where a watercourse separates a proposed street from abutting property provision shall be made for access to all lots by means of culverts or other structures of design approved by the City Engineer. Where a subdivision is traversed by a watercourse, drainage way, channel, or stream, a stormwater easement or drainage right-of-way shall be provided as required by the City Engineer and in no case less than 20 feet in width.

Any culvert or other drainage facility must be large enough to accommodate potential runoff from its entire upstream drainage area, whether inside or outside the subdivision. The City Engineer must approve the design and size of the drainage facility based on anticipated runoff from a 10-year storm under conditions of total potential development as permitted by the Zoning Ordinance in the watershed.

The above requirements are designed for adequate conveyance of stormwater. Because the application of these requirements will help prevent erosion and resulting sedimentation, they are important aspects of water quality protection. However, it is possible that the city's Subdivision Regulations require only the minimum necessary for stormwater and watercourse conveyance. Improvements to the regulations may be effective for improved water management.

Stormwater Management Plan

The draft 2010 City of Kingston Stormwater Management Plan is an update from the previous version adopted in 2007. This plan has been developed to comply with the NYSDEC General Permit for Stormwater Discharges from MS4. The plan incorporates the following methods that are designed to reduce the discharge of pollutants as required by the SPDES permit:

- Public Education and Outreach – Educate all property owners, especially those within the MS4 boundaries, on the importance of incorporating responsible stormwater management practices.
- Public Involvement/Participation – Encourage public participation in the development and implementation of the stormwater management plan.
- Illicit Discharge Detection and Elimination – Identify and eliminate illicit discharges into the MS4 systems. Outfall mapping is a key component of this measure.
- Construction Site Runoff Control – "Develop, implement and enforce an erosion and sediment control program for construction activities that disturb greater than or equal to one acre of land."
- Post Construction Stormwater Management – "Develop, implement and enforce a plan that addresses stormwater runoff from new development and redevelopment projects and incorporates enforceable mechanisms. Applicable controls could include preventative actions (e.g., protecting sensitive areas) or the use of structural controls (e.g., grassed swales or porous pavement)."
- Pollution Prevention/Good Housekeeping for Municipal Operations – Limit the amount of pollutant runoff from municipal operations.

Effective stormwater management practices limit erosion and resulting sedimentation, reduces pollutant loading, and reduces nonpoint source pollution. Therefore, the implementation of

stormwater best management practices is a key component to improving water quality within Rondout Creek.

4.4 Town of Esopus Plans, Policies, and Regulations

Comprehensive Plan

The Town of Esopus Comprehensive Plan was adopted in 1994. Aside from providing a good description of land uses, zoning, and anticipated development at the time, the Comprehensive Plan does not contain specific goals or objectives related to watershed management or improving water quality.

Code of the Town of Esopus

The Code of the Town of Esopus was updated in 2012 and is intended to guide and protect the community's physical, social, and aesthetic development and provide a framework for all legislation related to the town. The following aspects of the Town Code relate to watershed management:

- Chapter 80 requires a floodplain development permit for all construction and other development in areas of special flood hazard for the purpose of protecting its citizens from increased flood hazards and insuring that new development is constructed in a manner that minimizes its exposure to flooding.

- Chapter 88 states that the Town of Esopus will not accept any roadway or driveway project that does not meet the minimum standards including drainage issues. In addition, the owner shall, at his own cost and expense, install all drainage structures and driveway crossings of a design, size, and length acceptable to the Superintendent of Highways. Necessary easements shall be obtained for drainage ditches, which shall also be of a size and design satisfactory to the Superintendent of Highways. The owner/applicant must submit a Stormwater Pollution Prevention Plan.

- Chapter 104 states that stormwater and all other unpolluted drainage shall be discharged to such sewers as are specifically designated as storm sewers or to a natural outlet approved by the Town Engineer. Industrial cooling water or unpolluted process waters may be discharged, upon approval of the Town Engineer, to a storm sewer or natural outlet.

- Chapter 106 addresses Stormwater Management and Erosion and Sediment Control. Under this chapter, the town must meet the requirements of minimum measures 4 and 5 of the NYSDEC SPDES General Permit for MS4s, including to minimize increases in stormwater runoff from land development activities in order to reduce flooding, siltation, increases in stream temperature, and streambank erosion and maintain the integrity of stream channels; minimize increases in pollution caused by stormwater runoff from land development activities that would otherwise degrade local water quality; minimize the total annual volume of stormwater runoff that flows from any specific site during and following development; and reduce stormwater runoff rates and volumes, soil erosion, and nonpoint

source pollution, wherever possible, through stormwater management practices and to ensure that these management practices are properly maintained and eliminate threats to public safety.

4.5 Town of Ulster Plans, Policies, and Regulations

Comprehensive Plan

The Town of Ulster's Comprehensive Plan was adopted in 2007 and is an update of the previous plans adopted in 1970. The plan provides guidelines for its residential and economic development. The plan supports the town's vision to preserve its rural character while providing guidelines for its residential and economic development. It is also intended to guide planning for commercial, industrial, residential, rural, and suburban settings.

The Town of Ulster was predominantly a farming community with many farms located along the plains of Esopus Creek. The town also includes several hamlet centers such as Eddyville. Eddyville is located within the tidal Rondout Creek watershed in the southern portion of the town of Ulster. It is situated along the northern bank of Rondout Creek and historically operated as a canal trade community until the closing of the D&H Canal in 1898. Currently, business in Eddyville is predominantly comprised of waterfront restaurants and marinas including the Anchorage Marina and Restaurant and Rondout Bay Marina & Restaurant.

The plan states that when considering future development it is important to understand that "underutilized industrial sites hold promise for redevelopment; abandoned rail lines could become rail trails, and the remnants of the D&H Canal in Eddyville should be developed into an important heritage tourism site."

The Comprehensive Plan includes a detailed description of the town's Zoning Code, which divides the town into eight zoning districts. Of the eight districts, the following five are located within the portion of the town that is located within the tidal Rondout Creek watershed:

- The R-60 District requires a minimum lot size of 60,000 square feet for a single-family lot and also allows agricultural operations, bed and breakfasts, camps, conservation preserves, farming, forestry, golf courses, horse stables, kennels, livestock keeping, marinas, mobile home parks, multiple and attached dwellings, nursery schools, schools, summer colonies, and veterinarian clinics.

- The R-30 District requires a minimum lot size of 40,000 square feet for a single-family lot and also allows agricultural operations, bed and breakfasts, conservation preserves, farming, golf courses, marinas, mobile home parks, nursery schools, schools, and senior citizen housing.

- The R-10 District requires a minimum lot size of 10,000 square feet in areas served with water and sewer, 15,000 sq. ft. with central water and sewer, 20,000 sq. ft. with central water or sewer, and 40,000 sq. ft. in areas with no central water and sewer. This district does not allow farming operations.

- ❑ The LC District allows for convenience retail and other business enterprises within neighborhood or hamlet centers. This district allows a variety of land uses including agricultural operations, farming operations, garages, gas stations, hospitals, kennels, local convenience stores, marinas, offices, single-family and two-family residences, restaurants, retail businesses, senior citizen housing, theaters, veterinarian clinics, and wholesale uses.

- ❑ The OM District allows airports, cemeteries, excavation, junkyards, livestock keeping, marinas, mobile homes, mobile home parks, recycling yards, and indoor theater complexes.

In addition to the Zoning Districts, the Comprehensive Plan recommends the creation of a Ridge Protection Overlay District which, "would establish supplemental regulations that would better control the siting of buildings in ridgeline areas, the amount of tree clearing that would be permitted, and stricter controls on grading and cutting in ridge protection areas."

The Comprehensive Plan discusses the significance of regulating timber harvesting in order to preserve natural resources and prevent environmental damage associated with harvesting. The plan specifically states that "one of the environmental concerns associated with timber harvesting relates to the potential for soil erosion. When soil washes into streams and lakes, it reduces water quality and may harm spawning beds. With proper logging practices, erosion never starts and streams are protected from careless disturbance and water quality is maintained. Best management practices recommended by the DEC include keeping stream crossing to a minimum, protecting streambanks, and logging steep slopes during dry weather."

In summary, the plan lists several goals and recommendations with respect to long-term development and growth within the town of Ulster. A selection of the goals and recommendations that directly relate to effective watershed management techniques are:

Goal: Protect groundwater resources to ensure that the quantity and quality of water is available to serve future needs.

- ❑ Strictly enforce NYSDEC requirements for a 100-foot buffer between development and state-mapped wetlands.
- ❑ Restrict the development of buildings and other impervious surfaces within the 100-year floodplain; require Storm Water Pollution Prevention Plans (SWPPP) in accordance with the NYSDEC State Pollution Discharge Elimination System (SPDES) general permit for commercial/industrial developments or major subdivision applications.
- ❑ Encourage the use of retention/detention basins that are an integral part of the overall site plan or subdivision plan.

Goal: Protect the town's scenic views, rural-community atmosphere, and natural quality for its intrinsic and economic value.

- ❑ Develop land use policies aimed at retaining large blocks of farmland that are able to support a variety of farm businesses.
- ❑ Create Riparian Protection Zones along the Esopus Creek and Rondout Creek; form a Town of Ulster Agricultural Advisory Committee to address issues facing farmers and to develop programs to support agriculture.

- ❑ Support efforts by property owners to participate in the Conservation Tax Credit (CTC) Program.
- ❑ Coordinate with a land trust to manage conservation easements on large tracts of land.
- ❑ Encourage the use of cluster subdivisions to retain large tracts of open space.

Goal: Provide greater protection of ridgelines from inappropriate development.

- ❑ Limit development in those areas of the town where the slope exceeds 15%.
- ❑ Require sediment & erosion control plans for proposed development near ridgelines.
- ❑ Encourage participation in the Forestry Management Programs to keep ridgelines forested for the long term.
- ❑ Limit the clearing of vegetation along ridgelines.
- ❑ Adopt a local law to regulate timber harvesting within the town of Ulster.

Goal: Enhance resource protection and public access to the town's waterfront lands along the Hudson River, Esopus Creek, and Rondout Creek.

- ❑ Develop Local Water Revitalization Plans (LWRP) for the Hudson River and Rondout Creek waterfronts.

Goal: Keep existing farmland in agricultural production and maintain the viability of area farms.

- ❑ Develop land use policies aimed at retaining large blocks of farmland.
- ❑ Support applications to the state and federal government to purchase agricultural easements on local farms also referred to as Purchase of Development Rights (PDR).
- ❑ Create a local program to purchase conservation easements from area farmers.
- ❑ Create an AG-Agricultural Zoning District.
- ❑ Encourage cluster or conservation subdivisions to retain prime farm lands.
- ❑ Discourage the extension of water and sewer lines to areas with prime farmlands.

Goal: Manage growth in relation to "Vision Statement" for the Town of Ulster.

- ❑ Protect environmentally sensitive areas such as steep slopes, floodplains, and wetlands.
- ❑ Encourage in-fill development in established areas that is compatible with existing and/or proposed land use, that is at a compatible scale with the surrounding area, and that can be supported by adequate public facilities and transportation systems.
- ❑ Direct development to those areas already served with water and sewer infrastructure by allowing for a higher intensity of residential and nonresidential development.

Subdivision of Land

The Town of Ulster Subdivision of Land was amended in 2006, updated from the previous regulations adopted in 1991. The subdivision of land is administered by the Planning Board. The purpose of the regulations is to ensure the "orderly, efficient and economical development of the town." The following guidelines that relate to watershed management are outlined in the regulations:

- ❑ Where topography or other conditions are such as to make impractical the inclusion of utilities or drainage facilities within street right-of-way, perpetual unobstructed easements at least 20 feet in width for such utilities shall be provided across property outside the street

lines and with satisfactory access to the street. Such easements shall be centered on rear or side lot lines.

- ❑ Streets shall be suitably located, of sufficient width, and adequately improved to accommodate the prospective traffic and to afford satisfactory access to police, firefighting, snow removal or other road maintenance equipment and shall be coordinated so as to compose a convenient system.
- ❑ Facilities for water and sewerage shall be provided in each new subdivision in accordance with the requirements of the appropriate agency having jurisdiction over the planning and installation of these in the area of the subdivision; however, the following minimum requirements of the town shall be met:
- ❑ Sanitary sewers shall not be used for storm water drainage.
- ❑ Central sewage systems, if any, shall provide a 6-inch minimum size connection to each lot. The service lateral may be reduced to a minimum of 4-inch diameter within the lot.
- ❑ That proper provision shall be made for open spaces and recreational purposes.
- ❑ Storm drainage facilities shall provide a clear and protected channel fully adequate to handle runoff from a 25-year storm and designed so that heavy runoff that exceeds the capacity of the channels can be handled with the least possible damage to improvements and structures. United States Department of Agriculture Technical Release 55 shall be used for design of stormwater management systems.

5.0 MANAGEMENT STRATEGIES

The vision for the Tidal Rondout Creek Watershed is that it becomes a healthy, naturally sustainable stream system surrounded by a vibrant waterfront community.

As discussed in earlier chapters, this Watershed Management Plan has identified two specific long-term goals with the intention of achieving the vision of this plan, "a watershed that becomes a healthy, naturally sustainable stream system surrounded by a vibrant waterfront community." The goals were developed with input from the PAC and through series of public outreach meetings and workshops in collaboration with technical expertise. The goals of this plan are (1) restore tributary streams and subwatersheds to improve water quality and (2) create a vibrant waterfront by improving water quality.

In total, 11 objectives were developed for these two goals. The objectives identify more specific and desired outcomes. The management strategies discussed below may be used to advise a set of activities that when implemented will help to achieve the goals and objectives of this plan. A number of management strategies are possible for the Tidal Rondout Creek watershed to address the two goals and 11 objectives of this plan. Tables 5-1 and 5-2 show which management strategies may be helpful for meeting each objective.

TABLE 5-1
Management Strategies for Goal #1:
Restore tributary streams and subwatersheds to improve water quality

	Management Strategies							
	Stormwater Management	**Sanitary Wastewater Management**	**Land Use Planning and Regulations**	**Tributary Stream Restoration**	**Flood Mitigation**	**Wetlands and Habitat Restoration**	**Water Quality Monitoring**	**Education and Training**
1.1 - Restore and enhance riparian vegetation along tributary streams				X	X	X	X	X
1.2 - Reduce streambank and channel erosion along tributary streams				X	X	X	X	X
1.3 - Prevent or minimize flood damage along tributary streams	x		X	X	X	X	X	X
1.4 - Modify stormwater management in tributary stormwatersheds	X		X				X	X

	Management Strategies							
	Stormwater Management	Sanitary Wastewater Management	Land Use Planning and Regulations	Tributary Stream Restoration	Flood Mitigation	Wetlands and Habitat Restoration	Water Quality Monitoring	Education and Training
1.5 - Manage land use and redevelopment in tributary subwatersheds	x		X				X	X
1.6 - Manage disposal of sanitary wastewater in tributary subwatersheds	x	X	X				X	X

TABLE 5-2
Management Strategies for Goal #2:
Create a vibrant waterfront by improving water quality

	Management Strategies							
	Stormwater Management	Sanitary Wastewater Management	Land Use Planning and Regulations	Tributary Stream Restoration	Flood Mitigation	Wetlands and Habitat Restoration	Water Quality Monitoring	Education and Training
2.1 - Manage land use and redevelopment along the waterfront			x		x			X
2.2 - Mitigate tidal flooding in the Kingston and Esopus waterfront areas					x			X
2.3 - Reduce sewer overflows into Rondout Creek		x					x	X
2.4 - Improve water quality classification of Rondout Creek from C to B	x	x	x	x	x	x	x	X
2.5 - Increase training, education, and stewardship							x	X

These management strategies are discussed below. All of the management strategies have one intended outcome, which is to reduce the potential for continued water quality impairments and implement measures to improve the overall water quality within the Tidal Rondout Creek watershed.

5.1 Stormwater Management Strategies

The volume and quality of stormwater runoff has a direct impact on the quality of downstream surface water resources. Development oftentimes involves the replacement of vegetated land with impervious surfaces and hence increases the amount of stormwater runoff from a site, decreases infiltration, and alters natural drainage patterns. The increase in impervious coverage both increases the source of pollutants and inhibits the natural pollutant-removal mechanisms offered by vegetated and pervious land.

Some of the greatest threats to water quality are impacts from commercial and industrial land uses, high density residential areas, construction sites, and high traffic roads and highways. These types of land uses typically contribute the largest sediment loads and pollutants to natural systems. Water quality can be affected by runoff from the most distant reaches of a watershed, not just by development directly adjacent to surface water supply reservoirs. By controlling the sediment and pollutant loading upstream, water quality downstream can be greatly enhanced.

Stormwater management strategies may include:

- ❑ Incorporate low impact development principles and green infrastructure
- ❑ Clean and maintain catch basins and other system components
- ❑ Maintain detention and retention basins
- ❑ Install collection and conveyance systems
- ❑ Retrofit aging systems
- ❑ Vegetate swales

Best management practices (BMPs) for stormwater management have improved over the years as new technologies have become available. The EPA classifies BMPs as structural or nonstructural:

- ❑ Nonstructural BMPs include good housekeeping, optimizing the use of road sands and salts, semiannual street sweeping, and cleaning of catch basins to remove accumulated sediments.

- ❑ Structural BMPs as published in *Preliminary Data Summary of Urban Stormwater Best Management Practices* (EPA, 1999) include:

  - → Infiltration systems that capture runoff and promote recharge of groundwater
  - → Detention systems that capture runoff and temporarily retain it for subsequent release. Detention systems are typically dry between storm events.
  - → Retention systems that capture runoff and retain that volume until it is displaced by the next rain event. These systems maintain a significant pool of water between runoff events.
  - → Constructed wetland systems are similar to retention and detention systems except a major portion of the area contains vegetation.
  - → Filtration systems typically employ a filter media such as sand, soil, organic material, carbon, or other membrane to remove contaminants from stormwater.
  - → Vegetated systems (biofilters) such as swales and filter strips
  - → Vendor-supplied systems that include catch basin inserts, filtration devices, and hydrodynamic devices

Table 5-3 presents a summary of preferred BMPs specific to different proposed land uses.

TABLE 5-3
Best Management Practices on Individual Sites

Residential	Retail/Commercial	Both
Rain gardens or barrels	Pervious parking	Grass swales
Infiltration basins or trenches	Green roof storage	Deep sump catch basins in roads/parking areas
Dry wells	Single sidewalks	Hydrodynamic separators
	Reduction in building footprint	Oil/water separators
	Parking lot storage	Created wetland systems
	Decentralized parking	Bioretention facilities
	Bioretention at parking lot islands	Detention basins

The selection of specific BMPs varies from site to site. Applications such as infiltration systems may not be appropriate for all land uses or all sites. Table 5-4 summarizes the uses and limitations of some common BMPs.

TABLE 5-4
Use and Limitation of Some Common BMPs

BMP Type	Watershed Size	Space Requirements	Site Considerations	Maintenance
Rain barrels	Limited to roof areas.	Limited	None	Low
Infiltration basins or trenches	Trenches: 5 acres maximum; 2 acres recommended Basins: 25 acres maximum; 10 acres recommended	Varies with watershed size. Minimum 20 square feet.	Do not use with high potential for sediment load. Keep > 50' from slopes 15% or greater; bottom of unit >3' to water; maintain distance from wells and septic.	Moderate to High
Dry wells (underground structures that accept drainage water to allow the water to slowly infiltrate into the ground)	< 1 acre	Varies with watershed size. Minimum 20 square feet.	Not for use where rooftop may contribute pollutants. Bottom of unit 3' above water, 4' above bedrock; maintain distance from wells and septic.	Low

BMP Type	Watershed Size	Space Requirements	Site Considerations	Maintenance
Pervious pavement	Traffic volume <500 Average Daily Traffic (ADT)	Not applicable	Minimum infiltration of underlying soils 0.3 in./hr. but less than 5.0 in./hr.; avoid use in aquifer recharge areas; no use on slopes greater than 15%; depth to water – 3' min., depth to bedrock – 4' min.	Moderate
Green roof storage	Generally limited to roof area	Varies with size of roof	Structural considerations.	Low
Bioretention/ rain gardens (garden that takes advantage of rainfall and stormwater runoff in its design and plant selection)	5-10 acres; rooftop area for rain gardens	200-square-foot minimum; 25-square-foot rain garden	Slopes 6% or less; 3' from bottom of structure to water.	Low
Grass swales	As space permits for swale construction	2' minimum bottom width	Avoid steep slopes to prevent erosion.	Low
Oil/water or hydrodynamic separators	<1 acre impervious cover	None. Below grade structure.	None	Low
Created wetlands	25-acre minimum	Proportional to watershed size	Must intersect groundwater if unlined; not appropriate for land uses generating large amounts of contamination; steep slopes not appropriate.	Moderate to High
Detention basins	One-acre minimum	Proportional to watershed size	Must intersect groundwater if unlined and wet basin; not appropriate for land uses generating large amounts of contamination; steep slopes not appropriate.	Moderate

Low Impact Development (LID) Principles and Green Infrastructure

Changes to the land's surface associated with land development and other activities can alter hydrologic conditions by modifying the way water moves over, through, and from the land. In broad classification, typical impacts to receiving waters due to the alteration of hydrologic conditions associated with land development and other activities include degraded water quality, unnatural stream channel geomorphic changes, and increased flooding.

Three generic ways are available for looking at stormwater management to protect water quality. The first of these is land use controls, which involves regulatory processes that govern land development and other activities. A second is source controls, which are intended to reduce potential pollutants at their source by identifying and either prohibiting or conditioning land uses or activities that are known to have a high risk to generate pollutants. The third is treatment controls. These are both nonstructural and structural practices to mitigate the impacts of hydrologic condition changes that have occurred or will occur as a result of land development or other activities.

Through history, most development has relied on treatment controls to mitigate the impacts of development. Other mechanisms such as retention/detention systems have been used to mitigate changes in hydrology.

In LID, land development design practices for stormwater management make use of creative site planning and design tools that are intended to preserve or reduce the changes to a site's hydrology, rather than simply providing "end of pipe" treatment or highly engineered management systems. Instead of a traditional stormwater management approach that conveys stormwater in pipe and catch basin systems to a centralized detention area, LID techniques allow stormwater management to occur in discrete locations across a site.

The principal goal of LID is to maximize protection of the ecological integrity of receiving streams by maintaining watershed hydrology. LID techniques and practices are intended to preserve natural systems and protect resources and their buffer areas through design of drainage systems that mimic natural systems. The following goals are common:

- ❑ Protect existing vegetation
- ❑ Minimize changes in surface drainage patterns
- ❑ Avoid excessive site grading
- ❑ Reduce areas of impervious and managed surface coverage

Green Infrastructure Example – Kingston Library

The Kingston Library undertook a capital project to improve environmental and site conditions. Faced with a badly deteriorated parking lot, one objective was to resurface the parking lot with new pavement. In doing this, the library faced other challenges. The roof leaders or downspouts on the building were connected to the City of Kingston sanitary sewer system, which carried the roof runoff to the Kingston Wastewater Treatment Facility and contributed to combined sewer overflows into Rondout Creek from the Wilber Avenue diversion chamber. The library chose to disconnect the roof leaders from the sanitary sewer system in order to comply with the law and to assist the city in its efforts to remove stormwater from the sanitary system. This led to the reduction of 400,000 gallons per year of rainwater entering the sanitary sewer system. Another challenge was to treat and reduce the flow of stormwater from the site. The stormwater sewer system discharges to the Twaalfskill Brook. The library achieved these goals by reducing impervious surfaces, installing a rain garden, and installing a stormwater exfiltration system.

Source: NYSDEC, www.dec.ny.gov/lands/86684.html

- ❑ Encourage disconnection of impervious surfaces
- ❑ Create temporary storage of stormwater runoff
- ❑ Encourage infiltration of stormwater runoff
- ❑ Reduce or mitigate increases in the volume of stormwater runoff as well as changes in magnitude, frequency, and duration of stormwater discharges to receiving waters

The use of these planning and design tools can reduce or eliminate the requirement for more costly and sometimes obtrusive storage, infiltration, or end-of-pipe structural practices for the management of stormwater runoff. They can also result in development that better fits characteristics of a site and are aesthetically pleasing.

LID site planning should maintain hydrologic functions while allowing development of the property. LID site planning begins by understanding the essential hydrologic functions of the site, including the streams, wetlands, buffer areas, floodplains, steep slopes, high permeability soils, and conservation zones. The remaining site area is the development zone, which is located where development activities will have the least impact on hydrologic function. Successful LID requires the micromanagement of site watersheds and hydrology. This means addressing stormwater control on a lot-by-lot basis. On-lot stormwater management may include microstorage, functional landscaping, open swale drainage systems, reduction in impervious cover, increased runoff travel time, and depression storage.

Green infrastructure incorporates vegetation and soil into stormwater management designs and can assist in minimizing overall development impacts. The *New York State Stormwater Design Manual* discusses ways to incorporate green infrastructure into stormwater management practices such as: (1) the preservation of natural features and conservation designs, (2) preservation of buffers, (3) reduction of clearing and grading, (4) locating development in less sensitive areas, (5) open space design, and (6) soil restoration.

Typical Definitions of Green Infrastructure (GI)

EPA: Green stormwater infrastructure includes a wide array of practices at multiple scales that manage wet weather and maintain and restore natural hydrology by infiltrating, evapotranspiring, harvesting, and using stormwater…. On the local scale, green infrastructure consists of site- and neighborhood-specific practices, such as bioretention, trees, green roofs, permeable pavements and cisterns.

American Rivers: GI is an approach to water management that protects, restores, or mimics the natural water cycle…. GI incorporates both the natural environment and engineered systems to provide clean water, conserve ecosystem values and functions, and provide a wide array of benefits to people and wildlife…. On the local level, GI practices include rain gardens, permeable pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting systems.

The Nature Conservancy: GI solutions are planned and managed natural and semi-natural systems which can provide more categories of benefits, when compared to traditional gray infrastructure. GI solutions can enhance or even replace a functionality that is traditionally provided by man-made structures…. GI solutions employ ecosystem services to create more resource efficient systems involving water, air and land use.

This approach requires a design that takes existing natural features into consideration during the development process. These features can then be incorporated into the project in a manner that minimizes impacts and allows for their use in the preservation of water quality and habitats.

The City of Kingston and the Towns of Esopus and Ulster may consider incorporating various LID and green infrastructure techniques into local regulations. New development projects such as the revitalization projects occurring and proposed along the Tidal Rondout Creek waterfront must incorporate stormwater BMPs and should incorporate LID and green infrastructure to the greatest extent practical.

Recall from Chapter 3.0 that Kingston's Climate Action Plan calls for adoption of a local green infrastructure ordinance promoting the use of rain gardens, vegetated swales, green roofs, and porous pavement that recharges groundwater systems or retains water on site to the maximum practical extent instead of detaining and conveying stormwater off site.

Recall from Chapter 4.0 that Strategy #7.1.3 of Kingston's Comprehensive Plan promotes reduction of stormwater, erosion, upland flooding, and combined sewer overflows through green infrastructure, low impact development, and best stormwater management practices.

Catch Basin Maintenance

Recognizing that the municipalities of Kingston, Ulster, and Esopus will continue to utilize traditional stormwater systems, it is important that they be maintained. Cleaning and maintenance of catch basins and other system components are critical to their continued functioning.

If a catch basin is clogged as pictured to the right, it may not collect stormwater, which could then run downstream in a less desired location and mobilize pollutants or cause flooding. If a catch basin is full of sediment, it may not be able to accept additional sediment, thus eliminating a key collection point for new sediment entrained in stormwater. In many urban communities, clogged or full catch basins have contributed to severe erosion of roadways during intense rainfall events.

Many communities have found that their catch basin cleaning and maintenance programs have not allowed for the frequency of cleaning that is necessary. Kingston, Ulster, and Esopus should review catch basin maintenance programs to ensure that sufficient maintenance is occurring.

Detention and Retention Basin Maintenance

The portions of Kingston, Ulster, and Esopus in the watershed include many older, dense developments and more recent rural developments, neither of which tends to include numerous stormwater detention and retention basins. However, some basins are present such as those pictured to the right in Esopus along Plantasie Kill.

When stormwater basins of different types are found in a community, it is important that resources are available for basin maintenance such as cleanouts, vegetation management, and repair of structures such as outlets. Some municipalities accept basins as infrastructure and budget for their maintenance, but many do not. A Memorandum of Understanding (MOU) framework is one method of compelling basin maintenance. A MOU provides a bipartisan and multilateral agreement between parties and can be used to identify effective methods of managing stormwater and water quality. The MOU's binding power creates a better atmosphere to resolve current and upcoming issues by following procedures and technicalities recorded by the parties.

Residential subdivisions that share detention or water quality basins could be operated and maintained through a homeowners' association; however, enforcement of proper maintenance is often lacking, and the burden of maintenance often falls onto the municipal entity. MOUs and other agreements can help to prevent this shift of the maintenance burden.

There are multiple ways to develop an MOU depending on the issues and parameters of concern. The particular interest in this case is water quality and water resources protection through stormwater management, wastewater disposal, and watershed conservation and protection, among others. In general, an MOU should accomplish the following:

- ❑ Clarify the purpose and scope
- ❑ Provide background information sufficient for context
- ❑ Establish roles for each party
- ❑ Explain, in detail, the responsibilities for each party
- ❑ Present an assessment protocol and technical procedures
- ❑ Spell out penalties or repercussions
- ❑ Establish mutual agreement

Groton Utilities (a water utility in Groton, Connecticut) has successfully used the MOU approach to ensure future basin maintenance when approving redevelopments in its public water supply watershed.

A drawback of MOUs is that they do not have enforcement penalties or a requirement for performance bonding to ensure monitoring and maintenance of stormwater basins. Nevertheless, MOUs may be an effective tool for compelling landowners to maintain stormwater basins in Kingston, Ulster, and Esopus.

Install Collection and Conveyance Systems

Recognizing that LID and green infrastructure cannot be applied universally in the Tidal Rondout Creek watershed, and that areas of dense development are already present, one method of stormwater management that should be considered is the installation of traditional piped stormwater collection systems in areas that are not served by any stormwater management systems. Installing and maintaining systems where none are present would avoid urban drainage flooding, which mobilizes pollutants and causes erosion of roadways and adjacent lands. Furthermore, new collection and conveyance systems could be engineered to discharge to a new retention or detention basin, thus providing an opportunity to improve water quality where no opportunity was previously available.

Improvement of Swales and Ditches

The use of swales is considered an effective stormwater BMP. However, they must remain vegetated to provide water quality benefits, and steep slopes must be avoided in order to prevent erosion due to high velocities. Many examples of roadside swales and ditches are found in the Tidal Rondout Creek watershed. If traditional stormwater systems (described above) are not appropriate or too costly to install, swales and ditches can continue to be used in lieu of curbing and piping. The use of vegetated swales allows for filtration of runoff pollutants and provides a more environmentally aesthetic alternative to stormwater management. This alternative could be utilized in the more residential areas as a means of treating stormwater runoff prior to it discharging to Rondout Creek.

Where possible, green infrastructure principles should be applied to existing swales and ditches. The use of unvegetated ditches for stormwater conveyance should be minimized. For example, the ditches along Rodman's Lane and Clay Road in Esopus (pictured to the right) could be enhanced with additional vegetation or controls on velocity to prevent erosion of soil and transport to Rondout Creek via Plantasie Kill.

Retrofit Aging Stormwater Systems and Tying In Newer Systems

Older stormwater systems in the Tidal Rondout Creek watershed may require repair in the coming years. When possible, some of the techniques described above, such as green infrastructure, should be incorporated.

One aspect of retrofitting stormwater systems may involve the tie-in of other systems. New development can involve large-scale, single-lot projects or take the form of residential subdivisions adjacent to existing developed areas. In these cases, it may be possible to analyze the entire area as a whole and develop stormwater management measures to address the aggregate impervious coverage resulting from the combination of new and existing development. This approach is sometimes referred to as "centralized BMPs."

NYSDEC Stormwater Management Toolbox

The construction stormwater management toolbox contains standard guidance manuals available in New York including:

- ❑ Web-Based Electronic Natural Resources Conservation Service (NRCS) Mapping
- ❑ 2005 Erosion and Sediment Guidelines
- ❑ 2015 Stormwater Management Design Manual
- ❑ Runoff Reduction Worksheets
- ❑ Construction Stormwater Inspection Manual
- ❑ Construction Notice of Intent Database
- ❑ Engineering Schematics for Erosion and Sediment Controls.

In particular, adjacent or clustered commercial and industrial developments can be designed to share storm drainage structures and detention basins to address water quality issues on sites that may otherwise be too restrictive to provide individual management measures. Designs such as this will require cooperation between landowners and developers and may involve permanent easements and/or operation and maintenance programs such as MOUs.

Off-site or centralized treatment can be an effective solution, particularly on more challenging sites or in areas that have previously been developed without BMPs. If possible, systems should be designed to accommodate future potential development in the area whereby future generators of stormwater would tie in to the system and also enter into agreements for shared maintenance.

Stormwater Management Methods Where All Proximate Options are Limited

Developments in the upper reaches of a watershed that have been constructed without stormwater quantity and quality control measures may contribute to sediment and pollutant loading downstream. Because there is no funding source or regulatory requirement to do so, it can be difficult or nearly impossible to retrofit existing development with acceptable stormwater quality control measures such as those described above. Cost, limited land, and land ownership are but a few of the obstacles that must be overcome.

Furthermore, stormwater from streets can directly enter watercourses that flow to Rondout Creek in almost any location where roads cross these watercourses. This is possible via catch basins where curbing is present and by direct flow from the street to the watercourse where curbs are not present. To retrofit these roads would be a sizable undertaking. In order to treat roadway runoff prior to discharge, the water would need to be filtered by either mechanical or natural methods. A retrofit would require costly design and construction of stormwater drainage structures and associated piping. Curbing would be required in locations where the construction of filter swales would be precluded by slope or lack of available land.

A more feasible option to address stormwater management from existing developments and roadways is to treat the stormwater that has already entered tributary streams before it discharges into Rondout Creek. This method entails the capture of a portion of the silt and sediment load before it reaches Rondout Creek through the use of water quality and sediment basins at key locations along the tributary streams within the subwatersheds. This methodology could also be an effective method of reducing sedimentation and pollutant loading from agricultural operations in the rural parts of Esopus and Ulster.

A subwatershed-scale approach requires the strategic siting of facilities such as bypass channels and large basins to handle stormwater runoff from subwatershed drainage areas. Typically, municipalities and other entities must together assume the capital costs for constructing these facilities as well as the administrative and financial responsibility for their operation and maintenance. The following vital issues should be considered in determining potential locations for such water quality management structures:

- ❑ Specific locations for basins should be based on watershed development and stormwater outfall locations.
- ❑ The size of the area discharging to the existing stormwater outfall will have an impact on the ability to control peak flows. If a catchment area is too big, then sediments will be flushed from a basin during storm events.
- ❑ The larger the percentage of impervious area within the watershed the more likely it is to increase velocities within contributing streams, thereby increasing sediment transport to downstream reservoirs.
- ❑ Land area is a critical consideration for construction of water quality basins. Municipalities should either own the land or be able to acquire the land either through purchase or long-term lease agreement. These factors increase the cost and lead time associated with construction.
- ❑ Maintenance of stormwater systems is critical to their proper operation. Land on which systems are constructed should be accessible for future maintenance. When maintenance is not performed, the management system ceases to function properly, and water quality is not protected.
- ❑ Normal, nonstorm flows within the stream must be maintained along with the existing functions and values of the natural stream system. Fish passage should be addressed if fisheries resources are present.

Suggested Actions

Many stormwater management strategies have been described above. The selected actions are organized by objective below.

Objective #1.4 – Modify stormwater management in tributary subwatersheds

- ❑ Continue to separate storm and sanitary sewer systems – this action will allow improved functioning of both systems and help avoid overflows from CSOs
- ❑ Increase the frequency of catch basin cleanouts – this action will facilitate proper functioning of catch basins to reduce drainage-related flooding and improve capture of sediment.
- ❑ Require green infrastructure techniques and low impact development for new developments and significant redevelopments – this action will continue efforts such as those at the Kingston Library and lead to reduced stormwater discharge.
- ❑ Replace impervious surfaces with pervious surfaces when approving redevelopment proposals – this action is a subset of the green infrastructure action above but is important to pursue on its own merits where other green infrastructure methods will not be possible.
- ❑ Maintain existing detention and retention basins – this action involves ensuring that basins continue functioning to protect water quality. MOUs and other methods can be employed.

Enhanced stormwater management will lead to reduced flooding and erosion along tributary streams. Therefore, **despite the fact that stormwater management strategies do not *directly* lead to actions for objectives 1.1, 1.2, and 1.3, stormwater management strategies *will help the municipalities meet* objectives 1.1, 1.2, and 1.3.**

- ❑ Identify opportunities to detain stormwater in areas of existing development, and construct stormwater basins in areas that can receive runoff from small groups of existing developed parcels – this action will help the municipalities plan for better stormwater management in areas of existing development.
- ❑ Install collection and conveyance systems in areas that are not served by stormwater systems – this action may be pursued in certain areas if the provision of collection and conveyance systems will reduce erosion and overland transport of pollutants.
- ❑ Vegetate and stabilize swales and ditches located along roadways – this action is important where swales and ditches will continue to be used.
- ❑ Incorporate green infrastructure and improved stormwater management at and along the Route 9W bypass – this action arose from municipal input through the PAC meetings and will help reduce stormwater from the Kingston portion of the Tidal Rondout Creek watershed.

Objective #1.5 – Carefully manage land use and redevelopment in tributary subwatersheds

- ❑ Update engineering design standards to incorporate increasing precipitation intensities – Section 5.9 describes changing precipitation patterns and intensities. Municipal design standards should be modified to account for more severe rain events, otherwise stormwater systems will not be able to handle them.
- ❑ Require zero increase in runoff from new developments – this action would encourage green infrastructure and LID techniques to reduce stormwater formation.
- ❑ Amend Zoning and Subdivision Regulations to incorporate Low Impact Development standards – this action would directly encourage green infrastructure and LID techniques by requiring them.

Objective #1.6 – Carefully manage disposal of sanitary wastewater in tributary subwatersheds

- ❑ Reduce sanitary sewer inflow and infiltration – reducing the generation of stormwater and urban flooding will help lead to reduced sanitary sewer inflow and infiltration. Additional sanitary wastewater management strategies are discussed in Section 5.2 below.

In summary, there are numerous stormwater management techniques that can be implemented to improve the overall water quality within Tidal Rondout Creek. These techniques are especially important along the riverfront where commercial and industrial practices have a potential to negatively impact water that is flowing directly into the creek. However, stormwater management in the subwatersheds with tributary drainage is also critical because the tributary streams (whether open or buried) carry pollutants to the creek.

5.2 Sanitary Wastewater Strategies

The results of the Public Outreach Workshop survey referenced in Section 1.6 indicate that the impact of sanitary sewer inflows and outflows to water quality within Rondout Creek are a concern. As such, sanitary wastewater management is associated with Goal #1 of this plan, to restore tributary streams and subwatersheds to improve water quality.

Sanitary Sewers

Sanitary wastewater is treated by individual septic systems in the more rural portions of the Rondout Creek watershed and a combination of individual septic systems and sanitary sewers in the more populated areas of the Tidal Rondout Creek watershed. The sanitary sewer systems in the vicinity of Rondout Creek consist of both combined sewer systems and separate sanitary systems. Combined sewer systems collect sanitary sewage and stormwater runoff in the same piping system.

Separate sanitary systems are utilized for the collection, transport, and treatment of sewage from residential, commercial, and industrial facilities. According to the EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters,"*occasional unintentional discharges of raw sewage from municipal separate sanitary sewers occur in almost every system. These types of discharges are called sanitary sewer overflows (SSOs). There are a variety of causes, including but not limited to severe weather and flooding, improper system operation and maintenance, and vandalism."

As noted in Section 2.6 of this plan, CSOs are a major problem in the watershed. According to EPA's *Handbook,* in 1994 EPA issued its Combined Sewer Overflow Control Policy, which is a national framework for controlling CSOs through the NPDES permitting program. The first milestone under the CSO Policy was the January 1, 1997 deadline for implementing minimum technology-based controls, commonly referred to as the "nine minimum controls." These controls are measures that can reduce the frequency of CSOs and minimize their impacts when they do occur. Communities with combined sewer systems were also expected to develop long-term CSO control plans that will ultimately provide for full compliance with the Clean Water Act, including attainment of water quality standards. Kingston has a long-term CSO control plan in place.

Flooding of pumping and treatment facilities is another common cause of overflows and releases of untreated (or partly treated) wastewater. Flooding can directly cause overflow by overwhelming pumping and treatment facilities or can indirectly cause overflows by causing electrical components and control systems to fail.

Other strategies for addressing sewers include but are not limited to the following:

- ❑ Conduct a comprehensive sanitary sewer study to determine the feasibility of separating combined sewer systems where not yet accomplished.
- ❑ Develop a plan to prioritize combined sewer system improvements.
- ❑ Develop a plan to determine if separate sanitary sewer systems have sufficient capacity. If not, develop plans to prioritize upgrades.
- ❑ Ensure that Kingston utilizes a sanitary system overflow tracking database to help prioritize and develop a corrective action plan.
- ❑ Implement proactive maintenance schedules of sewer systems.

Communities should also encourage residents to disconnect downspouts and sump pumps from any systems they may be tied to – whether sanitary or stormwater – in the areas where overflows are prevalent.

Septic Systems

Septic systems can greatly impair water quality if they fail. For this reason, all septic systems and septic tanks must be maintained and replaced as needed to ensure that property owners can properly dispose of sanitary wastewater. Maintenance should include regularly timed pump outs, such as annually, as well as other practices.

According to the Wallkill Watershed Conservation and Management Plan, "nationally, 10-20% of septic systems are estimated to be failing at any given time, but this is based on very incomplete data and may not be reliable." Anecdotal reports suggest that even today, septic systems are being installed and/or operated improperly in the Wallkill watershed and other parts of New York State.

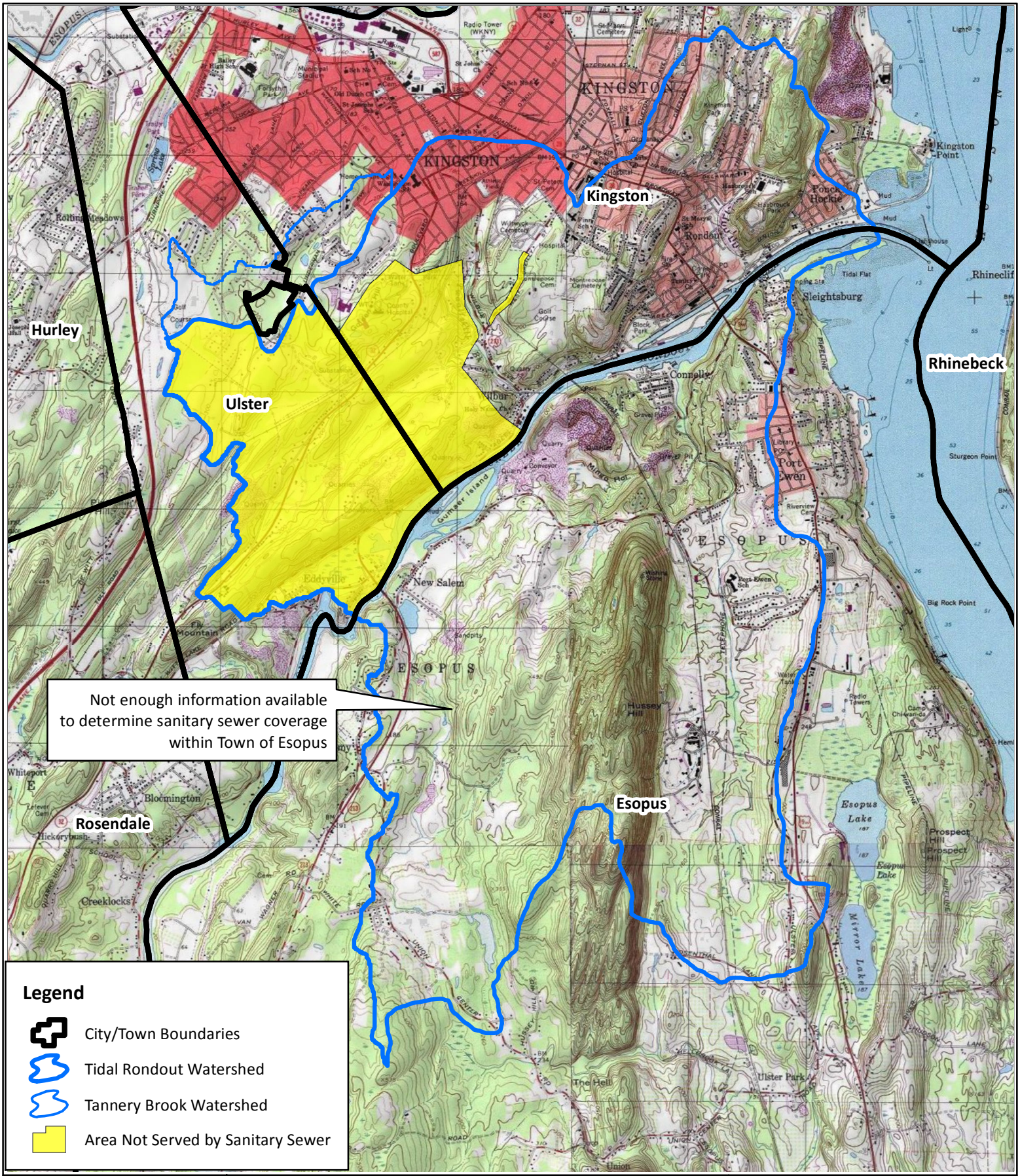
Unlike sanitary sewer overflows, it can be exceedingly difficult to directly link septic system failures to poor water quality in watercourses. Oftentimes, septic systems do not fail with catastrophic visible results. More frequently, system failures are gradual, and pollutants are released slowly or via groundwater that discharges to watercourses downstream.

Depending on their daily discharge rate, wastewater discharges are regulated either by the Ulster County Department of Health for smaller systems or by NYSDEC for larger systems. Regulations governing municipal systems generally require regular inspections, monitoring, and reporting to ensure that treated wastewater meets certain standards in the discharge permit. For individual on-site systems, however, there is no state requirement for any regular inspection, monitoring, or maintenance activities. It is up to individual property owners to conduct inspections, pump septic tanks, and take other steps to ensure that systems are operating properly. There are numerous sources of technical assistance available for communities to address septic systems.

Nevertheless, municipalities tend to lack the regulatory authorities to compel septic system maintenance. The watershed management plans for the upper Rondout Creek, lower nontidal Rondout Creek, and Wallkill River watersheds suggest that septic systems may be potential issues, but specific actions and strategies are not offered in these plans.

One way to address groups of failing or aged septic systems is to extend sanitary sewer service to properties served by the septic systems. While costly, the judicious extension of sewer systems can solve a multitude of problems caused by septic systems. Communities need to ensure that treatment facilities can accept additional wastewater before expanding sewer service areas. Additionally, new sewer system lines must be either sited to flow by gravity or be pumped to adjacent collection systems.

Figure 5-1 illustrates areas served by sanitary sewer and septic systems in the Kingston and Ulster parts of the watershed. This information is not available for Esopus.



SOURCE(S):
Base Map: Copyright:© 2013 National Geographic Society, i-cubed

Figure 5-1: Sanitary Sewer Coverage within Watershed

LOCATION:
Ulster, Kingston, Esopus, New York

N

Tidal Rondout Creek Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\KingstonSanSewer_update.mxd

Map By: JCS
MMI#: 4766-01
Original: 6/13/2016
Revision: 12/20/2016
Scale: 1 inch = 3,500 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

Suggested Actions

In short, management of sanitary wastewater is focused squarely on making sure individual and sanitary sewer systems are in good working order and functioning as intended. Selected actions are organized by objective below.

Objective #1.6 – Carefully manage disposal of sanitary wastewater in tributary subwatersheds

- ❑ Reduce sanitary sewer inflow and infiltration – this action will help reduce overflows elsewhere in the system at CSO locations or at the treatment plant, directly leading to improved water quality.
- ❑ Ensure that regular maintenance of septic systems is occurring – this action addresses the disrepair of septic systems.
- ❑ Extend sewer systems where groups of septic systems are failing or reaching the ends of their period of effectiveness – this action may be helpful in the parts of Kingston and Esopus that are adjacent to currently sewered areas.
- ❑ Delineate sewer avoidance and future sewer system service areas – this action derives its benefits from the process of evaluating portions of the municipalities relative to existing and future wastewater needs. Through the process of delineating sewer avoidance and future sewer system service areas, the municipalities will collect data and make thoughtful decisions that will have long-term water quality benefits.

Objective #2.3 – Reduce sewer overflows into Rondout Creek

- ❑ Reduce sanitary sewer inflow and infiltration – as noted above, this action will help reduce overflows elsewhere in the system at CSO locations or at the treatment plant, directly leading to improved water quality in Rondout Creek.
- ❑ Eliminate combined sewers – this action will directly lead to improved water quality in Rondout Creek.
- ❑ Maximize treatment capacities to avoid overflow of untreated wastewater – this action will directly lead to improved water quality in Rondout Creek by preventing overflows that are caused by capacity problems, if any [none are believed present at this time].
- ❑ Protect the wastewater treatment plant from flooding – this action will prevent overflows that are directly or indirectly caused by flooding as explained above.

5.3 Land Use Planning and Regulations

Sound land management practices are essential to effective watershed management. Land use plans are useful for setting specific policies that can lead to improved water quality whereas regulations provide the tools needed to compel the regulated community to follow these policies. The following discussion focuses on various strategies that can result in effective land use management for watershed protection.

Review and Update Land Use Plans

It is essential to review and update plans and regulations as needed to address future development and growth as it relates to watershed management and improving water quality. While Kingston and Ulster have prepared or updated Comprehensive Plans in the last decade, the Town of Esopus has not. Its Comprehensive Plan was adopted in 1994. An update of the Esopus Comprehensive Plan would provide an opportunity to incorporate directly, or by reference, many of the objectives of this watershed management plan (as well as the watershed management plan for the lower nontidal Rondout Creek).

The Town of Ulster Comprehensive Plan is largely consistent with many aspects of watershed planning as it emphasizes preservation of sensitive areas as discussed in Section 4.5. Nonetheless, a future update of the Ulster Comprehensive Plan should consider incorporation of objectives from this watershed management plan.

The City of Kingston Comprehensive Plan is current and emphasizes city-wide green infrastructure and a variety of methods to reduce flood damage along Rondout Creek. It is considered consistent with this watershed management plan, and the two plans will set consistent policies for improving water quality in Rondout Creek.

According to information in the American Water Works Association publication "Watershed Management for Drinking Water Protection," **land use planning ordinances provide an opportunity to:**

- ❑ Educate the public on the presence of the watershed through planning polices and maps.
- ❑ Give legal status to guidelines/ standards required for development in the watershed by incorporating them into the planning system.
- ❑ Develop clear, transparent processes and policies for assessing development applications.
- ❑ Obtain water quality improvements by negotiation with developers and landowners.
- ❑ Improve water quality controls during the construction phase of a development.
- ❑ Lock in requirements for long term maintenance of controls.
- ❑ Generate support from environmental interest groups.

Open Space

Watershed lands that exist as open spaces are essential for helping to maintain the quality of water in watercourses. Protecting watershed lands is a crucial step in maintaining and even improving water quality. Thus, establishing the best lands for protection will increase the possibility of improving water quality.

Section 2.4 noted that while there are several locations of open space in the Tidal Rondout Creek watershed such as golf courses and parks, the three watershed communities are generally lacking significant tracts of permanently protected open space. The *Ulster County Open Space Plan* cites figures of 3% to 7% of lands in the three municipalities are permanently protected open space. Still, general observations in the rural parts of Ulster and Esopus and the Twaalfskill Brook region of Kingston indicate that existing open space figures are likely higher. This discrepancy points to a gap between existing and *permanently protected* open space. Conversion of open space that exists as a result of development patterns into open space that is permanently protected should be a key consideration for protecting water quality in Rondout Creek.

Local comprehensive plans and open space plans (when available) typically provide the basis for selecting open space properties for conservation by any means, including acquisitions. Local planning boards, land trusts, and open space committees are often charged with coordination of conservation efforts. Section 4.3 notes that the City of Kingston has taken steps to develop an open space plan entitled *Preliminary Review of Open Space and Natural Resources* (draft, December 2013) and a natural resource inventory report entitled *Natural Areas and Wildlife in Your Community – A Habitat Summary Prepared for the City of Kingston* (May 2014). These efforts should continue with completion of an open space plan for Kingston. Likewise, Esopus and Ulster should develop open space plans.

The Trust for Public Lands (TPL) *Water Protection Series* is an excellent resource for watershed protection and should be consulted as needed for advice on how to accomplish conservation methods such as:

- Own and manage land
- Own land and others manage
- Sell land to third party
- Allow limited development
- Acquire partial interest such as conservation easements
- Transfer development rights
- Lease land
- Accept land donations

While all of the methods described in the TPL series may be useful in the Tidal Rondout Creek watershed municipalities, this plan promotes the permanent protection of open space through acquisitions first and foremost, followed by conservation easements.

Another method of protecting open space is through zoning. Some municipalities have found that adoption of open space zoning districts can validate the importance of open space protection in a community. Placing land into an open space zoning district will also add another layer of protection to the land. This watershed management plan supports the evaluation of Kingston, Ulster, and Esopus adding "Open Space" districts to the zoning maps and zoning ordinance.

Encourage "Cluster" Development through Zoning

In an effort to maintain and preserve open space and protect natural resources, many communities are encouraging "cluster" developments. Essentially, developers can "cluster" or build houses in close proximity, usually in the least environmentally sensitive areas, leaving the more vulnerable areas (e.g., riparian zones, wetlands, buffers, or areas with highly erodible soils) as permanent open spaces. In addition, this type of development can significantly reduce the amount of impervious surfaces, thereby reducing the amount of stormwater runoff contributing to nearby water bodies.

The three watershed municipalities address cluster developments differently:

- The Town of Ulster Comprehensive Plan encourages "Cluster" subdivisions within the north-south ridgeline between Routes 9W and 32, but the zoning code and subdivision code do not specifically address cluster developments.
- The Town of Esopus zoning code allows cluster developments in its riverfront zones, including along Rondout Creek.
- The City of Kingston subdivision regulations do not have a process for allowing "cluster" development. However, the new Comprehensive Plan includes "Goal 3: Preserve constrained lands as open space, agriculture or very low density residential clustered development as appropriate."

Therefore, there are potential opportunities to revise the regulations in Ulster and Kingston to include appropriate conditions and guidelines associated with development applications.

Develop Overlay Protection Zones

Overlay Zoning can be used to safeguard areas that are not explicitly protected under existing zoning districts and regulations. This practice geographically defines environmentally sensitive areas and can be used to prohibit or manage land uses in those areas that threaten water quality.

The Town of Ulster Comprehensive Plan discussed the idea of adopting a Ridge Protection Overlay District, and all three municipalities use overlays to some degree for specific desired outcomes involving development. Therefore, the concept would not be foreign to the municipalities. A "water resources protection overlay" district could provide for additional protections and design standards relative to stormwater management, sediment and erosion control, septic systems, and other issues discussed in this plan. The development of this district could provide increased protections to water quality in Rondout Creek above and beyond the minimal protections afforded by low density zoning and other provisions in existing districts.

Low Impact Development

Section 5.1 provided a thorough discussion of Low Impact Development (LID). Aside from the occasional development of single lots and ongoing development along the Kinston waterfront, development pressures in the watershed are limited at the present time. However, it is recognized that changes in economic conditions can result in increased development pressures. The Zoning and Subdivision codes and regulations of the three municipalities within the tidal Rondout Creek watershed should be amended to require LID when possible. This can help minimize adverse impacts to water quality when design characteristics such as dwelling unit size and driveway areas are the same.

Retire or Modify Obsolete Zoning Districts and Classes

The towns of Esopus and Ulster have only a handful of zoning districts, and mainly residential districts are located in the watershed of Tidal Rondout Creek. A few nonresidential districts in

these towns are situated along Rondout Creek to encourage water-dependent uses, which is appropriate.

The City of Kingston has a variety of nonresidential zoning districts in the watershed of Tidal Rondout Creek. Some of these are appropriate and protect existing commercial and residential land uses in the city. Two blocks of M-2 zoning (general manufacturing) are located in very close proximity (nearly adjacent) to Rondout Creek. While some of the uses permitted as of right are not necessarily at odds with watershed protection (such as offices and restaurants), some may be at odds with watershed protection unless very strong stormwater and spill prevention controls are in place. The City of Kingston should consider retiring or modifying this zoning class to encourage redevelopment that is more protective of water quality even without strong stormwater and spill prevention controls.

The purpose of the M-2 district is to provide opportunities for industrial and related activities, which are not likely to meet the high performance standards of the M-1 District, and which involve a heavy dependence upon trucks and potentially noisy or otherwise objectionable industrial activity. Some of the uses permitted may not be consistent with watershed protection unless very strong stormwater and spill prevention controls are in place including:

- ❑ Manufacturing, assembling, converting, altering, finishing, cleaning, or any other processing and incidental storage of products or material….
- ❑ Wholesale storage, distribution, and warehousing facilities, including facilities for storage of petroleum products and coal
- ❑ Automobile repair and motor vehicle service stations

Stream Dumping

Evidence of intentional depositing of debris (stream dumping) can be observed throughout the subwatersheds of Tidal Rondout Creek. The photograph below shows debris along the channels of the tributary to Twaalfskill Brook located in subwatershed 4b. Active stream dumping was observed by the consultant team for this watershed plan as recently as 2015 during a drive through the watershed. Stream dumping is counter to the protection of streams and water quality. Debris in streams can block natural flow patterns, move downstream during floods, and reduce water quality during decomposition.

Ulster Town Code: *No person shall throw or deposit or procure, cause or direct the throwing or depositing, or shall allow or suffer the throwing or depositing, of any garbage, refuse, rubbish, recyclable material, bulky waste, major appliances, plastic, paper, construction or demolition debris onto, on or upon any property, lot or land, either public or private, or upon or into any creek, river or stream within the Town of Ulster.*

Of the three watershed municipalities, only the Town of Ulster prohibits stream dumping in its municipal code. However, without enforcement, dumping can still occur. The Town of Esopus and the City of Kingston should specifically ban stream dumping with amendments to their

municipal code. Ultimately, an enforced stream dumping prohibition would be helpful in the watershed.

Agricultural Practices

Agricultural practices are also known to contribute to water quality issues and should be addressed through local regulations, best management practices, technical assistance, and public education.

Municipalities should encourage local farmers to join the New York State Soil and Water Conservation Committee, Agricultural Environmental Management program (AEM). According to the AEM website, the program "is a voluntary, incentive-based program that helps farmers make common-sense, cost-effective and science-based decisions to help meet business objectives while protecting and conserving the State's natural resources." Farmers work with local AEM resource professionals to develop comprehensive farm plans using a tiered process:

- Tier 1 – Inventory current activities, future plans, and potential environmental concerns.
- Tier 2 – Document current land stewardship; assess and prioritize areas of concern.
- Tier 3 – Develop conservation plans addressing concerns and opportunities tailored to farm goals.
- Tier 4 – Implement plans utilizing available financial, educational, and technical assistance.
- Tier 5 – Evaluate to ensure the protection of the environment and farm viability.

A program of this nature focuses on watershed management from a regional standpoint and has the potential to significantly reduce impacts to the tidal Rondout Creek watershed through effective management practices.

Additional strategies aimed at minimizing impacts to surface waters due to increased pesticides, nutrients, erosion, and pathogens associated with agricultural practices include but are not limited to the following:

- Work with local farmers to ensure that livestock are kept away from watercourses.
- Encourage local agricultural operators to retain stormwater and irrigation water on site.
- Provide local farmers with technical guidance regarding nutrient management.
- Encourage the use of vegetative buffer strips to filter runoff.
- Ensure agricultural practices maintain a minimum 25-foot buffer from wetlands and/or watercourses.

Other Land Uses

As noted in Chapter 3.0, Callanan Industries, Inc. operates a quarry immediately south of Rondout Creek in the town of Esopus. Quarries are potential sources of rock dust, silt, and sediment that can make their way to Rondout Creek during precipitation and runoff events. The town should work to ensure that the quarry operators receive proper technical assistance to manage runoff from their facilities by utilizing proper BMPs.

Elsewhere in the town of Esopus, several industrial facilities are located in the vicinity of Plantasie Creek. The Dyno Nobel facility, which has known soil contamination, is one example. These sites may not receive the level of attention they would receive in Kingston where redevelopment is desired, and funds may be more prevalent for brownfield projects. The Town of Esopus should work with specific industrial land owners to address issues related to soil and groundwater quality as they may impact surface water quality.

Numerous marinas are located along the shoreline of the tidal section of Rondout Creek. Because they are in direct contact with tidal waters, their operations can quickly impact water quality. While marinas are bound by the requirements of various regulatory programs, they should all be using best management practices to protect water quality.

Harbor Management Planning

To resolve conflicts arising from competing water uses, Chapter 791 of the Laws of 1992 was enacted, amending Article 42 of the state's Executive Law (Waterfront Revitalization and Coastal Resources Act) to provide local governments with the authority to comprehensively manage activities in harbor and nearshore areas by developing comprehensive harbor management plans and laws to implement those plans. Article 42 contains procedures for the development and approval of harbor management plans and their local implementing legislation. Specifically, harbor management plans are to be developed with the participation of the public and federal, state, and local governments and agencies. The Department of State provides information and technical and financial assistance to municipalities for the development of Harbor Management Plans as components of their LWRPs.

The U.S. Army Corps of Engineers completed a Harbor Management Plan for the Kingston portion of the Tidal Rondout Creek in 2014. However, the three tidal watershed municipalities lack an intermunicipal harbor management plan. Inclusion of all three municipalities may provide stronger management of the creek as well as increase support from the public.

Suggested Actions

Selected land use policy and regulatory actions are organized by objective below.

Objective #1.5 – Manage land use and redevelopment in tributary subwatersheds

- ❑ Enact stream dumping prevention regulations in Kingston and Esopus and enforce in all three municipalities.
- ❑ Increase outreach and technical assistance for agricultural and animal feed operations.
- ❑ Increase outreach and technical assistance for extraction/mining operations.
- ❑ Support remedial actions at Dyno facility, if applicable.
- ❑ Update the Town of Esopus Comprehensive Plan.
- ❑ Update engineering design standards to incorporate increasing precipitation intensities [described in Section 5.1].
- ❑ Require zero increase in runoff from new developments [described in Section 5.1].

- ❑ Amend Zoning and Subdivision Regulations to incorporate Low Impact Development standards [described in Section 5.1].
- ❑ Retire or modify obsolete zoning districts and classes.
- ❑ Consider amending zoning and subdivision codes in Kingston and Ulster to encourage clustered developments to maximize open space.
- ❑ Consider watershed or water resources protection overlay zoning districts that require additional reviews and design criteria.
- ❑ Acquire open space when available.
- ❑ Consider open space zoning districts to further protect open space.

Objective #2.1 – Manage land use and redevelopment along the waterfront

- ❑ Develop a Harbor Management Plan for all three municipalities or revise the existing Rondout Harbor Management Plan to include Esopus and Ulster.
- ❑ Ensure that marinas are utilizing best management practices to avoid water pollution.

5.4 Tributary Stream Restoration

As described in Chapter 2.0, several tributaries to the tidal Rondout Creek have been identified within the subwatersheds. Some are open named watercourses (such as Twaalfskill Brook, Tannery Brook, Plantasie Kill, and Swarte Kill), some are open unnamed watercourses (such as the short segment of stream located on the east side of the 9W bypass in subwatershed 2), and some are neither named nor flowing in open, natural channels. However, they all share one key characteristic: each has the potential to directly impact water quality within Rondout Creek. Therefore, it is critical to preserve and restore healthy functioning streams with natural channels and banks, connections to floodplains, and vegetation and/or wetlands along the banks to the greatest extent possible in the entire Tidal Rondout Creek watershed.

Daylighting

Daylighting is the process of restoring open channel flow to a stream that was relegated to a buried culvert or tunnel to control flooding, make space for development, or hide waste-laden polluted water. It is understood that segments of both Twaalfskill Brook and Tannery Brook are located within a series of drainage pipes in subwatersheds 4a and 4c. It is highly suspected that several unnamed tributaries of Rondout Creek are encased in tunnels and culverts for more than 50% of their length, including streams that were likely visible in subwatersheds 1, 2, and 3 many decades ago. The picture to the right is the bottom of a steep urban valley in Kingston where a stream was likely present many years ago.

However, this is not unique to Kingston. Segments of streams are in culverts in the town of Esopus as well, including unnamed streams that flow northward into Rondout Creek.

Daylighting is costly and not without enormous logistical issues to solve. However, a restored and open watercourse can be lined with vegetation that filters stormwater and can be designed with a channel and banks that slow velocities, thereby reducing scour and the transport of sediment and pollutants. Buried streams lack any opportunities for water quality mitigation, whereas open watercourses with natural banks, channels, and vegetation have increased opportunities to convey cleaner water.

Kingston, Ulster, and Esopus should consider daylighting sections of streams where feasible. This is a very long-term strategy, but planning will be needed to pursue the funds needed for these projects.

According to American Rivers, *preserving and protecting small streams is the best approach to ensure environmental and community benefits such as clean water and flood reduction. In highly urbanized areas where small headwater streams are often buried, hidden, and forgotten, protecting headwater streams is not possible. Stream daylighting is an approach that brings these buried waterways back to life by physically uncovering and restoring them. Daylighting is an applicable technique to assist communities in reducing polluted runoff, addressing flash flooding concerns, and improving the livability of the built environment.*

Streambank Restoration

Various segments of Twaalfskill Brook and its tributary in subwatershed 4b are flowing between vertical or nearly vertical rock walls as pictured below to the left and right, respectively. This practice was used many years ago to stabilize or channelize streams and make space for other land uses.

Vertical walls have the potential to cause significant downstream erosion due to increased velocities during floods. Municipalities may consider installing energy dissipaters such as check dams to slow water velocities. However, other functions are not restored.

Similar to daylighting, restoring streambanks by replacing vertical walls with sloping, natural materials will provide water quality benefits. Sloping banks will provide less constriction relative to the velocities found between vertical walls, allowing high flow velocities to decrease during

floods. Furthermore, natural banks can be planted with vegetation that filters stormwater. Natural banks can also reconnect streams to floodplains, further relaxing flood flows and reducing flood damage from rushing waters even if inundation is not prevented. If bank failure is a concern, streambanks can be bioengineered to ensure that they provide natural functions while retaining some structure.

Streambank and Channel Erosion Control

Natural streambanks and channels are present along several tributary streams in the subwatersheds, but some of them are subject to erosion due to changes in hydrology from upstream stormwater and changes in precipitation intensity. In the past, Kingston diverted flows from the Tannery Brook to the Twaalfskill Brook as a flood control measure. As a result, along Twaalfskill Brook, it is likely that erosion of banks and channels has increased since high flows from Tannery Brook were diverted to Twaalfskill Brook. This is because the watercourse is now conveying more water than it did historically. The picture to the right shows fallen trees along steep banks along Twaalfskill Brook.

When erosion of banks or channels occurs, sediment can be washed downstream and into Rondout Creek. Therefore, stabilization is desired. As noted above, streambanks can be bioengineered to ensure that they provide natural functions while retaining some structure.

Downcutting should be evaluated and addressed on a case-by-case basis if it is occurring. One method of mitigating downcutting is to try and control grade with cross vanes, which are carefully placed rock structures built below the water level to control the direction of flow within a stream. Other base level control techniques could work as well such as repositioning bridge and culvert levels.

Ultimately, each municipality should conduct a comprehensive analysis of tributary streams to identify and prioritize areas of erosion and bank stabilization.

Vegetation Management

Vegetation management is an important aspect of the strategies described above. Planting native and resilient vegetation will be a component of any daylighting or streambank project, including bioengineered banks. However, the watershed municipalities should also look for opportunities to protect existing riparian vegetation as it helps protect water quality and reduce erosion. Where possible, streamside buffers should be set aside. This is something that is mentioned in all of the other watershed plans for Rondout Creek. If necessary, buffers should be cleared of invasive species and revegetated. It is understood that sometimes invasive species are desirable because they provide good erosion control. However, there may be opportunities to replace such vegetation with equally resilient native vegetation.

Suggested Actions

The selected actions are organized by objective below.

Objective #1.1 – Restore tributary streams and enhance riparian vegetation along tributary streams

- ❑ Pursue opportunities to daylight sections of streams
- ❑ Replace walled streambanks with naturalized and bioengineered streambanks along Twaalfskill Brook and its tributaries in Kingston and Ulster
- ❑ Protect existing riparian wetlands
- ❑ Set aside stream buffers and vegetate accordingly
- ❑ Remove invasive species

Objective #1.2 – Reduce streambank and channel erosion along tributary streams

- ❑ Stabilize eroding banks along watercourses in Kingston, Ulster, and Esopus using natural, bioengineered, and hybrid gray/green bank treatments
- ❑ Address downcutting and channel erosion on a case-by-case basis with cross vanes, which are carefully placed rock structures built below the water level to control the direction of flow within a stream, and other base-level control techniques

5.5 Flood Mitigation

Flooding and flood damage are major contributors to water pollution as explained in Chapter 2.0. Numerous measures can be taken to reduce the impact of a flood event. These include measures that prevent increases in flood losses by managing new development, measures that reduce the exposure of existing development to flood risk, and measures to preserve and restore natural resources. These are described below under the typical hazard mitigation categories of prevention, property protection, structural projects, public education and awareness, natural resource protection, and emergency services.

- ❑ ***Prevention*** does not mean prevention of a flood; it refers to prevention of damage. Prevention of damage from flood losses takes the form of floodplain regulations and redevelopment policies that restrict the building of new structures or other development in zones of risk. These are usually administered by building, zoning, planning, and/or code enforcement offices using building codes, zoning, subdivision, floodplain, and wetland ordinances. It also occurs when land is prevented from being developed through the use of conservation easements or conversion of land into open space. Prevention may also include maintenance of existing mitigation systems such as drainage systems.

- ❑ Measures for ***property protection*** include elevation or relocation of structures at risk for flooding (either to a higher location on the same lot or to a different lot outside of the floodplain), floodproofing, moving building utilities, and relocating valuable belongings above flood levels to reduce the amount of damage caused during a flood.

- Floodplains can provide a number of ***natural resources*** and benefits, including storage of floodwaters, open space, recreation, water quality protection, erosion control, and preservation of natural habitats. Retaining the natural resources and functions of floodplains cannot only reduce the frequency and consequences of flooding but also minimize stormwater management and nonpoint source pollution. Projects that improve the natural condition of areas or restore diminished or destroyed resources can reestablish an environment in which the functions and values of these resources are again optimized. Acquisitions of floodprone property with conversion to open space are the most common of these types of projects.

- ***Structural projects*** include the construction of new structures or modification of existing structures to lessen the impacts of a flood event. Stormwater controls such as drainage systems, detention dams and reservoirs, and culvert resizing may be employed to lessen or control floodwater runoff. On-site detention can provide temporary storage of stormwater runoff. Barriers such as levees, floodwalls, and dikes physically control the hazard to protect certain areas from floodwaters. Channel alterations can be made to confine more water to the channel and accelerate flood flows. Care must be taken when using these techniques to ensure that problems are not exacerbated in other areas of the watershed.

- ***Emergency services*** that would be appropriate mitigation measures for flooding include forecasting systems to provide information on the time of occurrence and magnitude of flooding, a system to issue flood warnings to the community and responsible officials, an emergency notification system that combines database and GIS mapping technologies to deliver outbound emergency notifications to geographic areas or specific groups of people such as emergency responder teams, and lastly emergency protective measures such as outlining procedures for the mobilization and position of staff, equipment, and resources to facilitate evacuations and emergency floodwater control.

- The objective of ***public education*** is to provide an understanding of the nature of flood risk and the means by which that risk can be mitigated on an individual basis. Public information materials should encourage individuals to be aware of flood mitigation techniques, including discouraging the public from modifying channels near their yards and dumping in or otherwise altering watercourses. The public should also understand what to expect when a hazard event occurs and the procedures and time frames necessary for evacuation.

All six types of flood mitigation measures will help to prevent water pollution, including less obvious categories such as emergency services. For example, if people are evacuated early, then there is lower risk of vehicles being stranded and releasing fuels into floodwaters. However, the management strategies for this watershed management plan will focus on the other categories.

Floodplain and Floodway Encroachments

Despite the limited floodplain mapping, there may be several opportunities to enhance or create narrow floodplains through a combination of hydraulic improvements and natural resources protection/restoration. Newly graded floodplain is not likely to provide floodwater storage due to its limited potential area, but it may provide "room for the brook" and for lower

erosive velocities by providing additional capacity for flood conveyance at reduced flood elevations. Floodplain bench areas that are created would serve as an area for debris deposition.

Similar to creating or enhancing floodplains, opportunities should be pursued to reconnect streams to floodplains. Vertical walls and berms can cut off streams from areas that could serve as floodplains. Removal of walls and berms may allow some land to flood that does not currently flood, but velocities would be slower, and floodplains could help filter pollutants from floodwaters.

Potential project areas include the following:

- Portions of Twaalfskill Brook near Wilbur Avenue and Brook Street currently consist of concrete vertical walls. This is an area where the acquisition of certain parcels could provide an opportunity to create new floodplain areas. For example, in the photograph to the right, the barn could be removed to allow for the removal of the vertical wall. Once the wall is removed, the area could be regraded to provide additional floodplain storage.

- In the town of Ulster, concrete vertical walls are located near Rockwell Terrace as shown in the photograph to the right. This may also be an area where the creation of additional floodplain may alleviate flooding. However, due to the proximity to residential homes, acquisitions would be necessary.

In areas recommended for daylighting of streams, sufficient space must be set aside to make floodplains for the newly exposed watercourses. However, this must not be recognized as a net loss of floodable land as the area overlying buried watercourses is already a place where flooding can occur.

Refine Risk Maps

Without an accurate map of flood risks along tributaries to Rondout Creek, it can be difficult to build consensus for flood mitigation in these areas. Likewise, without extensive risk maps being approved by FEMA and adopted locally, the flood damage prevention and building codes are not directly applicable or enforceable.

There are many areas in the Tidal Rondout Creek watershed where flood risk maps could benefit from revision. For example, some tributary streams in all three municipalities simply lack any FEMA mapping. Without a FEMA-designated SFHA along a watercourse, the public perceives that there is no risk, and the municipalities cannot enforce flood damage prevention codes. This puts Rondout Creek at risk of further water quality impairment due to activities along these watercourses that could be regulated if SFHAs were delineated.

Furthermore, some streams in SFHAs have been designated unnumbered A zones due to the lack of detailed modeling studies by FEMA. In A zones, a base flood elevation has not been determined. Municipalities must regulate activities based on the ground elevation and other methods. This also puts Rondout Creek at risk of water quality impairment. For example, a fuel tank set too low in the absence of a base flood determination could be damaged by floodwaters.

If new flood risk mapping is completed, it is critical to conduct the mapping in accordance with FEMA standards and submit new maps for a FIRM map revision. Otherwise, the regulatory and enforcement tools are unavailable.

Diversions

It is quite rare that communities have options to divert water from one watershed to another to control flooding. Kingston was able to do this in the past when flows from Tannery Brook were diverted to Twaalfskill Brook. However, the result is that Twaalfskill Brook now conveys more water during storm events than it did many years ago. Moving forward, the city may have opportunities to evaluate the possibility of restoring natural flow to Tannery Brook and Twaalfskill Brook by reducing or eliminating the diversion. This will help reduce high flows along Twaalfskill Brook, but downstream reaches of Tannery Brook may need to be addressed relative to flood mitigation.

Whether the present diversion is maintained or modified, all flood mitigation projects (and streambank and channel projects too) supported by this plan for the Twaalfskill Brook corridor must take into account the discharges expected in Twaalfskill Brook. Floodplain benches, bioengineered streambanks, and channel grade control modifications (if implemented) must all be designed to accommodate existing and future flows in Twaalfskill Brook.

Bridges and Culverts

The watershed municipalities and Ulster County maintain capital improvement programs and periodically allocate funding to replace bridges and culverts. When this is conducted, it is important to upsize capacities to allow for more intense precipitation events, higher flows, and passage of debris carried in floodwaters. If these structures are better equipped to convey high flows, then washouts and adjacent flood damage are less likely to occur, and pollutants are less likely to be mobilized from areas that erode or flood. Larger capacities also benefit aquatic habitats and fish passage.

Individual Properties

All of the strategies within the mitigation category "property protection" should be strongly promoted throughout the Tidal Rondout Creek watershed. This includes:

- ❑ Remove outbuildings, small tanks, and stored materials from stream corridors
- ❑ Consider relocating residents and removing homes located adjacent to streams through negotiations with and approval of homeowners
- ❑ Elevate residential structures located along streams
- ❑ Floodproof nonresidential structures located along tributaries

While not always obvious, the water quality benefits of these actions cannot be understated. Floodwaters that enter and exit basements and homes typically carry an array of pollutants, and outbuildings are often washed downstream with their contents.

Without zoning and building codes, it can be difficult to compel property owners to make these types of changes. This underscores the importance of delineating SFHAs and replacing A zones with AE zones wherever possible. Without those tools, communities must rely on other sections of the zoning, subdivision, and wetlands codes and regulations to affect change along watercourses.

Waterfront Tidal Flood Mitigation

In 2014, MMI worked with the City of Kingston to assess the redevelopment potential of the East Strand Street waterfront along the Rondout Creek. According to the *East Strand Street Flooding and Stormwater Management Analysis*, the primary contributors to frequent, less severe nuisance flooding are the inadequate roadway drainage systems and the low roadway elevations in comparison to normal high tides. The major contributor to less frequent but more damaging floods is tidal and storm surge influences from the Hudson River.

Three strategies were outlined for mitigating floodwaters from rising sea level, and the alternative selected by the city may involve a combination of these three strategies:

1. Fortification of Infrastructure: Fortification of the East Strand waterfront may be viable for protecting against smaller, more frequent nuisance floods. This may involve shoreline treatments; bulkheads; raising the elevation of the roadway, railroad, and adjacent land; and installing backflow prevention devices on drainage systems to prevent flooding.
2. Relocation of Infrastructure: Relocating the development areas along East Strand is an option the city may choose to pursue if flooding of certain infrastructure such as the wastewater treatment plant (WWTP) or the entire roadway itself is deemed unacceptable.
3. Accommodation of Floodwaters: Accommodating floodwaters in a manner that minimizes damages when they recede is a third strategy that will play an important role in the future development of the East Strand waterfront as rising sea levels will ensure that the frequency and severity of inundation that occurs in the area will only increase with time. Examples of this include elevating new buildings and providing parking or other related uses underneath.

This watershed management plan is supportive of flood mitigation for its significant water quality benefits and does not attempt to promote one solution over the others. Indeed, a combination of solutions may be most appropriate. At a minimum, the following should be considered in Kingston as well as in the tidally influenced zones of flood risk in Ulster and Esopus along Rondout Creek.

Local Protective Measures

This class of flood protection measures can be applied to independent properties or areas to minimize the vulnerability of that property to flood hazards. These measures include but are not limited to filling and raising of individual properties (something that is *not permissible* along the tributary streams due to the loss of floodplain storage), elevating whole buildings or internal mechanicals, floodproofing buildings at grade, raising or floodproofing public utilities, and backflow prevention on drains and sewers.

Many of the existing buildings are historic brick structures constructed on slabs that would be difficult to elevate. However, even these types of buildings can gain flood relief using devices such as flood doors (refer to picture to the right). New buildings will be constructed to comply with NFIP regulations and building codes that require elevation or floodproofing of the buildings.

The primary disadvantage of individualized local measures is that the roadway and public areas will still be floodprone, which would obstruct traffic and emergency services from reaching the buildings in the event of a severe flood. Local protective measures are most suitable to use for moderate flood frequency, but at an increased cost, most buildings can be raised or sealed from even the most extreme floods.

Drainage Improvements

Roadway reconstruction efforts may only be effective if coupled with the reconstruction of the existing drainage systems. Rebuilding the existing drainage systems to ensure proper inlet and pipe capacity and adding tide gates at the end of them will help prevent smaller, more frequent floods caused by heavy rainfall or higher tides.

Given the low-lying nature of East Strand as compared with the other uphill streets in Ponckhockie, one recommendation for the proposed drainage system involves disconnecting the uphill drainage systems from those that serve East Strand and allowing them to discharge separately. Under existing high tide conditions, these drainage systems exacerbate surcharging of the drainage structures in East Strand. If they are disconnected from the system and discharged separately, their higher elevations may give them the hydraulic head necessary to continue to discharge during high tide events.

After disconnecting the uphill tributary systems, East Strand can be reconstructed with new drainage systems with much smaller, localized contributing drainage areas. This minimizes the amount of water that will accumulate at the low points while tidal influence prevents the drainage systems from discharging.

The second general option for the new drainage systems would be the installation of tidal backflow prevention devices or flap gates to prevent backwater from storm surge and extremely high tides from surcharging the drainage systems and causing the road to become inundated.

Roadway Elevation

Raising the elevation of the roadway and sidewalks provides a simple alternative to lessen the impact of tidal flooding on East Strand Street but also presents a number of complicating factors. The close proximity of historic buildings such as the Cornell Building, the Steel House restaurant, the WWTP, and the adjacent railroad tracks limits the height to which the road can be raised before buildings need to be removed, relocated, or reconstructed.

Roadways along Rondout Creek in other parts of Kingston as well as Esopus and Ulster may be good candidates for elevation because they are less intensely developed than East Strand. In these areas where development density is lower, there may be sufficient space to regrade driveways and yards to meet the new road elevations.

Raise Elevation of Waterfront Land

Increasing the elevation of low-lying waterfront areas along East Strand Street may provide limited benefit to the East Strand area for less extreme flooding events (less than the 10% annual chance flood). In any future development plan for these parcels, especially those that are currently undeveloped, it would be beneficial to require developers to fill these isolated low points such that the waterfront land remains continuously at grade for the length of the street. These areas are primarily located on private property.

Levees and Flood Barriers

Earthen levees and structural floodwalls of concrete, steel sheeting, or timber can form a barrier that separates rising waters in Rondout Creek from the East Strand waterfront or any other area with flood risk. Flood barriers can be located along the riverfront at a sufficient height to provide a high level of protection, but several special considerations must be addressed. For example, flood barriers require routine maintenance such that the physical integrity is maintained and the eligibility for FEMA Flood Insurance Certification is retained. Earthen levees require a wide area for their construction and

> The installation of levees or floodwalls would isolate enclosed areas from the effects of flooding but in doing so would make access to the waterfront more difficult. This is contrary to the expressed goals of the City of Kingston to provide a more vibrant, publically accessible waterfront. For this reason and others, this watershed management plan does not support creation of levees or extensive flood walls along Rondout Creek or any other watercourse.

maintenance to provide structural stability. A 10-foot-high levee with a 12-foot-wide crest and 2:1 (horizontal to vertical) side slopes would require a total width of 52 feet. In areas where open space is restricted, structural floodwalls can be used in a much smaller footprint but at a higher cost.

Limited flood walls that are constructed to serve a specific need or a single property can be an effective and sustainable solution for some land uses. Readily available examples from the Tidal Rondout Creek area include the petroleum terminal and storage facilities. These are water-dependent uses and will remain in areas of flood risk, but flood walls can be used to protect the facilities from flooding. An example of a low flood wall in Walton, New York is pictured to the right.

When flood walls are used, stormwater runoff and interior drainage obstructed by the walls must be addressed. To accommodate the interior runoff that cannot discharge due to the high water on the flooded side of the wall, the following devices are commonly installed: (1) backflow prevention devices at the stormwater discharge outlets, which extend through the flood walls, and (2) interior detention or pumping stations.

In order to be effective, any barriers must provide protection for at least the 100-year or 500-year water surface elevation. However, planning for sea level rise in Kingston has resulted in potential new design criteria that should be used.

Policies for Coastal Resiliency in Redevelopment

Consideration of long-term and severe flooding is likely to be an important part of sustainably developing and redeveloping along Rondout Creek. Coastal resiliency and adaptation to coastal hazards have traditionally been undertaken using shoreline hardening and engineered defenses, which are often unsuccessful against the rising waters from sea level rise. While nuisance flooding may be reduced by the countermeasures and fortification methods described above, it would become increasingly expensive to prevent more severe flooding.

The three municipalities may choose to enact provisions in their codes and regulations to account for the increase in flooding. The city may consider revising its zoning regulations to be consistent with its long-term policies, goals, and vision for the waterfront. Responsible development can minimize damages that occur during an emergency event. Based on zoning changes that the city may choose to enact, certain land uses that cannot accommodate periodic flooding may become nonconforming uses. Examples on East Strand may include the WWTP, oil storage, or other areas that could suffer failure if inundated. It may be necessary to plan for the longer-term relocation of these land uses away from floodprone areas, especially as sea level rise (SLR) causes more frequent and more severe flooding. Other land uses that are not consistent with the city's long-term goals could be removed from the permitted zoning uses such as recycling facilities and other industrial uses.

Other considerations for the zoning regulations may include eliminating certain other types of land uses from the area. In addition to the previously described municipal facilities and industrial uses, allowing residential development in floodprone areas may become a safety issue. Even if structures are not damaged during the flood evacuations could prove difficult. Revising the zoning regulations to discourage residential land use in floodprone areas could be considered.

In addition to disallowing certain uses of the waterfront, revisions to the zoning regulations could also be used to promote more recreational and open space types of water-dependent land uses. These uses may become public assets that are naturally more resilient to the periodic inundation that may occur.

Current zoning regulations provide a Flood Hazard Overlay District to restrict and control development within the floodprone areas of the city and are defined by FEMA mapping. However, the overlay zone is directly referenced to the FIRM. Since the FEMA mapping does not consider projected sea level rise, the provisions may not provide adequate protection for those properties identified as at-risk or may incorrectly identify at-risk properties as safe from flooding.

Suggested Actions

The selected actions are organized by objective below.

Objective #1.3 – Prevent or minimize flood damage along tributary streams

- ❑ Reconnect tributary streams to their floodplains by pursuing all the actions suggested above (daylighting streams, replacing walls with naturalized streambanks, and stabilizing banks) and by removing berms and any other obstructions.
- ❑ Enhance existing floodplains and construct floodplain benches to accommodate floodwaters and provide space for debris flowing downstream in floods.
- ❑ Increase bridge and culvert capacities to allow conveyance of floodwaters while minimizing debris clogs.
- ❑ Develop flood risk mapping along sections of streams that have not been studied by FEMA (such as the upper Twaalfskill Brook) and submit results to FEMA with a request for FIRM revision.
- ❑ Refine flood risk mapping along the unnumbered A zones (such as the tributaries in the town of Esopus) and submit results to FEMA with a request for FIRM revisions.
- ❑ Remove outbuildings, tanks, and stored materials from stream corridors.
- ❑ Consider relocating residents and removing homes located adjacent to streams through negotiations with and approval of homeowners.
- ❑ Elevate residential structures located along tributaries.
- ❑ Floodproof nonresidential structures located along tributaries.
- ❑ Ensure that projects completed along Twaalfskill Brook, or flood risk mapping conducted for Twaalfskill Brook, include consideration of high flows diverted from Tannery Brook.

- ❑ Evaluate options for restoring flow from Tannery Brook to the downstream portion of Tannery Brook rather than diverting high flows to Twaalfskill Brook.

Objective #2.2 – Mitigate tidal flooding in the Kingston, Esopus, and Ulster waterfront areas

- ❑ Pursue drainage system improvements.
- ❑ Elevate roads.
- ❑ Elevate buildings that cannot be floodproofed.
- ❑ Floodproof buildings that cannot be elevated.

5.6 Wetlands and Habitat Restoration

Through decades of well-documented research, it is understood that wetlands and watercourses provide a host of important physical and chemical functions as well as a suite of beneficial societal values. These functions and values operate at all scales, from the microscopic up to the local and regional landscape. While most wetlands perform some, or even many, of these functions and values, some wetland types are inherently more valuable than others because of their location, vegetation, geology, aesthetics, prior impacts, or history.

Therefore, where possible, opportunities should be identified to restore wetland areas located along Rondout Creek and its tributaries. Reforesting wetland/riparian zone areas will increase habitat biodiversity and will provide benefits to water quality including thermal protection, nutrient filtering, allochthonous inputs or sediment storage, and bank stabilization.

Some of the actions previously described in the context of stream daylighting and bank restoration will result in the expansion of wetland vegetation through necessity as the streams and banks will require vegetation for stabilization.

Protecting existing wetland vegetation is also very important. While limited in some of the subwatersheds, these pockets of wetlands are valuable. The efforts completed in recent years for the Kingston Open Space Plan include mapping of natural resources. This plan should be used to guide protection of wetlands and remove invasive species where they are found.

In the long term, the three watershed municipalities should look for opportunities to create diverse habitats throughout the subwatersheds. All types of wetlands should be considered, with appropriate proportions of each (palustrine, emergent, shrub/scrub, and open water wetlands) balanced to reflect the habitat needs of the area and the topography, hydrology, and soils available to support these types of wetlands. This could happen in connection with stream daylighting, open space acquisition, or many other actions suggested in this watershed management plan. In short, those who are implementing this plan should be cognizant of how to enhance wetlands and introduce new wetland vegetation when other projects are being pursued.

Suggested Actions

The selected actions are organized by objective below.

Objective #1.1 – Restore and enhance riparian vegetation along tributary streams

- ❑ Pursue opportunities to daylight sections of streams [described in Section 5.4].
- ❑ Replace walled streambanks with naturalized and bioengineered streambanks along Twaalfskill Brook and its tributaries in Kingston and Ulster [described in Section 5.4].
- ❑ Provide diverse wetland habitats (palustrine, emergent, shrub/scrub, and open water wetlands) throughout the subwatersheds.
- ❑ Protect existing riparian wetlands.
- ❑ Set aside stream buffers and vegetate accordingly.
- ❑ Remove invasive species.

Objective #1.5 – Carefully manage land use and redevelopment in tributary subwatersheds

- ❑ Acquire open space when available [described in Section 5.3].
- ❑ Consider open space districts to further protect open space [described in Section 5.3].

5.7 Monitoring

Water Quality Monitoring

Chapter 2.0 described water quality monitoring conducted by the City of Kingston and Riverkeeper. Additional water quality monitoring does not appear to be ongoing in the Tidal Rondout Creek watershed. Future water quality monitoring locations are desired and have been identified with the following three objectives:

- ❑ Provide data that is *needed at the present time* to better characterize the relationships between land use and water quality. Focus should be placed on Twaalfskill Brook, Tannery Brook, Plantasie Kill, Swarte Kill, and unnamed streams in many of the subwatersheds.

- ❑ Begin providing a *baseline of water quality data* where future development is planned or possible in order to assess changes that may occur in the future. Examples include upstream reaches of Plantasie Kill and Swarte Kill where undeveloped land is located. The photograph to the right shows commercial land for sale adjacent to Plantasie Kill.

- ❑ Provide support for listing or delisting impaired watercourses in the watershed.

Monitoring data will be increasingly important to collect and understand if watershed stakeholders wish to pursue the inclusion of Rondout Creek on the state's impaired water list. The monitoring information may help get the creek (and possibly tributaries) listed, which will be important in leveraging financial resources to make improvements and to eventually get the creek and its tributaries back off the impaired list. Likewise, the information could be helpful to support progress from Class C to Class B status for Rondout Creek as water quality improves.

Figure 5-2 illustrates a number of potential water quality monitoring locations in the Tidal Rondout Creek watershed. New monitoring locations have not been suggested for Rondout Creek as several sites are already being monitoring by the city and Riverkeeper. In other words, all sites depicted in Rondout Creek are existing monitoring locations. For the longer tributary streams, multiple monitoring locations are proposed ("A" is the upstream site and "B" is the downstream site). However, in most cases, the tributary has only a short daylighted section, and only one sample site is proposed.

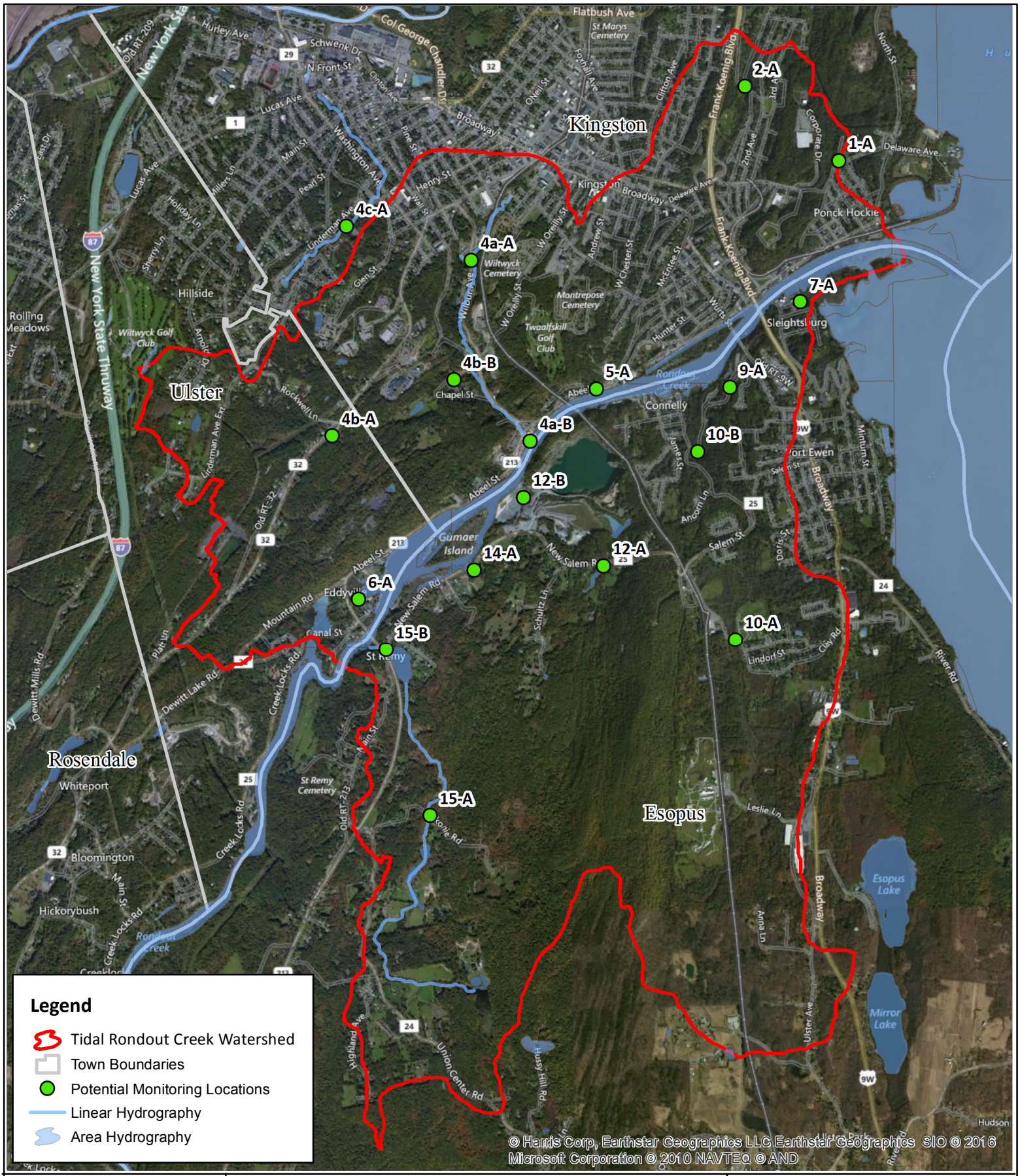
At this time, the frequency of monitoring and the specific parameters of concern have not been determined for every site. However, parameters to evaluate should include turbidity, physical parameters, pH, bacteria, nutrients such as nitrogen and phosphorus, and possibly a handful of metals and other specific constituents of concern related to land uses in the subwatersheds. Sufficient data should be collected during dry weather *and* during runoff-producing events.

Monitoring efforts could be a collaboration between many stakeholders including municipal personnel, Riverkeeper, and local schools or volunteers. Oftentimes, monitoring programs will provide good linkage to the public education objectives of a watershed management plan.

Stream Monitoring

Monitoring of geomorphological processes within the streams is an additional parameter that is recommended for monitoring in the Tidal Rondout Creek watershed. Geomorphology practitioners such as Rosgen (ref. the *Watershed Assessment of River Stability & Sediment Supply* process, http://water.epa.gov/scitech/datait/tools/warsss) note that a stream monitoring program can accomplish or contribute to the following:

- ❑ Measure the response of the system to a change.
- ❑ Document the response of a specific process and compare to the predicted response for the prescribed treatment.
- ❑ Define short-term vs. long-term changes.
- ❑ Document spatial variability of process and system responses.
- ❑ Reduce prediction uncertainty.
- ❑ Provide confidence in management practice modifications or recommendations.
- ❑ Determine if mitigation is implemented correctly.
- ❑ Evaluate effectiveness of stabilization approaches.
- ❑ Build a database to extrapolate for similar applications.



SOURCE(S):
BING Aerial Imagery

Figure 5-2: Potential Water Quality Monitoring Locations

LOCATION:
Kingston, NY

N

Tidal Rondout Creek Watershed Management Plan

MXD: P:\4766-01\Design\GIS\Maps\Potential Water Quality Monitoring_update.mxd

Map By: CMP
MMI#: 4766-01
Original: 1/15/2013
Revision: 12/20/2016
Scale: 1 inch = 3,250 feet

MILONE & MACBROOM
99 Realty Drive Cheshire, CT 06410
(203) 271-1773 Fax: (203) 272-9733
www.miloneandmacbroom.com

While some of these objectives are inappropriate for the small sizes of the tributary subwatersheds and the nature of issues in the watershed, monitoring will be necessary to determine at a minimum whether improvements in the subwatersheds are (1) successful for their stated purpose and (2) result in improved water quality through reduced sediment loading and transport.

One method of monitoring the success of specific mitigation projects for bank and channel stabilization is to periodically measure changes of the slopes and channels where the project was focused as well as downstream. "Permanent cross sections" are recommended to be set in locations at and downstream from stream projects that are implemented. These cross sections would then be used to periodically measure channel dimensions and bed elevations relative to known surveyed elevations. The comparison of measurements from 1 year to the next will provide a direct measure of whether banks are remaining stable and whether the channel is aggrading, degrading/incising, or neither.

It may be beneficial to estimate sediment transport rates as an indirect measure of stream project success rates. To do so, discharge rates, suspended sediment, and bedload sediment must be measured from time to time. Gauging stations should be set up for this purpose. Because it is unrealistic to expect the USGS to install gauging stations on the small tributary streams and maintain such gauges, the stations should be ones that can be set up and maintained by designated stakeholders. Steep sections of streams are unsuitable for gauging stations, but the flatter sections of Twaalfskill Brook and Plantasie Kill have several appropriate locations. Each station should be fitted with a durable staff gauge, and a rating curve, or a graph of the discharge versus the stage for a given point on a stream, should be developed for each by measuring stream discharges periodically. Suspended sediment and bedload sediment should be measured at the two gauging stations periodically as well.

The combination of indirect data from the gauging stations and direct data from the permanent cross sections will provide a solid record of whether streambank and channel projects are working as intended.

Wetland Monitoring

Monitoring the progress of restoration projects within wetlands would provide data of benefit to the project. If wetland areas are restored or cleared of invasive vegetation, annual vegetation surveys should be conducted in selected locations. These are typically conducted by walking the same transect through the wetland on an annual basis and recording the numbers of plants present in different species and the condition of these plants.

Suggested Actions

The selected actions are organized by objective below.

Objective #2.4 – Improve water quality classification of Rondout Creek from C to B

- ❑ Consider requesting designation of impaired status for the tidal Rondout Creek.

- ❑ If impaired status is granted, leverage the resources made available as a result of the impaired status.

Objective #2.5 – Increase training, education, and stewardship

- ❑ Coordinate existing water quality monitoring programs to increase data sharing and avoid redundant efforts.
- ❑ Set up and implement a new water quality sampling and monitoring program to fill gaps and augment existing programs while providing metrics for measuring implementation of this plan.
- ❑ Set up and implement a monitoring protocol for tributary stream projects such as revegetation and streambank stabilization.

5.8 Education and Training

Watershed management plans are essential tools designed to assist local municipalities, residents, business owners, and environmental awareness groups in improving overall water quality within a watershed. The objectives of public education and stakeholder training are to provide an understanding of effective watershed management and then demonstrate to stakeholders how to implement actions on an individual level, if appropriate. A key component of watershed management lies in taking a holistic approach and understanding that activities upstream can have significant impacts downstream; this needs to be understood by all members of a community.

Public information materials should encourage individuals to be aware of watershed management techniques, including discouraging the public from modifying channels and/or detention basins in their yards, dumping, or otherwise altering watercourses and storage basins. Individuals should be made aware of effective land management techniques and other methods of watershed management. While not everyone can take on a green infrastructure project, an individual homeowner or business can make changes like using pavers and rain barrels to try reducing stormwater runoff.

Suggested Actions

The selected actions are organized by objective below; several are repeated from the previous section (Monitoring) given the potential involvement of citizen scientists and other stakeholders.

Objective #2.5 – Increase training, education, and stewardship

- ❑ Promote the use of the online tool (http://www.kingston-ny.gov/reportit) for residents to report water quality concerns such as spills, stream dumping, and streambank erosion.
- ❑ Link watershed water quality awareness to existing recreational programs through interpretative signage and modification of recreational program curriculums.

- ❑ Set up and implement a new water quality sampling and monitoring program to fill gaps and augment existing programs while providing metrics for measuring implementation of this plan.
- ❑ Set up and implement a monitoring protocol for tributary stream projects such as revegetation and streambank stabilization.

5.9 Consideration of Changing Conditions

This watershed management plan recognizes that watershed conditions will change over time. Two main groups of change are *climate change* (discussed throughout this plan in the context of the City of Kingston Climate Action Plan, the City of Kingston Comprehensive Plan, and in other references) and *physical changes*.

Climate Change

Some researchers have suggested that the intensity of tropical cyclones, which includes hurricanes, has increased over the last 35 years, with some believing that there is a connection between this increase in intensity and climate change. While most climate simulations agree that greenhouse warming enhances the frequency and intensity of tropical storms, models of the climate system are limited by resolution and computational ability. However, given the past history of major storms such as Tropical Storm Irene and the possibility of increased frequency and intensity of tropical storms due to climate change, it is prudent to expect that there will be hurricanes impacting New York in the near future that may be of greater frequency and intensity than in the past.

Apart from tropical storm activity, recent climate change studies predict that fewer, more intense precipitation events will occur with more precipitation falling as rain rather than snow in future years.

The three watershed municipalities experienced growth and development following World War II. This population increase led to concomitant increases in impervious surfaces and infrastructure. Many storm drainage systems and culverts were likely designed using rainfall data published in *Technical Paper No. 40* by the U.S. Weather Bureau (now the National Weather Service). The rainfall data in this document dates from the years 1938 through 1958.

This engineering standard was based on the premise that extreme rainfall series do not change through time such that the older analyses reflect current conditions. Recent regional analyses have shown that this is not the case as the frequency of 2-inch rainfall events has increased, and storms once considered a one-in-100 year event are now likely to occur twice as often. As such, the Northeast Regional Climate Center (NRCC) has partnered with the Natural Resources Conservation Service (NRCS) to provide a consistent, current regional analysis of rainfall extremes (http://precip.eas.cornell.edu/) for engineering design. Communities should incorporate these new methods into design standards. One action under Objective #1.5 has been developed for this strategy:

Objective #1.5 – Manage land use and redevelopment in tributary subwatersheds

- ❑ Update engineering design standards to incorporate increasing precipitation intensities.

Three strategies from the Kingston Comprehensive Plan (discussed in Chapter 4.0) directly address sea level rise and are supported by this watershed management plan:

- ❑ Strategy 10.1.3: Require that any proposed new private structures or major renovations with proposed ground floor elevations lower than 13 feet above 2014 mean sea level be constructed to FEMA standards for construction in flood zones. Current (2014) 100-year flood elevation is 8.2 feet. New York State building code standards require at least 2 feet of freeboard above 100-year flood elevations. High range projections for sea level rise in 2060 and mid-range projections for 2100 are for 3 feet. To safeguard persons and property from future flooding loss, the city should require that any significant new private real property be constructed in a manner that conforms to current requirements for construction in flood zones. Examples of requirements applicable to construction within flood zones may include such safeguards as not constructing on fill, requiring construction on pilings, prohibiting residential occupancy to elevations above flood elevations, and requiring breakaway walls.

- ❑ Strategy 10.1.4: Require that any proposed new public structures or infrastructure or major renovations be constructed to withstand flood elevations of 14 feet above 2014 mean sea level. Current (2014) 100-year flood elevation is 8.2 feet. High range projections for sea level rise for 2100 are for 5 to 6 feet. Long-term planning for public infrastructure and facilities should be designed and located in a manner that will not subject them to future flood risk based on high range projections.

- ❑ Strategy 10.2.2: Promote appropriate private redevelopment of Island Dock, as governed by sound planning for sea level rise, along with construction of a new passive/interpretive park at its eastern tip. Create Island Dock Park located on the east tip of Island Dock in conjunction and in cooperation with the private redevelopment of Island Dock. Island Dock is completely within the 100-year flood zone. Any private redevelopment must be done in a manner consistent with recommendations for future sea level rise. Contingent upon the findings of the recommended Long-Term Resiliency Plan, the best approach for adaptation may be for the city to purchase the island for open space purposes of flood storage and wave attenuation. If used for maritime purposes including cruise ship dockage or marina, the improvements should be built in a manner that will adapt to rising sea level and storm surges.

Physical Changes in the Watershed

Physical changes are difficult to predict. For example, this watershed management plan encourages the daylighting of buried watercourses. If accomplished, the restored stream corridors will represent an altered landscape with a number of needs such as revised FEMA flood risk mapping and the establishment of stream buffers. The actions recommended in this plan have been crafted to assume that change may occur and subsequently *allow* other actions in this plan to be applied. For example, one action is to daylight streams. Actions of this plan

that may follow the daylighting of a stream include establishment of naturalized streambanks and setting aside stream buffers.

This watershed management plan also supports the restoration of flows from Tannery Brook to its natural channel and outlet at Esopus Creek. If accomplished, then other actions may be necessary such as turning attention to areas outside of this watershed management plan.

A physical change that is possible, subject to the will of the communities and availability of funding, is the removal of the dam at Eddyville. If this structure were removed, the hydrodynamics upstream and downstream would change. Tidal influence could extend further upstream than its present limit. The discussion of the pros and cons associated with removal of the dam are beyond the scope of this watershed management plan, and this plan cannot offer removal of the dam as a recommended action. However, several comments received on the draft edition of this plan asked that dam removal be recommended.

If the dam were removed, tidal flushing of Rondout Creek could extend further upstream. Changes in water quality could result. If the Eddyville Dam were removed, the City of Kingston's and Riverkeeper's monitoring programs may need to be modified to adapt to this change, but the tributary stream monitoring programs recommended in this plan would not be affected.

6.0 ACTIONS AND IMPLEMENTATION

6.1 Summary of Goals, Objectives, and Actions

Goals and objectives were introduced in Chapter 1.0. Actions corresponding to the objectives were developed in Chapter 5.0. A summary is provided below.

Appendix E lists the actions of this watershed management plan and indicates the relative priority for implementing the action in each subwatershed (high, medium, or low). This will help facilitate implementation.

Goal #1 – Restore tributary streams and subwatersheds to improve water quality

Objective #1.1 – Restore tributary streams and enhance riparian vegetation along tributary streams

a. Pursue opportunities to daylight sections of streams.
b. Replace walled streambanks with naturalized and bioengineered streambanks along Twaalfskill Brook and its tributaries in Kingston and Ulster.
c. Provide diverse habitats (palustrine, emergent, shrub/scrub, and open water wetlands) throughout the subwatersheds.
d. Protect existing riparian wetlands.
e. Set aside stream buffers and vegetate accordingly.
f. Remove invasive species.

Objective #1.2 – Reduce streambank and channel erosion along tributary streams

a. Stabilize eroding banks along watercourses in Kingston, Ulster, and Esopus using natural, bioengineered, and hybrid gray/green bank treatments.
b. Address downcutting and channel erosion on a case-by-case basis with cross vanes and other base level control techniques.

Objective #1.3 – Prevent or minimize flood damage along tributary streams

a. Reconnect tributary streams to their floodplains by pursuing all the actions suggested above (daylighting streams, replacing walls with naturalized streambanks, and stabilizing banks) and by removing berms and any other obstructions.
b. Enhance existing floodplains and construct floodplain benches to accommodate floodwaters and provide space for debris flowing downstream in floods.
c. Increase bridge and culvert capacities to allow conveyance of floodwaters while minimizing debris clogs.
d. Remove outbuildings, tanks, and stored materials from stream corridors.
e. Consider relocating residents and removing homes located adjacent to streams through negotiations with and approval of homeowners.
f. Develop flood risk mapping along sections of streams that have not been studied by FEMA (such as the upper Twaalfskill Brook) and submit results to FEMA with a request for FIRM revision.

g. Refine flood risk mapping along the unnumbered A zones (such as the tributaries in the town of Esopus) and submit results to FEMA with a request for FIRM revisions.
h. Elevate residential structures located along tributaries.
i. Floodproof nonresidential structures located along tributaries.
j. Ensure that projects completed along Twaalfskill Brook, or flood risk mapping conducted for Twaalfskill Brook, include consideration of high flows diverted from Tannery Brook.
k. Evaluate options for restoring more flow from Tannery Brook to the downstream portion of Tannery Brook rather than diverting high flows to Twaalfskill Brook.

Objective #1.4 – Modify stormwater management in tributary subwatersheds

a. Continue to separate storm and sanitary sewer systems.
b. Increase the frequency of catch basin cleanouts.
c. Replace impervious surfaces with pervious surfaces when approving redevelopment proposals.
d. Require green infrastructure techniques and low impact development for new developments and significant redevelopments.
e. Maintain existing detention and retention basins.
f. Identify opportunities to detain stormwater in areas of existing development, and construct stormwater basins in areas that can receive runoff from small groups of existing developed parcels.
g. Install collection and conveyance systems in areas that are not served by stormwater systems if the provision of collection and conveyance systems will reduce erosion and overland transport of pollutants.
h. Vegetate swales and ditches located along roadways.
i. Incorporate green infrastructure and improved stormwater management at and along the Route 9W bypass.

Objective #1.5 – Manage land use and redevelopment in tributary subwatersheds

a. Enact stream dumping prevention regulations in Kingston and Esopus and enforce in all three municipalities.
b. Increase outreach and technical assistance for agricultural and animal feed operations.
c. Increase outreach and technical assistance for extraction/mining operations.
d. Support remedial actions at the Dyno facility, if applicable.
e. Update the Town of Esopus Comprehensive Plan.
f. Update engineering design standards to incorporate increasing precipitation intensities.
g. Require zero increase in runoff from new developments.
h. Retire or modify obsolete zoning districts and classes.
i. Amend Zoning and Subdivision Regulations to incorporate Low Impact Development standards.
j. Consider amending zoning and subdivision codes in Kingston and Ulster to encourage clustered developments to maximize open space.
k. Consider watershed or water resources protection overlay zoning districts that require additional reviews and design criteria.
l. Acquire open space when available.

m. Consider open space districts to further protect open space.

Objective #1.6 – Manage disposal of sanitary wastewater in tributary subwatersheds

a. Reduce sanitary sewer inflow and infiltration.
b. Ensure that regular maintenance of septic systems is occurring.
c. Extend sewer systems where groups of septic systems are failing or reaching the ends of their period of effectiveness.
d. Delineate sewer avoidance and future sewer system service areas.

Goal #2 – Create a vibrant waterfront by improving water quality

Objective #2.1 – Manage land use and redevelopment along the waterfront

a. Develop a Harbor Management Plan for all three municipalities or revise the existing Rondout Harbor Management Plan to include Esopus and Ulster.
b. Repair and replace bulkheads using standard methods, including sheet piling, but also considering other methods evaluated by the Hudson River Estuary Program.
c. Ensure that marinas are utilizing best practices to avoid water pollution.

Objective #2.2 – Mitigate tidal flooding in the Kingston, Esopus, and Ulster waterfront areas

a. Pursue drainage system improvements.
b. Elevate roads.
c. Elevate buildings that cannot be floodproofed.
d. Floodproof buildings that cannot be elevated.

Objective #2.3 – Reduce sewer overflows into Rondout Creek

a. Reduce sanitary sewer inflow and infiltration.
b. Eliminate combined sewers.
c. Maximize treatment capacities to avoid overflow of untreated wastewater.
d. Protect the wastewater treatment plant from flooding.

Objective #2.4 – Improve water quality classification of Rondout Creek from C to B

a. Consider requesting designation of impaired status for the tidal Rondout Creek.
b. If impaired status is granted, leverage the resources made available as a result of the impaired status.

Objective #2.5 – Increase training, education, and stewardship

a. Coordinate existing water quality monitoring programs to increase data sharing and avoid redundant efforts.
b. Set up and implement a new water quality sampling and monitoring program to fill gaps and augment existing programs while providing metrics for measuring implementation of this plan.
c. Set up and implement a monitoring protocol for tributary stream projects such as revegetation and streambank stabilization.
d. Link watershed water quality awareness to existing recreational programs through interpretative signage and modification of recreational program curriculums.
e. Promote the use of the online tool (http://www.kingston-ny.gov/reportit) for residents to report water quality concerns such as spills, stream dumping, and streambank erosion.

6.2 Implementation Strategy

Table 6-1 presents a list of actions, time frames, and responsible parties. Some of the actions have a corresponding distinct task (i.e., "Set up and implement a new water quality sampling and monitoring program") and some do not (i.e., "Acquire open space when available"). Therefore, estimating costs is challenging. To enable cost estimates, an "example project" is suggested for each action, and costs are based on the completion of the example project; refer to the snapshot to the right.

- Action: Require green infrastructure techniques and low impact development for new developments and significant redevelopments
- Example Project: Install rain garden along edge of parking lot on East Strand.
- Cost: Medium

Potential costs are provided qualitatively as "low," "medium," or "high" with the following assumptions:

- "Low" costs have either no cost or they can be handled by existing municipal, county, or state personnel with few outside expenses.
- "Medium" costs would require less than $100,000 to implement and may include studies or investigations.
- "High" costs would require a greater level of funding with identified sources of the funding and may include capital expenditures for land acquisition or major projects involving construction or infrastructure.

The Table 6-1 entries in the "Time Frame" column are similarly divided into three categories:

- "Ongoing" indicates recommendations that may be underway and should continue or should commence upon plan completion.
- "Near-Term" indicates recommendations that should be implemented in the next 2 years, some of which may continue for a period of time or indefinitely.
- "Long-Term" indicates recommendations that should be pursued within 10 years, some of which may continue for a period of time or indefinitely.

In Table 6-1, the column entitled "Priority Action" highlights those action items that the PAC has determined to be actions that should to be implemented in the near future. Of the numerous starred action items, the following three projects have been advanced as high priority potential projects. The projects are as follows:

1. ***225 Wilbur Avenue***

From Objective #1.2, "Reduce streambank and channel erosion along tributary streams," the actions identified are (1) stabilize eroding banks along watercourses in Kingston, Ulster, and Esopus using natural, bioengineered, and hybrid gray/green bank treatments and (2) address downcutting and channel erosion on a case-by-case basis with cross vanes and other base-level control techniques.

Eroding streambanks, steep slopes, and sharp turns in the Twaalfskill Brook were identified in a section of the brook that runs parallel to Wilbur Avenue near address number 225. Signs of damage from erosion are evident upstream, downstream, and at this location. Streambanks and the stream channel can be stabilized using a number of techniques such as cross vanes in the channel and combinations of rocky and vegetated treatments in the streambanks. These channel and bank treatments must be designed to withstand water velocities and elevated stream power during high discharge events.

2. ***Tannery Brook parallel to Linderman Avenue beginning at Twin Ponds Drive***

Objective #1.3, "Prevent or minimize flood damage along tributary streams" was identified as a high priority objective for the neighborhood bordered by Twin Ponds Drive to the southwest and Washington Avenue to the northeast. Beginning near Twin Ponds Drive, Tannery Brook flows roughly parallel to Linderman Avenue and crosses Loughran Court, Navara Street, and Hewitt Place, approximately 200 feet from the start of each side street. Tannery Brook then becomes piped and buried and is no longer visible. There has been a great deal of nuisance flooding in this neighborhood. Clogged and undersized culverts were observed along this stream segment as well as natural debris and man-made structures that span or are in the tributary and pose a threat during storm events. Under Objective #1.3, the following action items could greatly improve conditions within this area:

a. Reconnect tributary streams to their floodplains by pursuing all the actions suggested above (daylighting streams, replacing walls with naturalized streambanks, and stabilizing banks) and by removing berms and any other obstructions.
b. Enhance existing floodplains and construct floodplain benches to accommodate floodwaters and provide space for debris flowing downstream in floods.
c. Increase bridge and culvert capacities to allow conveyance of floodwaters while minimizing debris clogs.
d. Remove outbuildings, tanks, and stored materials from stream corridors.

In the short term, option c. may be most easily implemented as it would require a lesser acreage of disturbance and involve fewer property owners. Option d. may also be relatively easy to implement, whereas options a. and b. will require working with property owners and securing easements for floodplain projects.

3. ***Green Infrastructure along 9W Bypass***

From Objective #1.4, "Modify stormwater management in tributary subwatershed," action "i. to incorporate green infrastructure and improved stormwater management at and along the Route 9W bypass," has been identified as a high priority action item. This section of 9W is largely void of green infrastructure. The addition of green infrastructure features such as vegetated swales and increased stormwater retention would aid in the management of stormwater from this area. Reducing stormwater runoff would then help reduce nonpoint source pollution and lower the frequency of combined sewer overflows.

Numerous potential funding sources may be available to the City of Kingston and the Towns of Ulster and Esopus as well as Ulster County and its departments for the implementation of actions of this plan. These have been suggested in Table 6-1. Refer to Appendix F for descriptions of potential funding sources.

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
Goal #1 – Restore tributary streams and subwatersheds to improve water quality						
Objective #1.1 – Restore tributary streams and enhance riparian vegetation along tributary streams						
a. Pursue opportunities to daylight sections of streams	Daylight a segment of Twaalfskill Brook (subwatershed 4a).	Long Term	High	USFWS, CWSRF, WQIP, NYSDOS, EFC GIGP	Municipalities	
b. Replace walled streambanks with naturalized and bioengineered streambanks along Twaalfskill Brook and its tributaries	Replace stone wall along Twaalfskill Brook just south of Brook Street with bioengineered streambanks (subwatershed 4a).	Long Term	High	NRCS, USFWS, WQIP, NYSDOS, Trees for Tribs	Municipalities	
c. Provide diverse habitats (palustrine, emergent, shrub/scrub, and open water wetlands) throughout the subwatersheds	Plant noninvasive native vegetation around the pond (subwatershed 14).	Near Term	Medium	USFWS, CWA, NYSDOS, EPF, WQIP, Trees for Tribs	Municipalities	
d. Protect existing riparian wetlands	Strengthen stream buffer regulations through planning and zoning tools (subwatershed 4b).	Ongoing	Low	Municipal, Trees for Tribs	Municipalities	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
e. Set aside stream buffers and vegetate accordingly	Work with property owners along Hooker Street to set aside buffers along unnamed stream and plant native riparian wetland vegetation (subwatershed 2).	Near Term	Medium	USFWS, CWA, NYSDOS, EPF, WQIP, Trees for Tribs	Municipalities	
f. Remove invasive species	Plant noninvasive native vegetation at the end of Fawn Meadows Court in Esopus where *Phragmites* is present (subwatershed 10).	Near Term	Medium	USFWS, CWA, NYSDOS, EPF, WQIP, Trees for Tribs	Municipalities	
Objective #1.2 – Reduce streambank and channel erosion along tributary streams						
a. Stabilize eroding banks along watercourses in Kingston, Ulster, and Esopus using natural, bioengineered, and hybrid gray/green bank treatments	Stabilize eroding banks along the Twaalfskill Brook near 225 Wilbur Avenue (subwatershed 4a).	Near Term	High	NRCS, USACE, NYSDOS, Trees for Tribs	Municipalities	★

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
b. Address downcutting and channel erosion on a case-by-case basis with cross vanes and other base-level control techniques	Additional project element in Twaalfskill Brook near 225 Wilbur Avenue (subwatershed 4a).	Near Term	High	NRCS, USACE, NYSDOS	Municipalities	★
Objective #1.3 – Prevent or minimize flood damage along tributary streams						
a. Reconnect tributary streams to their floodplains by pursuing all the actions suggested above (daylighting streams, replacing walls with naturalized streambanks, and stabilizing banks) and by removing berms and any other obstructions	Remove stone walls along Twaalfskill Brook tributary and replace with natural banks at Rockwell Terrace (subwatershed 4b).	Long Term	High	NRCS, USFWS, USACE, WQIP, NYSDOS, CWSRF, EFC GIGP	Municipalities	★
b. Enhance existing floodplains and construct floodplain benches to accommodate floodwaters and provide space for debris flowing downstream in floods	*Alternative to the example for 1.1.b* – create floodplain bench where walls are currently located (subwatershed 4a).	Near Term	High	NRCS, FEMA, USACE, USFWS, WQIP, NYSDOS	Municipalities	★
c. Increase bridge and culvert capacities to allow conveyance of floodwaters while minimizing debris clogs	Improve conveyance and floodplain functions along Tannery Brook (subwatershed 4c).	Near Term	High	FEMA, USACE, NYSDOS, HREP	Ulster County and Municipalities	★

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
d. Remove outbuildings, tanks, and stored materials from stream corridors	Along Tannery Brook (subwatershed 4c) and Twaalfskill Brook (subwatershed 4a).	Near Term	Medium-High	FEMA, CDBG	Municipalities	★
e. Consider relocating residents and removing homes located adjacent to streams	Identify residences that are damaged during flood events and approach those willing to relocate (subwatersheds 4a, 4b, 4c, and 10).	Long Term	High	FEMA, CDBG	Municipalities	
f. Develop flood risk mapping along sections of streams that have not been studied by FEMA and submit results to FEMA with a request for FIRM revision	Upper Twaalfskill Brook, its tributaries, and Tannery Brook are the priorities (subwatersheds 4a, 4b, and 4c).	Near Term	Low-Medium	FEMA, USACE	Ulster County and Municipalities	
g. Refine flood risk mapping along the unnumbered A zones and submit results to FEMA with a request for FIRM revisions	Plantasie Kill is the primary candidate (subwatershed 10)	Near Term	Low-Medium	FEMA, USACE	Ulster County and Municipalities	★
h. Elevate residential structures located along tributaries	Identify residences that are damaged during flood events and approach those unwilling to relocate (subwatersheds 4a, 4b, 4c, and 10).	Long Term	High	FEMA, CDBG	Municipalities	★

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
i. Floodproof nonresidential structures located along tributaries	Identify businesses that are damaged during flood events and approach them about floodproofing (subwatersheds 4a, 4b, 4c, and 10).	Near Term	Medium-High	FEMA, Ulster County IDA, Empire State Development Program	Municipalities	★
j. Ensure that projects completed along Twaalfskill Brook, or flood risk mapping conducted for Twaalfskill Brook, include consideration of high flows diverted from Tannery Brook	NA; this is a specific action that pertains only to these streams (subwatersheds 4a and 4c).	Ongoing	Low-Medium	Municipal, Project Applicants	City of Kingston Engineering and Public Works	
k. Evaluate options for restoring more flow from Tannery Brook to the downstream portion of Tannery Brook rather than diverting high flows to Twaalfskill Brook.	NA; this is a specific action that pertains only to these streams (subwatersheds 4a and 4c).	Long Term	Medium-High	FEMA, USACE, CWSRA, NYSDOS, WQIP	City of Kingston Engineering and Public Works	
Objective #1.4 – Modify stormwater management in tributary subwatersheds						
a. Continue to separate storm and sanitary sewer systems	Separate storm and sanitary sewer systems in the remaining locations (subwatersheds 1, 2, 3, and 4a)	Long Term	High	CWSRF, WQIP, HREP	City of Kingston Engineering and Public Works	★

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
b. Increase the frequency of catch basin cleanouts	Revise the current schedules to increase cleanout frequency. May require hiring of additional staff.	Ongoing	Medium	Municipal	Municipalities	
c. Replace impervious surfaces with pervious surfaces when approving redevelopment proposals	Install rain gardens along edge of parking lots on East Strand (subwatershed 1).	Ongoing	Medium-High	Municipal, land owners, Ulster County IDA, Empire State Development Program	Municipalities	★
d. Require green infrastructure techniques and low impact development for new developments and significant redevelopments	Incorporate green infrastructure requirements into appropriate planning and zoning codes.	Ongoing	Medium	Municipal, land owners, Ulster County IDA, Empire State Development Program, HREP, EFC GIGP	Municipalities	★
e. Maintain existing detention and retention basins	Create or update a schedule to clean out basins.	Ongoing	Low-Medium	Municipal	Municipalities	
f. Identify opportunities to detain stormwater in areas of existing development, and construct stormwater basins in areas that can receive runoff from small groups of existing developed parcels	Identify locations for detaining stormwater from clusters of existing development in the Tannery Brook watershed (subwatershed 4c).	Long Term	Medium-High	FEMA, USACE, WQIP, NYSDOS	Municipalities	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
g. Install collection and conveyance systems in areas that are not served by stormwater systems if the provision of collection and conveyance systems will reduce erosion and overland transport of pollutants	Densely developed parts of Kingston may benefit from traditional systems (subwatershed 3).	Long Term	High	CWSRF, Municipal	Municipalities	
h. Vegetate swales and ditches located along roadways	Plant hardy native vegetation in swales along roads such as Rodmans Lane and Pokonoie Road in Esopus (subwatersheds 10 and 15).	Near Term	Medium-High	CWA, WQIP, NYSDOS, HREP, EFC GIGP	Municipalities	
i. Incorporate green infrastructure and improved stormwater management at and along the Route 9W bypass	NA; this is a specific action that pertains to the 9W bypass (subwatershed 2).	Near Term	Medium-High	DOT, Municipal, HREP, EFC GIGP	City of Kingston Engineering and Public Works	★
Objective #1.5 – Manage land use and redevelopment in tributary subwatersheds						
a. Enact stream dumping prevention regulations	Insert language into the appropriate Kingston city code and Esopus town code	Near Term	Low	Municipal	Municipalities	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
b. Increase outreach and technical assistance for agricultural and animal feed operations	Provide a course on maintaining stream buffers through the County Soil and Water Conservation District	Near Term	Low	Ulster County SWCD	Ulster County, Municipalities	
c. Increase outreach and technical assistance for extraction/ mining operations	Provide a course with operational BMPs and detailing assistance that is available to operators (subwatersheds 11, 12, and 13).	Near Term	Low	Municipal	Town of Esopus	
d. Support remedial actions at the Dyno facility, if applicable	Assist by providing support for actions that require local approvals (subwatershed 10).	Ongoing	Low	Municipal	Town of Esopus	
e. Update the Town of Esopus Comprehensive Plan	Assign staff or retain consultants to update the Comprehensive Plan.	Near Term	Low to Medium	Municipal	Town of Esopus Planning Board	
f. Update engineering design standards to incorporate increasing precipitation intensities	Insert language into the appropriate city or town code.	Near Term	Low	Municipal	Municipalities with assistance from Ulster County	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
g. Require zero increase in runoff from new developments	Insert language into the appropriate city or town code to encourage this development goal.	Near Term	Low	Municipal	Municipalities with assistance from Ulster County	★
h. Retire or modify obsolete zoning districts and classes	Assign staff or hire consultants to review the zoning code for outdated districts or classes.	Near Term	Low	Municipal	Municipalities with assistance from Ulster County	
i. Amend Zoning and Subdivision Regulations to incorporate Low Impact Development standards	Based on recently completed Comprehensive Plan for Kingston, proceed with recommendations.	Near Term	Low	Municipal	Municipalities with assistance from Ulster County	★
j. Consider amending zoning and subdivision codes in Kingston and Ulster to encourage clustered developments to maximize open space	Based on recently completed Comprehensive Plan for Kingston, proceed with recommendations.	Near Term	Low	Municipal	Municipalities with assistance from Ulster County	
k. Consider watershed or water resources protection overlay zoning districts that require additional reviews and design criteria	Assign staff or hire consultants to develop language to insert into the appropriate city or town code	Near Term	Low	Municipal	Municipalities with assistance from Ulster County	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
l. Acquire open space when available	Focus on acquisitions where land is available (subwatersheds 4a through 15).	Ongoing	High	Municipal, Nonprofits, EPF	Municipalities	
m. Consider open space districts to further protect open space	Assign staff or hire consultants to assess if and where an open space district can be established.	Near Term	Low	Municipal	Municipalities with assistance from Ulster County	
Objective #1.6 – Manage disposal of sanitary wastewater in tributary subwatersheds						
a. Reduce sanitary sewer inflow and infiltration	Primary focus is in Kingston where the needs have been identified (subwatersheds 1-5).	Long Term	High	CWSRF	Municipalities	
b. Ensure that regular maintenance of septic systems is occurring	Educate homeowners on importance of septic system maintenance through public outreach such as pamphlets, training, etc.	Ongoing	Low-Medium	Municipal, WQIP, Ulster County	Municipalities with assistance from Ulster County	
c. Extend sewer systems where groups of septic systems are failing or reaching the ends of their period of effectiveness		Long Term	High	CWSRF	Municipalities	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
d. Delineate sewer avoidance and future sewer system service areas		Near Term	Low-Medium	Municipal, Ulster County	Municipalities with assistance from Ulster County	
Goal #2 – Create a vibrant waterfront by improving water quality						
Objective #2.1 – Manage land use and redevelopment along the waterfront						
a. Develop a Harbor Management Plan for all three municipalities	Assign staff or hire consultants to coordinate with NYSDOS and develop a Harbor Management Plan that includes all three towns (subwatersheds 1, 3, 5, 6, 8, 11, and 13).	Long Term	Medium	NYSDOS	Municipalities	
b. Repair and replace bulkheads using standard methods, including sheet piling, but also considering other methods evaluated by the Hudson River Estuary Program	Repair bulkheads where needed (subwatersheds 1, 3, 5, 6, 8, 11, and 13).	Ongoing	High	USACE, Municipal, and private	Municipalities	
c. Ensure that marinas are utilizing best practices to avoid water pollution	Focus on small number of nearby marinas to begin such as the two in Connelly (subwatershed 11).	Ongoing	Low-Medium	NYSDOS, CVAP	Municipalities	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
Objective #2.2 – Mitigate tidal flooding in the Kingston and Esopus waterfront areas						
a. Pursue drainage system improvements	Rondout Landing and East Strand (subwatershed 1)	Long Term	High	Municipal	Municipalities	
b. Elevate roads	Rondout Landing, East Strand, West Strand, Dock Street (subwatersheds 1 and 3)	Long Term	High	Municipal	Municipalities	
c. Elevate buildings that cannot be floodproofed	Elevate buildings along Abeel Street (subwatershed 3).	Long Term	High	FEMA, Ulster County IDA, Empire State Development Program	Municipalities	★
d. Floodproof buildings that cannot be elevated	Floodproof buildings along Rondout Landing and East Strand (subwatershed 1).	Long Term	Medium-High	FEMA, Ulster County IDA, Empire State Development Program	Municipalities	★
Objective #2.3 – Reduce sewer overflows into Rondout Creek						
a. Reduce sanitary sewer inflow and infiltration [see also Objective #1.6]	Primary focus is in Kingston where the needs have been identified (subwatersheds 1-5).	Long Term	High	CWSRF	Municipalities	
b. Eliminate combined sewers	Continue where needed (subwatersheds 1, 3).	Long Term	High	CWSRF, WQIP, HREP	City of Kingston Engineering and Public Works	★

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
c. Maximize treatment capacities to avoid overflow of untreated wastewater	Update WPCF/ WWTP to increase capacity (subwatershed 1).	Long Term	High	CWSRF, WQIP	City of Kingston Engineering and Public Works	
d. Protect the wastewater treatment plant from flooding	Regrade, construct berms and floodwalls (subwatershed 1)	Long Term	High	CWSRF, WQIP	City of Kingston Engineering and Public Works	
Objective #2.4 – Improve water quality classification of Rondout Creek from C to B						
a. Consider requesting designation of impaired status for the tidal Rondout Creek	Assign staff or hire consultants to submit request with supporting materials	Long Term	Low-Medium	Municipal	Municipalities	
b. If impaired status is granted, leverage the resources made available as a result of the impaired status	Apply for Section 319 Grants from the USEPA for various projects, including those in this plan.	Long Term	Low	Municipal	Municipalities	
Objective #2.5 – Increase training, education, and stewardship						
a. Coordinate existing water quality monitoring programs to increase data sharing and avoid redundant efforts	Assign a staff member to coordinate ongoing efforts.	Near Term	Low	USGS, NYSDEC, Riverkeeper, Municipal	Municipalities, Riverkeeper	

TABLE 6-1 Implementation Matrix						
Objectives and Actions	**Example Project**	**Time Frame**	**Cost**	**Potential Funding Sources**	**Responsible Party**	**Priority Action**
b. Set up and implement a new water quality sampling and monitoring program to fill gaps and augment existing programs while providing metrics for measuring implementation of this plan	Assign existing staff or coordinate with nonprofit or local college to implement sampling program.	Near Term	Low	USGS, NYSDEC, Riverkeeper, Municipal, local educational institutions	Municipalities, Riverkeeper	
c. Set up and implement a monitoring protocol for tributary stream projects such as revegetation and streambank stabilization	Twaalfskill Brook projects are good candidates (subwatershed 4a).	Near Term	Low	Municipal, local educational institutions	Municipalities	
d. Link watershed water quality awareness to existing recreational programs through interpretative signage and modification of recreational program curriculums	Add educational signage regarding water quality to the Kingston Point Park or Block Park off of Abeel Street in Kingston (subwatersheds 1, 3).	Near Term	Low-Medium	Municipal, EPF	Municipalities	
e. Promote the use of the online tool (http://www.kingston-ny.gov/reportit) for residents to report water quality concerns such as spills, stream dumping, and streambank erosion	Develop a flyer for an upcoming community event.	Near Term	Low	Municipal, local educational institutions	City of Kingston	

7.0 REFERENCES

Bloom, A.L., 1978, Geomorphology – A Systematic Analysis of Late Cenozoic Landforms.

City of Kingston, 2012, City of Kingston Climate Action Plan.

City of Kingston, 2013, Planning for Rising Waters: Final Report of the City of Kingston Tidal Waterfront Flooding Task Force.

City of Kingston, 2016, City of Kingston Comprehensive Plan.

Hey, R.D., The Rivers Handbook, Volume II, Chapter 18, Environmentally Sensitive River Engineering.

Leopold, L.B, and Maddock, T., 1953, Hydraulic Geometry of Stream Channels and some Physiographic Implications, USGS Professional Paper 252.

New York City Department of Environmental Protection (NYCDEP) and the Rondout Neversink Stream Management Program, 2010, Upper Rondout Creek Stream Management Plan.

New York State Water Quality Standards, including 6NYCRR Part 701.7 and 6NYCRR Part 701.8.

Orange County Soil and Water Conservation District and Ulster County Soil and Water Conservation District, Wallkill River Watershed Conservation and Management Plan.

Riverkeeper, 2014, How's the Water 2014 – Water Quality Monitoring, Fecal Contamination, and Achieving a Swimmable Hudson River.

Riverkeeper, 2015, How's the Water 2015 – Fecal Contamination in the Hudson River and its Tributaries provided addition data.

Rondout Creek Watershed Council (RCWC), 2010, Interim Watershed Management Plan for Lower Nontidal Rondout Creek.

Rosgen, D.L., 1998, The Reference Reach – A Blueprint for Natural Channel Design. ASCE Wetlands, Engineering, and River Restoration Conference, Denver, CO.

Rosgen, D.L, 1997, A Geomorphological Approach to Restoration of Incised Rivers, Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision.

Rosgen, D.L., 1994, A Classification of Natural Rivers, Catena – An Interdisciplinary Journal of Soil Science, Hydrology, and Geomorphology, Volume 22 No. 3.

Rosgen, D.L., Watershed Assessment of River Stability & Sediment Supply.

Town of Esopus, 1994, Town of Esopus Comprehensive Plan.

Town of Ulster, 2007, Town of Ulster Comprehensive Plan.

Ulster County, 2009, Ulster County Multi-Jurisdictional Natural Hazard Mitigation Plan.

Wallkill River Watershed Management Group, 2008, Watershed Restoration Plans for Clove Acres Lake watershed.

Wallkill River Watershed Management Group, 2008, Watershed Restoration Plans for the Papakating Creek watershed.

APPENDIX A

PROJECT ADVISORY COMMITTEE

Appendix A
Tidal Rondout Creek Watershed Management Plan
Project Advisory Committee

Committee Member	Affiliation
Mr. Steve Noble	Environmental Educator, Kingston Parks and Recreation Department
Mrs. Julie Noble	Kingston Parks and Recreation Department
Mr. Gregg H. Swanzey	Kingston Office of Economic Development & Strategic Partnerships
Mr. Ralph Swenson	City Engineer, Kingston Engineering Office
Ms. Kyla Haber	Assistant Planner, Planning Department
Mr. Eli Schloss	Waterfront Advisory Board, Town of Esopus
Ms. Joyce Barnes	Kingston resident
Mr. Donna McAuley	Town Council, Town of Esopus
Ms. Catherine Quick	Waterfront Advisory Board, Town of Esopus
Mr. Renno Budziak	Planning Board, Town of Ulster
Ms. Tracey O'Malley	Coastal Resources Specialist, New York Department of State

APPENDIX B

COMMUNITY OUTREACH PLAN

Community Outreach Plan
Tidal Rondout Creek Watershed Management Plan
January 23, 2013

Introduction

The City of Kingston, with funding through the New York State Department of State has commissioned the preparation of a watershed management plan of the tidal section of Rondout Creek. Milone & MacBroom, Inc. (MMI) was retained to work with the project partners to develop this comprehensive plan. The preparation of the plan is funded in part by the New York State Department of State with funds provided under Title 11 of the Environmental Protection Fund.

The Tidal Rondout Creek watershed is located within the City of Kingston, Town of Esopus, and Town of Ulster, all of which are located within Ulster County, New York. The management plan will address strategies associated with stream and wetland habitat protection; stormwater management; land management; and point and non-point source pollution prevention. Most of these issues directly affect water quality. Impacts of septic systems, road de-icing, and land use will be explored as potential sources of pollution. Protecting and enhancing wetlands may help protect and improve water quality.

The primary contact for the watershed planning process is:

Steve Noble
Environmental Educator
City of Kingston
Parks and Recreation Department
467 Broadway, Kingston, NY 12401
845-481-7336

The consultant retained to develop the watershed management plan is:

Jeanine Armstrong Gouin, P.E., Vice President
jeanineg@miloneandmacbroom.com

David Murphy, P.E., CFM, Associate
davem@miloneandmacbroom.com

Milone & MacBroom, Inc.
99 Realty Drive
Cheshire, CT 06410
(203) 271-1773
(203) 272-9733 fax
www.miloneandmacbroom.com

Role of the Project Advisory Committee (PAC)

The role of the Project Advisory Committee is to ensure that the watershed management plan development process and the policy recommendations contained therein are clear and appropriate, and that as diverse an audience as possible is engaged in developing the plan and its recommendations. The PAC must also be cognizant of keeping the plan "user-friendly" and understandable to the target audience to ensure community buy-in.

Potential representatives on the PAC include the following:

- City of Kingston
- Town of Ulster
- Town of Esopus
- Ulster County Soil and Water Conservation District
- Ulster County Planning Department
- New York Department of State
- USDA Natural Resource Conservation Service
- Ulster County Chamber of Commerce Representative
- Watershed Resident Representative(s)
- Impacted Business Owners

The final list of PAC members is provided in the following table.

Tidal Rondout Creek Watershed Management Plan Project Advisory Committee

Committee Member	Affiliation
Mr. Steve Noble	Environmental Educator, Kingston Parks and Recreation Department
Mrs. Julie Noble	Kingston Parks and Recreation Department
Mr. Gregg H. Swanzey	Kingston Office of Economic Development & Strategic Partnerships
Mr. Ralph Swenson	City Engineer, Kingston Engineering Office
Ms. Kyla Haber	Assistant Planner, Planning Department
Mr. Eli Schloss	Waterfront Advisory Board, Town of Esopus
Ms. Joyce Barnes	Kingston resident
Mr. Donna McAuley	Town Council, Town of Esopus
Ms. Catherine Quick	Waterfront Advisory Board, Town of Esopus
Mr. Renno Budziak	Planning Board, Town of Ulster
Ms. Tracey O'Malley	Coastal Resources Specialist, New York Department of State

Goals of Outreach and Target Audience

As noted in the U.S. EPA's "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," the specific objectives of a watershed management public outreach program "should directly support your watershed management goals and implementation of the watershed management plan."[1] Goals should be based upon specific driving forces, the salient issues of concern within the specific watershed management area. In the Tidal Rondout Creek Watershed Management Area, the driving forces will likely originate from the need for stream and wetland habitat protection, stormwater management, land management, and point and non-point source pollution prevention. The overarching and unifying goal of the public outreach campaign for this Watershed Management Plan will be engaging the community in addressing the need for improvements in these areas.

The general goals for public outreach as part of the Tidal Rondout Creek WMP include the following:

- ***Opportunity for involvement*** – Provide multiple opportunities for residents, key stakeholders, government officials and other impacted parties to participate in the development of specific action steps that will result in better management of the watershed.

- ***Involve a broad base of participants*** – Have an outreach program that is designed to draw in the broadest base of participants as possible, while still maintaining a manageable and timely planning process.

- ***Convenience and accessibility*** – Provide avenues of participation that are convenient for a diverse set of stakeholders and accessible to participants of varied means. Achieving this goal requires a mix of opportunities for engagement, from standard public meetings to social media to other means of participation.

- ***Logical progression*** – The public outreach program should present the issues facing the watershed, such as flooding, with supportive data, evidence and identified potential impacts before offering solutions to these issues. One of the underlying goals of any public outreach campaign is education; in other words, participants must be given the opportunity to learn and understand as much as possible about the underlying issues affecting their watershed before they proceed to evaluate potential solutions to these issues.

- ***Realistic expectations*** – The goals of a public outreach campaign should be as specific as possible so that they can be realistically addressed within a reasonable time frame. Overly broad or grandiose goals may be inspiring and do have their place in the planning process, but the specific goals identified need to be focused, actionable and measurable so that progress can be achieved and clearly recognized.

[1] http://water.epa.gov/polwaste/nps/upload/2008_04_18_NPS_watershed_handbook_ch12.pdf; p.12-2.

Target Audience

- All residents of Kingston, Ulster, and Esopus, particularly property owners located in the watershed.
- Business owners, particularly those with businesses located in the watershed.
- Public agencies and municipal officials – their understanding of the issues and potential and appropriate remediation/mitigation measures is critical.

Strategy and Process

In order to achieve a thorough and effective public outreach process the following strategy, process and schedule is proposed:

Events

The public outreach program for the Tidal Rondout Creek Watershed Management Plan (WMP) will have as its cornerstone two (2) PAC meetings/workshops and three (3) public outreach workshops. Each of these five events is described in greater detail below in terms of logistics, scheduling and desired outcomes. These meetings will be supplemented by informal communications.

- **Event 1 – PAC Meeting/Workshop – Task 1.1 (month)**
  PAC meetings will be held at the City Hall. The meeting will be preceded by an email to potential PAC participants.

  This initial meeting will allow the project team to introduce themselves to the PAC and to discuss the mechanisms and logistics of developing the WMP, generating public involvement and creating implementation strategies. A presentation of Milone & MacBroom, Inc.'s (MMI) initial impressions and characterization of the watershed will accompany the preliminary identification of pertinent issues, strengths and areas of concern that the project team has regarding the watershed. These elements will be presented to the PAC for reaction and discussion, with the goal being to have the group come to a preliminary consensus as to the areas of greatest concern that will help focus the watershed management plan.

  In addition, a discussion of the roles of the project team and the PAC members will occur which will be designed to clarify the expectations for everyone as part of this project. Specific responsibilities for individuals and/or groups will be identified and agreed upon so that the plan development process can move forward seamlessly. By the conclusion of this meeting, participants should be able to clearly answer the question "What are we trying to accomplish as part of this planning process?"

- **Event 2 – Public Outreach Workshop – Task 1.4 (month)**
  The initial public outreach workshop will be held at the City Hall.

  The goals of the first public outreach workshop can be best summarized as introduce, characterize and identify. The "introduce" component will involve introducing the project

team from MMI and the PAC. This component will also include an educational component regarding what watershed management planning is, as well as what it is not.

The "characterize" component will involve describing the watershed in terms of a number of different characteristics, including the following:

- Boundaries
- Water quality
- Habitat
- Geomorphology
- Infrastructure
- History
- Socio-Economic Characteristics
- Land Use & Development Patterns

The "identify" component will involve soliciting and defining general goals and expectations from meeting participants, developing a framework of both the overall "global" issues impacting the watershed (e.g., land development in the floodplain) and more specific issues impacting the watershed at select points (e.g., a poorly managed farm has led to the runoff of manure and agricultural waste products into a water resource). As part of the "identify" component, additional pertinent organizations, groups and interested individuals should be identified as part of the meeting discussion.

Breakout Sessions: Topical (e.g., Habitats & Wildlife; Water Quality; Flooding & Sedimentation). Have stations for each topic area with maps that participants can use to pinpoint specific issues of concern and to also point out positive attributes of the watershed. Have a list of issues/survey form that participants can use to prioritize in order of greatest importance. Have a list of potential outcomes that an effective watershed management plan could have that participants can then rank/score by importance. Come back together as a group and summarize results.

- **Event 3 – PAC Meeting/Workshop – Task 3.3 (month)**
  This meeting will serve primarily to provide a Progress Report on the development of the WMP to date. Discussion topics will likely include the presentation of a synthesis of goals and objectives determined to date from the initial PAC meeting and the first public workshop and all issues that have been identified at this point in the plan development process. A written summary of the first public workshop feedback will also be reviewed at this meeting.

  Discussion topics will also likely focus on taking the proposed recommendations and reviewing them in light of the previously completed characterization and analysis. The outcome of this meeting should include a general consensus on the potential management practices, approaches and strategies for watershed protection, restoration and flood damage prevention for the watershed management area, with prioritization of these elements being

key. A draft implementation strategy and schedule should also result from the discussions held during this meeting.

- **Event 4 – Public Outreach Workshop – Task 3.4 (month)**
  In contrast to the goals of the first public outreach workshop in Event 2, the goals of the second public outreach workshop can be described as "present, summarize and respond." The "present" component will involve an overview of the entire project and the process from the initial PAC meeting through all public outreach efforts to the compilation of the final draft product. The "summarize" component will involve a discussion of the plan's objectives, findings, conclusions and action items. Clarifying how the WMP will be implemented into the future will also be part of this discussion. Finally, the "respond" component will involve gathering feedback from the workshop participants regarding the final presentation of the draft WMP.

- **Event 5 – Public Outreach Workshop – Task 5.2 (month)**
  The goals of the final public outreach workshop will be held to present the draft WMP and solicit input from the public. A written summary of public input will be prepared and input will be incorporated into the final plan.

Logistics for Discussion

- City/Town website(s)
- Project FTP site
- Use of social media
- Email lists
- Direct mailing to lists supplied by participating organizations
- Flyers at municipal and county facilities, Town Hall, public library
- Emails to all local and state elected officials
- Flyers and e-mail to all participating public agencies and nongovernmental organizations
- Public notices and ads in local newspapers

APPENDIX C

RESULTS OF LIMITED SURVEY

Appendix C
Survey Results from the April 4, 2013 Public Outreach Workshop

A survey was distributed during the meeting of April 4, 2013 to glean priority issues and ideal outcomes for the watershed as viewed by attendees. Survey results are summarized in the following tables.

Issue Priority Ranking Survey Results

Issue	High	Moderate	Low	Total Responses
Stormwater Runoff	10	2	0	12
Flooding and Erosion of Small Streams	3	9	0	12
Small Stream Management/ Maintenance	2	9	1	12
Sanitary Sewer Inflows or Overflows	10	1	1	12
Septic Systems	2	3	7	12
Water Quality in Rondout Creek	11	1	0	12
Recreation in Watershed and Creek	4	7	1	12
Aesthetics of Watershed	1	9	2	12
Ecological Habitats of Wetlands	7	5	0	12
Land Use Practices in Watershed	7	4	1	12

Ideal Outcome Survey Results

Outcome	High	Moderate	Low	Total Responses
Pollution Prevention	11	1	0	12
Improved Water Quality in Creek	12	0	0	12
Small Stream Stabilization	2	7	3	12
Establishment of Stream Buffers	0	10	2	12
Improved Stormwater Management	11	2	0	12
Floodplain Restoration and Reconnection	5	7	1	12
Floodplain Conservation	5	7	1	12
Flood Mitigation and Protection	11	2	0	12
Adoption of New Land Use Regulations	2	10	1	12
Future Development Management	7	5	1	12
Habitat Protection	7	5	1	12
Monitoring and Research	4	6	3	12
Training, Education, and Stewardship	7	4	1	12

The results of the survey show that stormwater runoff, sanitary sewer inflows and overflows, and water quality within the creek are the main concerns in the watershed. Consequently, the highest-ranked ideal outcomes are (1) improved water quality in the creek, (2) pollution prevention, (3) improved stormwater management, and (4) flood mitigation and protection. Future development management; habitat protection; and training, education, and stewardship were also ranked relatively highly. Based on the results it is clear that respondents are very concerned with ensuring that water quality concerns are addressed in the Tidal Rondout Creek watershed.

Ecological habitats and land use practices are often important issues in watershed management plans. Although ranked lower than water quality and stormwater management, this plan addresses these important and interrelated issues.

APPENDIX D

RONDOUT CREEK PEAK DISCHARGE SUMMARY

Appendix D
Rondout Creek Peak Discharge Summary

Flood Insurance Study

An analysis of upstream USGS stream gauge data to assess the peak flood flows on the Rondout Creek was presented in the FIS, which was used to generate flows along the creek at various locations. This Log-Pearson Type III statistical analysis was performed on available gauging data spanning 77 years (1927 to 2004). The following table summarizes the results of its analysis.

FEMA FIS
Peak Flow Discharges for Rondout Creek

Location	Distance Upstream of Hudson River (miles)	Watershed Size (square miles)	10% (cfs)	2% (cfs)	1% (cfs)	0.2% (cfs)
At Confluence with Hudson River	0	1,197	33,977	51,844	60,980	86,537
Upstream of Twaalfskill Brook Confluence	2.65	1,187	33,743	51,511	60,599	86,028
USGS Gauge 01367500 (Rosendale, Keator Avenue)	10.35	383	22,109	33,430	38,871	53,061

The FEMA FIS estimates hydrologic information at the Rosendale gauge and extrapolates downstream to the Hudson River confluence based on a ratio of drainage area.
cfs = cubic feet per second

The FIS presents a technical analysis of flooding behavior for the Rondout Creek and Hudson River area; however, it should be noted that this data is largely based upon historic analyses performed in the 1960s. Changing conditions such as climate change, increases in precipitation, and sea level rise may affect the accuracy of these values.

USGS StreamStats

The *StreamStats* web tool provided by the USGS was used to estimate flows for Rondout Creek at its confluence with the Hudson River. Peak flows were computed based upon regional regression equations (Lumia, 2006 and Mulvihill, 2009), which were derived from upstream gauge data. The underlying regression equations used by *StreamStats* only consider data published before September 1999. The following table presents the results of this analysis.

USGS *StreamStats*
Peak Flow Discharges for Rondout Creek

Location	Watershed Size (square miles)	50% (cfs)	10% (cfs)	2% (cfs)	1% (cfs)	0.2% (cfs)
Confluence with Hudson River	1,190	12,500	21,900	31,800	36,700	49,700

USGS *StreamStats* output considers hydrologic data analysis through September 1999

HEC-SSP Bulletin 17B

A program from the U.S Army Corps of Engineers (USACE) called the *Hydrologic Engineering Center Statistical Software Package* (HEC-SSP) was used to perform statistical analyses of the data from the USGS stream gauge referenced above. The raw data from the gauge was imported into the program, and the software performed a flood flow frequency analysis based on Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" (USGS, 1982).

These results use data from the same USGS gauge as *StreamStats* (described below) but take advantage of a more current data set, capturing recent weather events such as Tropical Storm Irene although the location of the gauge is 10.3 miles upstream of the Hudson River. As such, the contributing watershed is approximately 32% of the total watershed.

Although the drainage area at the Rosendale gauge is only 383 square miles, as compared to 1,190 square miles where the Rondout meets the Hudson, the 1% annual chance flood flow reported by this analysis is only 7% smaller. This is because the HEC-SSP analysis includes an additional 9 years of data over what was assessed by the FEMA FIS and 14 years more data than the USGS *StreamStats* application, which captures recent significant flow events such as Tropical Storm Irene. If these results were transferred downstream using a standard discharge area relationship derived from the USGS regression equations, the predicted flows would increase significantly.

The following table presents the results of this analysis. The flow results at the Rosendale gauge match those estimated in the FEMA FIS to within 12%.

HEC-SSP Bulletin 17B
Peak Flow Discharges for Rondout Creek

Location	Drainage Area (square miles)	50% (cfs)	10% (cfs)	2% (cfs)	1% (cfs)	0.2% (cfs)
USGS Gauge 01367500 (Rosendale, Keator Avenue)	383	12,382	21,935	30,504	34,181	42,860

HEC-SSP Bulletin 17B analysis on USGS Gauge 01367500 (Rosendale, New York);
Flows at the Hudson River confluence were extrapolated using the USGS discharge area; relationship for Region 4.

APPENDIX E

SUBWATERSHED PRIORITIES FOR EACH ACTION

Appendix E
Subwatershed Priorities for Each Action

	Subwatershed																
	1	**2**	**3**	**4a**	**4b**	**4c**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Goal #1 – Restore tributary streams and subwatersheds to improve water quality																	
Objective #1.1 – Restore tributary streams and enhance riparian vegetation along tributary streams																	
a. Pursue opportunities to daylight sections of streams in Kingston	H	H	H	H	L	H	H	--	--	--	--	--	--	--	--	--	--
b. Replace walled streambanks with naturalized and bioengineered streambanks along Twaalfskill Brook and its tributaries	--	--	--	H	H	--	--	--	--	--	--	--	--	--	--	--	--
c. Provide diverse habitats (palustrine, emergent, shrub/scrub, and open water wetlands) throughout the subwatersheds	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
d. Protect existing riparian wetlands	H	H	H	H	H	H	L	H	H	H	L	H	H	H	H	H	H
e. Set aside stream buffers and vegetate accordingly	H	H	H	H	H	H	L	L	M	M	L	H	H	H	H	H	H
f. Remove invasive species																	
Objective #1.2 – Reduce streambank and channel erosion along tributary streams																	
a. Stabilize eroding banks along watercourses in Kingston, Ulster, and Esopus using natural, bioengineered, and hybrid gray/green bank treatments	L	L	L	H	H	L	L	L	L	L	L	H	L	L	L	L	L
b. Address downcutting and channel erosion on a case-by-case basis with cross vanes and other base level control techniques	L	L	L	H	H	L	L	L	M	L	L	H	L	L	L	L	L
Objective #1.3 – Prevent or minimize flood damage along tributary streams																	
a. Reconnect tributary streams to their floodplains by pursuing all the actions suggested above (daylighting streams, replacing walls with naturalized streambanks, and stabilizing banks) and by removing berms and any other obstructions	H	H	H	H	H	H	L	L	M	L	L	H	L	L	L	L	L
b. Enhance existing floodplains and construct floodplain benches to accommodate floodwaters and provide space for debris flowing downstream in floods	L	L	M	H	H	H	L	L	L	L	L	H	L	L	L	L	L

	Subwatershed																
	1	**2**	**3**	**4a**	**4b**	**4c**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
c. Increase bridge and culvert capacities to allow conveyance of floodwaters while minimizing debris clogs	L	H	M	H	H	H	L	L	H	L	L	H	L	L	L	L	L
d. Remove outbuildings, tanks, and stored materials from stream corridors	H	H	H	H	H	H	L	L	M	L	L	H	L	L	L	L	M
e. Consider relocating residents and removing homes located adjacent to streams	M	M	M	H	H	H	L	L	L	L	L	M	L	L	L	L	L
f. Develop flood risk mapping along sections of streams that have not been studied by FEMA (such as the upper Twaalfskill Brook) and submit results to FEMA with a request for FIRM revision	M	H	M	H	H	H	L	L	M	L	L	H	L	M	L	M	H
g. Refine flood risk mapping along the unnumbered A zones (such as the tributaries in the town of Esopus) and submit results to FEMA with a request for FIRM revisions	--	--	--	--	--	--	--	--	--	--	--	H	--	--	--	--	--
h. Elevate residential structures located along tributaries	M	M	M	H	H	H	L	L	M	L	L	H	L	L	L	L	L
i. Floodproof nonresidential structures located along tributaries	M	M	M	H	H	H	L	L	M	L	L	H	L	L	L	L	L
j. Ensure that projects completed along Twaalfskill Brook, or flood risk mapping conducted for Twaalfskill Brook, include consideration of high flows diverted from Tannery Brook	--	--	--	H	--	--	--	--	--	--	--	--	--	--	--	--	--
k. Evaluate options for restoring more flow from Tannery Brook to the downstream portion of Tannery Brook rather than diverting high flows to Twaalfskill Brook	--	--	--	H	--	H	--	--	--	--	--	--	--	--	--	--	--
Objective #1.4 – Modify stormwater management in tributary subwatersheds																	
a. Continue to separate storm and sanitary sewer systems	H	H	H	H	L	H	L	L	L	L	L	L	L	L	L	L	L
b. Increase the frequency of catch basin cleanouts	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
c. Replace impervious surfaces with pervious surfaces when approving redevelopment proposals	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
d. Require green infrastructure techniques and low impact development for new developments and significant redevelopments	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
e. Maintain existing detention and retention basins	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

	Subwatershed																
	1	**2**	**3**	**4a**	**4b**	**4c**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
f. Identify opportunities to detain stormwater in areas of existing development, and construct stormwater basins in areas that can receive runoff from small groups of existing developed parcels	H	H	H	H	H	H	H	M	H	H	H	H	H	H	M	M	M
g. Install collection and conveyance systems in areas that are not served by stormwater systems if the provision of collection and conveyance systems will reduce erosion and overland transport of pollutants	M	M	M	M	M	M	M	M	M	M	M	H	M	M	M	M	M
h. Vegetate swales and ditches located along roadways	L	L	L	H	H	L	L	L	L	L	L	H	L	L	L	L	L
i. Incorporate green infrastructure and improved stormwater management at and along the Route 9W bypass	--	H	--	--	--	--	--	--	M	M	--	--	--	--	--	--	--
Objective #1.5 – Manage land use and redevelopment in tributary subwatersheds																	
a. Enact stream dumping prevention regulations	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
b. Increase outreach and technical assistance for agricultural and animal feed operations	L	L	L	L	L	L	L	L	L	L	L	H	L	H	H	H	H
c. Increase outreach and technical assistance for extraction/mining operations	L	L	L	L	L	L	L	L	L	L	L	L	H	H	L	L	L
d. Support remedial actions at the Dyno facility, if applicable	--	--	--	--	--	--	--	--	--	--	--	M	--	--	--	--	--
e. Update the Town of Esopus Comprehensive Plan	--	--	--	--	--	--	--	--	H	H	H	H	H	H	H	H	H
f. Update engineering design standards to incorporate increasing precipitation intensities	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
g. Require zero increase in runoff from new developments	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
h. Retire or modify obsolete zoning districts and classes																	
i. Amend Zoning and Subdivision Regulations to incorporate Low Impact Development standards	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
j. Consider amending zoning and subdivision codes in Kingston and Ulster to encourage clustered developments to maximize open space																	
k. Consider watershed or water resources protection overlay zoning districts that require additional reviews and design criteria	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

	Subwatershed																
	1	**2**	**3**	**4a**	**4b**	**4c**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
l. Acquire open space when available	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
m. Consider open space districts to further protect open space	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Objective #1.6 – Manage disposal of sanitary wastewater in tributary subwatersheds																	
a. Reduce sanitary sewer inflow and infiltration	H	H	H	H	H	H	L	L	H	H	H	H	L	L	L	L	L
b. Ensure that regular maintenance of septic systems is occurring	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
c. Extend sewer systems where groups of septic systems are failing or reaching the ends of their period of effectiveness																	
d. Delineate sewer avoidance and future sewer system service areas	L	L	L	L	H	L	M	M	L	L	L	H	H	H	H	H	H
Goal #2 – Create a vibrant waterfront by improving water quality																	
Objective #2.1 – Manage land use and redevelopment along the waterfront																	
a. Develop a Harbor Management Plan for all three municipalities	H	--	H	--	--	--	H	H	--	H	--	--	H	--	H	--	--
b. Repair and replace bulkheads using standard methods, including sheet piling, but also considering other methods evaluated by the Hudson River Estuary Program	H	--	H	--	--	--	H	H	--	H	--	--	H	--	H	--	--
c. Ensure that marinas are utilizing best practices to avoid water pollution	H	--	H	--	--	--	H	H	--	H	--	--	H	--	H	--	--
Objective #2.2 – Mitigate tidal flooding in the Kingston and Esopus waterfront areas																	
a. Pursue drainage system improvements	H	--	H	--	--	--	L	L	--	L	--	--	L	--	L	--	--
b. Elevate roads	H	--	H	--	--	--	H	H	--	H	--	--	H	--	H	--	--
c. Elevate buildings that cannot be floodproofed	H	--	H	--	--	--	H	H	--	H	--	--	H	--	H	--	--
d. Floodproof buildings that cannot be elevated	H	--	H	--	--	--	H	H	--	H	--	--	H	--	H	--	--
Objective #2.3 – Reduce sewer overflows into Rondout Creek																	
a. Reduce sanitary sewer inflow and infiltration [see also Objective #1.6]	H	H	H	H	H	H	L	L	H	H	H	H	L	L	L	L	L
b. Eliminate combined sewers	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L
c. Maximize treatment capacities to avoid overflow of untreated wastewater	H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

	Subwatershed																
	1	**2**	**3**	**4a**	**4b**	**4c**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
d. Protect the wastewater treatment plant from flooding	H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Objective #2.4 – Improve water quality classification of Rondout Creek from C to B																	
a. Consider requesting designation of impaired status for the tidal Rondout Creek	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
b. If impaired status is granted, leverage the resources made available as a result of the impaired status	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Objective #2.5 – Increase training, education, and stewardship																	
a. Coordinate existing water quality monitoring programs to increase data sharing and avoid redundant efforts	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
b. Set up and implement a new water quality sampling and monitoring program to fill gaps and augment existing programs while providing metrics for measuring implementation of this plan	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
c. Set up and implement a monitoring protocol for tributary stream projects such as revegetation and streambank stabilization	M	M	M	H	H	M	L	L	M	L	L	H	L	L	L	L	H
d. Link watershed water quality awareness to existing recreational programs through interpretative signage and modification of recreational program curriculums	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
e. Promote the use of the online tool (http://www.kingston-ny.gov/reportit) for residents to report water quality concerns such as spills, stream dumping, and streambank erosion	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

APPENDIX F

FUNDING SOURCES

Appendix F
Funding Sources

Numerous potential funding sources may be available to the City of Kingston and the Towns of Ulster and Esopus as well as Ulster County and its departments for the implementation of recommendations of this plan. In most cases, these programs can fund only projects that result in tangible benefits such as plans and projects. Studies such as hydraulic modeling are typically not funded through these programs.

Natural Resources Conservation Service (NRCS)

The NRCS provides technical assistance to individual landowners, groups of landowners, communities, and soil and water conservation districts on land use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Two major programs are described below.

Emergency Watershed Protection Program (EWP)

Through the EWP program, the U.S. Department of Agriculture's NRCS can help communities address watershed impairments that pose imminent threats to lives and property. Most EWP work is for the protection of threatened infrastructure from continued stream erosion. NRCS may pay up to 75% of the construction costs of emergency measures. The remaining costs must come from local sources and can be made in cash or in-kind services. No work done prior to a project agreement can be included as in-kind services or part of the cost share. EWP projects must reduce threats to lives and property; be economically, environmentally, and socially defensible; be designed and implemented according to sound technical standards; and conserve natural resources.

Watersheds and Flood Prevention Operations

This program element contains two separate and distinct programs, "Watershed Operations" and "Small Watersheds." The purpose of these programs is to cooperate with state and local agencies, Tribal governments, and other federal agencies to prevent damages caused by erosion, floodwater, and sediment and to further the conservation, development, utilization, and disposal of water and the conservation and utilization of the land. The objectives of these programs are to assist local sponsors in assessing conditions in their watershed, developing solutions to their problems, and installing necessary measures to alleviate the problems. Measures may include land treatment and structural and nonstructural measures. Federal cost sharing for installation of the measures is available. The amount depends upon the purposes of the project.

FEMA

Pre-Disaster Mitigation (PDM) Program

The Pre-Disaster Mitigation Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard

mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through pre-disaster mitigation planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities.

Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.

HMGP is available only in the months subsequent to a federal disaster declaration in the State of New York. Because the state administers HMGP directly, application cycles will need to be closely monitored after disasters are declared in New York.

Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

One limitation of the FMA program is that it is generally used to provide mitigation for structures that are insured or located in SFHAs.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the USACE for mitigation are listed below.

Section 205 – Small Flood Damage Reduction Projects

This section of the 1948 Flood Control Act authorizes the USACE to study, design, and construct small flood control projects in partnership with nonfederal government agencies. Feasibility studies are 100% federally funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 55%, with a 35% nonfederal match. In certain cases, the nonfederal share for construction could be as high as 50%. The maximum federal expenditure for any project is $7 million.

Section 14 – Emergency Streambank and Shoreline Protection

This section of the 1945 Flood Control Act authorizes the USACE to construct emergency shoreline and streambank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and nonprofit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

Section 208 – Clearing and Snagging Projects

This section of the 1954 Flood Control Act authorizes the USACE to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

Section 205 – Floodplain Management Services

This section of the 1950 Flood Control Act, as amended, authorizes the USACE to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100% federally funded.

In addition, the USACE also provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and postflood response. USACE assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the USACE can loan or issue supplies and equipment once local sources are exhausted during emergencies.

The U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service provides technical and financial assistance to restore wetlands and riparian habitats through the North American Wetland Conservation Fund and Partners for Wildlife programs. It also administers the North American Wetlands Conservation Act Grants Program, which provides one-to-one matching grants to organizations and individuals who have developed partnerships to carry out wetlands projects in the United States, Canada, and Mexico. Funds are available for projects focusing on protecting, restoring, and/or enhancing critical habitat. It is possible that recommendations of this plan regarding restoration of wetlands along Rondout Creek and its tributaries could be matched with some of these grant programs.

U.S. Environmental Protection Agency

Clean Water Act (CWA) Section 319 Grants are cost-share grants to state agencies that can be used for funding watershed resource restoration activities, including wetlands and other aquatic habitats such as

riparian zones. Only those activities that control nonpoint pollution are eligible. It is possible that recommendations of this plan regarding restoration of wetlands or management of stormwater in the watershed could be matched with a Section 319 grant but only if Rondout Creek were listed as impaired.

State of New York

NYS Department of State

The Department of State funded this watershed management plan and may be able to fund some of the actions from this plan. In order to be eligible, a project should link water quality improvement to economic benefits. An example from this plan would be flood mitigation at a key commercial property as this would reduce damages to an important local employer while reducing the potential for water quality impairments that could occur when the facility is flooded.

Clean Vessel Assistance Program (CVAP)

The CVAP is a federally funded program that provides grants to marinas for the installation, renovation, and replacement of pumpout stations for the removal and disposal of recreational boater septic waste. CVAP provides up to 75% of eligible project costs up to $60,000 to marinas, municipalities, and not-for-profit organizations for installing pumpout boats and up to $35,000 for installing or upgrading stationary pumpout units or upgrading pumpout boats. Additional CVAP grants are also available for the operation and maintenance of pumpout facilities as well as educational projects that address the benefits, use, and availability of pumpout stations. CVAP grants are federally funded through the United States Fish & Wildlife Service and administered by New York State Environmental Facilities Corporation.

Clean Water State Revolving Fund (CWSRF)

The CWSRF is jointly administered by the Environmental Facilities Corp (EFC) and the New York State DEC. The CWSRF provides low interest rate financing to municipalities to construct water quality protection projects such as sewers and wastewater treatment facilities. A variety of publicly owned water quality improvement projects are eligible for financing. Eligible projects include point source projects such as wastewater treatment facilities and nonpoint source projects such as stormwater management projects and landfill closures as well as certain habitat restoration and protection projects in national estuary program areas. Because stream daylighting can reduce the frequency of combined sewer overflows in some situations, the CWSRF may be a potential funding source for stream daylighting.

NYSDEC / Hudson Estuary Trees for Tribs

The “Hudson Estuary Trees for Tribs” program engages volunteers in restoring thousands of feet of streamside buffer through native trees and shrub planting. The program offers land owners with free native trees and shrubs for qualifying riparian buffer planting/restoration projects. Trees for Tribs staff may also be able to assist with plant selection, designing a planting plan, and other technical support to improve the odds of success for projects.

NYS Environmental Facilities Corporation

The New York State Environmental Facilities Corporation (EFC) is a component of Governor Cuomo’s administration that provides low-cost financing for local wastewater and drinking water infrastructure.

EFC invests more than $1 billion each year in water-quality improvements through the Clean Water State Revolving Fund and the Drinking Water State Revolving Fund, along with its "award-winning" Green Innovation Grant Program (GIGP). GIGP supports projects across New York State that utilize unique stormwater infrastructure design and create cutting-edge green technologies. GIGP-funded projects range from rain gardens to stream daylighting projects.

New York State Environmental Protection Fund (EPF)

The New York State EPF provides a dedicated fund for environmental protection, including open space conservation, public access, historic preservation, park development, urban waterfront redevelopment, and water quality improvement projects and activities. The EPF Municipal Grant program offers up to $16 million in matching grants for the acquisition, planning, development, and improvement of parks and historic places. Funds are available to municipalities or not-for-profits with an ownership interest. The maximum award is $500,000.

NYSDEC / Hudson River Estuary Program

The Hudson River Estuary Program (HREP) "helps people enjoy, protect, and revitalize the Hudson River and its valley. Created in 1987 through the Hudson River Estuary Management Act, the program focuses on the tidal Hudson and adjacent watershed from the federal dam at Troy to the Verrazano Narrows in New York City." The mission of the Estuary Program is built around six benefits: Clean Water; Resilient Communities; Vital Estuary Ecosystems; Estuary Fish, Wildlife, and Habitats; Natural Scenery; and Education, River Access, Recreation, and Inspiration.

The New York State DEC provides funding through the HREP to implement priorities outlined in the Hudson River Estuary Action Agenda aimed at conserving or improving clean water; fish, wildlife and their habitats; waterway access; the resiliency of communities; and river scenery. Culvert replacement is one example of a project that can be funded through this program. Another example is planning funds for separation of sewers when green infrastructure is involved.

Community Development Block Grant (CDBG)

The Office of Community Renewal administers the CDBG program for the State of New York. The NYS CDBG program provides financial assistance to eligible cities, towns, and villages in order to develop viable communities by providing affordable housing and suitable living environments as well as expanding economic opportunities, principally for persons of low and moderate income. It is possible that the CDBG funding program could be applicable for floodproofing and elevating residential and nonresidential buildings, depending on eligibility of those buildings relative to the program requirements.

Water Quality Improvement Project (WQIP) Grant Program

Through the Regional Economic Development Council (REDC) initiative, DEC has made up to $35 million available to support water quality improvements through Round 12 of the Water Quality Improvement Project (WQIP) Grant Program. Funding is available for municipalities, soil and water conservation districts, and nonprofit organizations. The WQIP program is a competitive, reimbursement grant program that directs funds from the New York State Environmental Protection Fund to projects that reduce polluted runoff, improve water quality, and restore habitat in New York's water bodies. Grants awarded through the WQIP program can fund up to 85% of the total project cost for Wastewater

Treatment Improvement projects or up to 75% of the total project cost for Non-Agricultural Nonpoint Source Abatement and Control, Aquatic Habitat Restoration, and Municipal Separate Storm Sewer Systems (MS4).

Other Potential Sources of Funding

- Ulster County Industrial Development Agency (IDA) – The IDA works in conjunction with the county Department of Economic Development to build a sustainable future by meeting the needs of new and existing businesses through expertise, financial assistance, and continued support. The IDA offers a variety of programs and performance-based incentives to encourage businesses to expand or locate within the county and create new jobs. The program primarily helps secure low interest loans and Industrial Revenue Bonds (tax-exempt financing alternatives for large-scale investments in facilities and equipment). It is possible that the program could be applicable for floodproofing, elevating, or relocating nonresidential buildings, depending on eligibility of those businesses relative to the program requirements.

- Empire State Development – The state's Empire State Development program offers loans, grants, and tax credits as well as other financing and technical assistance, to support businesses and encourage their growth. It is possible that the program could be applicable for floodproofing, elevating, or relocating nonresidential buildings, depending on eligibility of those businesses relative to the program requirements.

- Private Foundations – Private entities such as foundations are potential funding sources in many communities. The individuals charged with implementing this watershed management plan will need to identify the foundations that are potentially appropriate for some of the actions proposed in this report.

APPENDIX G

HOW'S THE WATER 2015
FECAL CONTAMINATION IN THE HUDSON RIVER AND ITS TRIBUTARIES

RIVERKEEPER®
NY's clean water advocate

HOW'S THE WATER? 2015

Fecal Contamination in the Hudson River and its Tributaries

Riverkeeper is a member-supported organization. Our mission is to protect the environmental, recreational and commercial integrity of the Hudson River and its tributaries, and to safeguard the drinking water of nine million New York City and Hudson Valley residents.

HOW'S THE WATER? 2015

Fecal Contamination in the Hudson River and its Tributaries

TABLE OF CONTENTS

About This Report 4

Acknowledgments 5

Executive Summary 6

Sources of Contamination 8

Riverkeeper's Water Quality Studies 12

How to Read Riverkeeper's Data Charts 13

Findings: 14–19

- Hudson River Estuary 14
- Hudson River Estuary: Rain Analysis 16
- Hudson River Estuary: Regional Analysis 17
- Tributaries: Regional Analysis 18
- Tributaries and NYC Shorelines: Rain Analysis 19

Maps and Data, Site by Site 20-28

- Hudson River Estuary 20
- Catskill Creek and Esopus Creek 22
- Rondout Creek and Wallkill River 24
- Sparkill Creek and Pocantico River 26
- New York City Area 28

Action Agenda 30

Success Stories 34

What You Can Do 36

Appendix: Waterborne Illnesses 37

Endnotes 38

ABOUT THIS REPORT

2014 Water Quality Program

John Lipscomb, Riverkeeper, *director*
Dan Shapley, Riverkeeper, *manager and author*
Jennifer Epstein, Riverkeeper, *associate*
Dr. Gregory O'Mullan, CUNY Queens College, *science advisor*
Dr. Andrew Juhl, Lamont-Doherty Earth Observatory of Columbia University, *science advisor*
Carol Knudson, Lamont-Doherty Earth Observatory of Columbia University, *research assistant*

Questions?

Contact Dan Shapley at dshapley@riverkeeper.org or 914-478-4501 x226

2015 Report

In addition to the Water Quality Program team, assistance in preparing this report came from Paul Gallay, Missy Falkenberg, Kara Matthews, Sean Dixon, Chloe Heintz, Tara D'Andrea, John Mickelson and Kaitlyn Shaw.

Design and layout: New Leaf Graphic Design

Printing: Executive Printing, Elmsford, N.Y.

Paper: Enviro 100 paper, made from 100% post-consumer waste

Cover Photo

Swimmers in the Hudson River at Croton Point, courtesy Toughman Triathlon.

Data Use Policy

These water quality data are made freely available to the public, and we encourage their wide use. However, if you use the data for research, policy, or educational purposes, we ask for notification. Data should not be posted on any website, but links can be made to riverkeeper.org. If the Riverkeeper data are used as background or ancillary information for any presentation, publication, website, or educational product, please cite its source. This report summarizes data gathered by different groups, and each set of data should be cited differently:

- Hudson River Estuary data: "Data collected by O'Mullan GD, Juhl AR, and Lipscomb J, available at www.riverkeeper.org."
- Tributary community science data: "Data collected by Riverkeeper in partnership with residents of the Hudson Valley, available at www.riverkeeper.org."
- New York City community science data: "Data collected by New York City Water Trail Association and The River Project, in partnership with more than 20 community boathouses, community groups, and waterfront parks."

Visit riverkeeper.org/water-quality for additional data, including from samples gathered in 2015.

ACKNOWLEDGEMENTS

Over nearly 10 years, many people and organizations have contributed to the funding, study design, data collection, data analysis, data presentation, and advocacy related to Riverkeeper's Water Quality Program. These acknowledgements focus on those who contributed in 2014, but we wish to thank all who have assisted, including Tracy Brown, Director of Western Sound Programs for Save the Sound; Brian Brigham, research assistant at CUNY Queens College; and the data visualization team at NiJeL.

2014 Community Science Partners

Many groups and individuals have participated in the community science projects described in this report. While all individuals are not listed here, we thank them all. Listed here are groups that have collected and processed samples:

- Catskill Creek Watershed Awareness Project
- Gardiner Environmental Conservation Commission
- Montgomery Conservation Advisory Council
- New York City Water Trail Association and The River Project, which partner with more than 20 community boathouses, community groups, waterfront parks, and labs
- Quassaick Creek Watershed Alliance (data available at riverkeeper.org)
- Rochester Environmental Conservation Commission
- Rosendale Commission for Conservation of the Environment
- Sparkill Creek Watershed Alliance
- Wawarsing Environmental Conservation Commission

2014 Funding

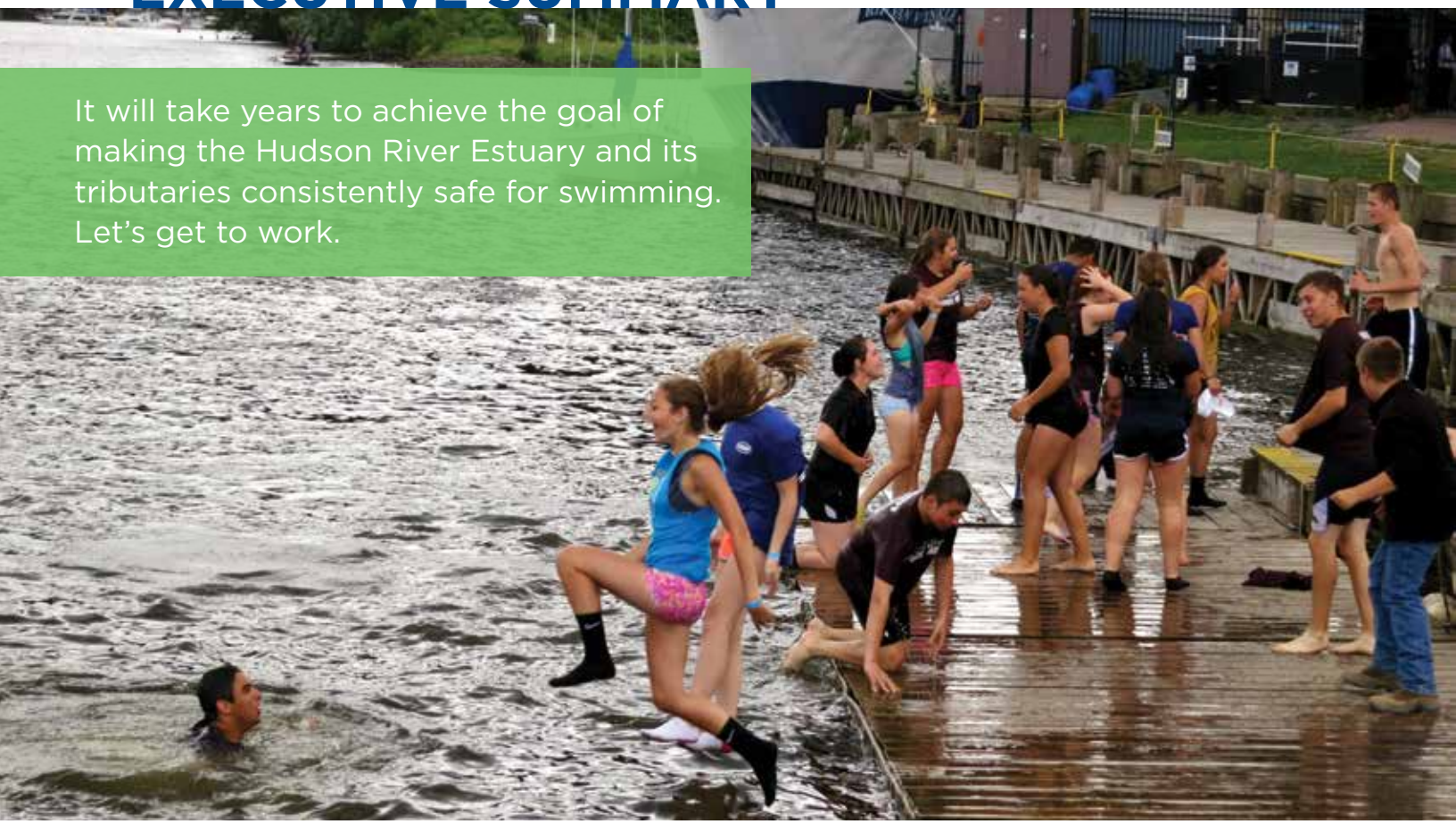
Austen-Stokes Ancient Americas Foundation, Chris and Suzanne Augustin, City University of New York, Dale and Laura Kutnick, Dextra Baldwin McGonagle Foundation, Double R Foundation, Eppley Foundation for Research, HSBC Water Programme, Hudson River Foundation for Science and Environmental Research, Lamont-Doherty Earth Observatory of Columbia University, John McLaughlin, Michele Hertz and Larry Friedman, The Nancy and Edwin Marks Family Foundation, New England Interstate Water Pollution Control Commission (NEIWPCC), S. Mackintosh Pulsifer, Mike Richter, Sun Hill Foundation, Wallace Research Foundation, and many Riverkeeper members.

The contents of this report do not necessarily reflect the views and policies of NEIWPCC or any other funder, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Riverkeeper's citizen sampling program is recognized by the Clinton Global Initiative as a Commitment to Action—a plan for addressing a significant global challenge.

EXECUTIVE SUMMARY

It will take years to achieve the goal of making the Hudson River Estuary and its tributaries consistently safe for swimming. Let's get to work.



Kids leap into the tidal Rondout Creek in Kingston. *Photo by John Lipscomb/Riverkeeper*

Investments in clean water infrastructure over decades have dramatically improved water quality On many days, in many places throughout the Hudson River Estuary, water quality is excellent for swimming.

In 2014, nearly 6,500 people swam in organized public swim events in the Hudson River Estuary and New York Harbor,[1] and thousands more swam at public beaches or other water access points.[2]

While the people of the Hudson Valley have made much progress toward achieving the Clean Water Act goal of making the watershed safe for swimming, we are failing to adequately protect these waters—the public's beach. There is a documented immediate need for more than 315 Hudson Valley and New York City wastewater projects, at a cost of $5.9 billion.[3]

This report demonstrates the cost of failing to make those investments, and of failing to adequately enforce the Clean Water Act, particularly in the tributaries of the Hudson. The information presented here is based on more than 6,000 water samples collected in the Hudson River estuary by Riverkeeper, CUNY Queens and Lamont-Doherty Earth Observatory; and in Hudson River tributaries and at New York City public water access points by dozens of community scientists. As measured against the Environmental Protection Agency's recommended Beach Action Value for safe swimming:

- **23% of Hudson River estuary samples fail.**
- **72% of Hudson River tributary samples fail.**
- **48% of New York City-area water access point samples fail.**

After periods of dry weather, the Hudson River Estuary is safe for swimming in many locations. But after rain, the water is more likely to be contaminated, especially in areas affected by combined sewer overflows and streetwater runoff. [4]

Rain also dramatically increases the degree of fecal contamination in the tributaries we have sampled with community science[5] partners. The sources of this contamination are likely complex, which points to the steep challenge of achieving improvements in water quality. Sources are known or suspected to include—each to an unknown degree—nearly 1,000 permitted

wastewater discharge outfalls,[6] thousands of streetwater outfalls,[7] hundreds of thousands of septic systems, [8] thousands of farms[9] and countless wild animals.

The Hudson River Valley has been a laboratory for the environmental movement since its inception, and our ingenuity will be tested by this problem. The good news is that there are success stories for reducing contamination from complex sources such as these[10] —but success relies on the full implementation of the Clean Water Act. To make progress, we must:

1. **Improve monitoring, modeling and public notification**, both so the public is well informed about present risks associated with known contamination, and so water quality is properly assessed so investments can be prioritized.
2. **Invest in clean water**, including sewage infrastructure; watershed protection plan implementation; green infrastructure; and management of animal feeding operations, farms and septic systems.
3. **Enforce the Clean Water Act** by verifying impairments identified by citizen water sampling, tightening pollution discharge permit conditions and enforcing compliance, and prioritizing projects to reduce pollution.
4. **Develop new science-based tools** to better understand pollution sources, wastewater contaminants, and their impacts on human and environmental health.

Riverkeeper's work gathering and publicizing water quality data has led to enforcement against polluters, the passage of the Sewage Pollution Right to Know Law, and millions of dollars in infrastructure investments from New York City to the Capital District.

Riverkeeper's water quality program has also invigorated grassroots water-protection efforts. To be effective partners to these efforts, environmental and health departments need sufficient staffing, budget and leadership. And yet at the Department of Environmental Conservation, staffing is down 10% over the past decade, and budget is projected to decline 25% by 2020.[11]

It will take years to achieve the goal of making the Hudson River Estuary and its tributaries consistently safe for swimming. Let's get to work.

FINDINGS AT A GLANCE

CONTAMINATION VARIES

At Hudson River Estuary sites sampled, contamination varies from location to location, and over time at all locations. Sites vary in both frequency and degree of contamination. The degree of risk varies based on when and where one enters the water.

RAIN INCREASES CONTAMINATION

At Hudson River Estuary sites sampled, the failure rate against the Environmental Protection Agency (EPA)'s recommended Beach Action Value (BAV) is 12% after periods of dry weather, but 35% after rain. The increase in contamination is most pronounced near communities with combined sewers, in tidal tributaries and urban near-shore areas.

CONTAMINATION IS GREATER IN TRIBUTARIES

At Hudson River Estuary sites sampled, the failure rate against the EPA's recommended BAV is 18% in the mid-channel and near-shore areas tested by Riverkeeper, but twice that – 36% – in and at the mouths of tidal tributaries.

CONTAMINATION LEVELS DIFFER BY TRIBUTARY*

At non-tidal tributary sites sampled, the frequency and degree of contamination is greater than in the Hudson River estuary, including the tidal portions of its tributaries. But the frequency and degree of contamination vary among tributaries.

RAIN INCREASES CONTAMINATION IN TRIBUTARIES*

At non-tidal tributary sites sampled, the failure rate against the EPA's recommended BAV is 59% after periods of dry weather, but 85% after rain.

* Findings based on data gathered by community scientists.

To keep informed about these issues, please visit riverkeeper.org and sign up to receive updates by e-mail.

SOURCES OF FECAL CONTAMINATION IN OUR

A sewer failure in July 2013 led to the discharge of raw sewage into the Twaalsfkill, a tributary of the Rondout Creek.
Photo by Dan Shapley/Riverkeeper

Riverkeeper's water quality monitoring projects are limited primarily to bacterial indicators of sewage and other fecal contamination, not other types of pollution such as toxic chemicals.[12] Our projects are designed to identify trends in fecal contamination and to make broad assessments of water quality, not to define specific sources. A number of known and suspected sources of fecal contamination can be surmised from a review of land uses and scientifically verified sources of fecal contamination in the Hudson River Watershed and nationwide. Identifying the specific sources of contamination is critical to solving water quality problems.

Combined Sewer Overflows

Combined sewers carry both sewage and streetwater in the same pipes, and when rain or snowmelt overwhelms wastewater treatment plant or pipe capacity, untreated sewage will overflow to prevent treatment plant failures. In the Hudson River Watershed, including the East and Harlem rivers, there are more than 660 Combined Sewer Overflow (CSO) outfalls. To reduce these discharges, the Department of Environmental Conservation is implementing CSO Long Term Control Plans under the Clean Water Act over the next decade or more in the Capital District, New York City and several other river cities.

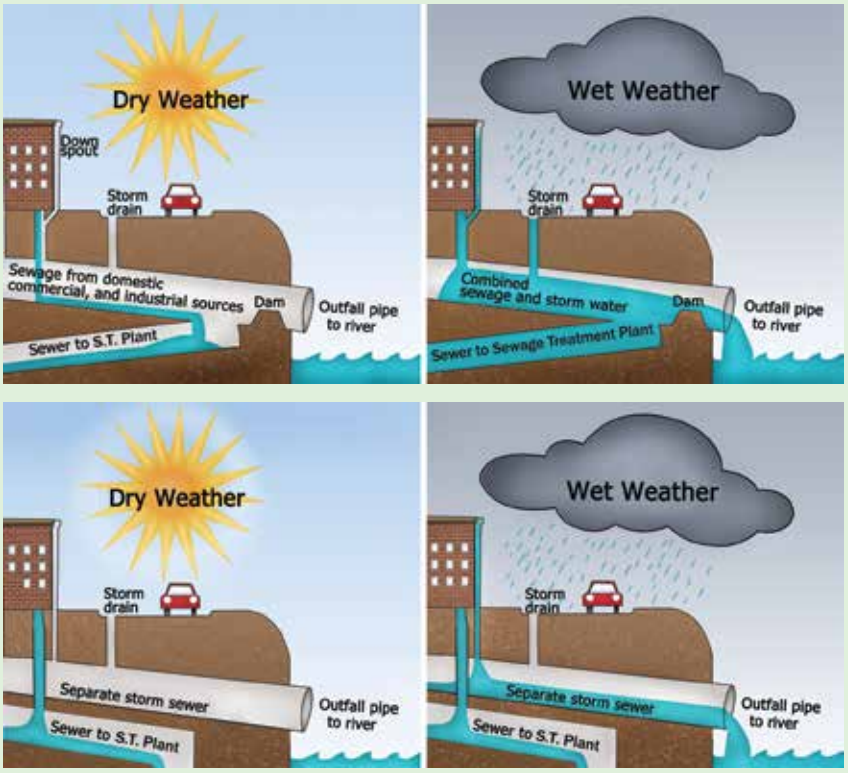
HUDSON RIVER WATERSHED CSO OUTFALLS

New York City[i]	426
Capital District[ii]	92
Hudson Estuary[iii]	58
Mohawk River[iv]	52
New Jersey[v]	26
Upper Hudson[vi]	12

i Approximately 20% of NYC outfalls discharge to waters not part of the Hudson Estuary, such as Long Island Sound and Jamaica Bay.
ii Albany, Cohoes, Green Island, Rensselaer, Troy and Watervliet.
iii Catskill, Hudson, Kingston, Newburgh, Poughkeepsie, West Point and Westchester County.
iv Amsterdam, Little Falls, Schenectady and Utica.
v Bayonne, Fort Lee, Guttenberg, Jersey City, North Bergen and North Hudson County.
vi Glens Falls, Washington County and Waterford.

Sources: NYS DEC, NY/NJ Baykeeper

SEWER SYSTEMS AT-A-GLANCE



COMBINED SEWER SYSTEMS

Sewage and streetwater are transported by the same pipes. To avoid sewage plant failures when rain or snowmelt enters pipes, sewage is discharged, untreated or partially treated, to water.

SEPARATE SEWER SYSTEMS

Sewage is transported to treatment plants in one set of pipes. Storm drains carry streetwater in a separate set of pipes.

(Graphic Source: US EPA)

Sewage Infrastructure Failures

There over 190 publicly owned systems that collect and/or treat sewage in the Hudson River Estuary watershed (and more in New York City and New Jersey, and in the Upper Hudson and Mohawk River watersheds). Well-run plants with sufficient capacity and good collection systems effectively treat sewage. But most were built decades ago, and today rely on aging, leaking pipes. In some cases these systems fail to treat all sewage. Overflows from sewer systems can be triggered by bypasses of treatment processes to alleviate streetwater inflow and infiltration, as well as pipe breaks and blockages. Further, smaller treatment plants are held to inadequate monitoring requirements, requiring only one sample of effluent per month to demonstrate compliance with pollution limits.

At least 29 of these municipal wastewater treatment plants have had effluent violations within the past three years.[13]

In addition to municipally owned plants, 850 other permits allow discharges of sewage or other wastewater into the Hudson River Estuary watershed from private, commercial or institutional facilities. More than 50 of these private, commercial or institutional facilities have had effluent violations in the past three years.[14] Many of the plants designed to treat sewage do not disinfect effluent before discharge, allowing the ongoing discharge of potentially harmful microbes.

Effluent violations are often identified only if self-reported by a facility. More than 175 facilities in the Hudson River Estuary watershed violated reporting requirements in the last three years.[15] Each year a fraction of these permits are reviewed or facilities inspected.[16]

A pipe discharges treated sewage effluent on the Indian Kill, a tributary of the Hudson River. *Photo by Dan Shapley/Riverkeeper.*

A farm adjacent to the Wallkill River. *Photo by Dan Shapley/Riverkeeper.*

Runoff from Streets

In addition to at least 3,500 streetwater outfalls in New York City[17] there are thousands of regulated outfalls in 150 Hudson River Estuary watershed communities[18] and northern New Jersey, as well as many unregulated outfalls.

Other studies have documented extremely high levels of fecal indicating bacteria in discharges of streetwater from storm sewer outfalls.[19] In addition, streetwater carries litter, sediment, salt, oil and other contaminants that can damage environmental or public health.

Sources of fecal indicating bacteria in streetwater may include:[20]

- human waste, including from illicit sanitary sewer connections or leaky sanitary sewers that infiltrate stormwater pipes, illegal dumping, or encampments of homeless or transient people;
- dog and other domestic pet waste;
- dumpsters, garbage cans and garbage trucks;
- urban wildlife such as pigeons, raccoons, feral cats and squirrels; and,
- biofilms, decaying plant matter, litter and sediment in storm drains (and on streets).[21]

Runoff from Agriculture

Runoff from farms and animal feeding operations (AFOs) can be a significant source of pathogens[22] and other pollutants, if manure spread as fertilizer or generated by livestock is not managed to avoid contaminating water. There are thousands of farms in the Hudson River watershed,[23] with varying degrees of regulation and investment in best management practices to avoid runoff and erosion, exclude cattle from streams, and manage manure and manure applications. While the risk of exposure to water contaminated by animals varies, the risk from cattle waste is comparable to human waste. [24]

REDUCING AGRICULTURAL RUNOFF

There are several "best management practices" farmers can employ to reduce runoff of pathogens, nutrients and soil, including:

- plant cover crops
- plant or protect streamside and flood plain vegetation
- don't spread manure in winter, when the ground is frozen
- build manure storage facilities
- compost manure
- fence streams to exclude cattle; and,
- build berms to control runoff.

Streetwater flows into a storm drain. *Photo by Riverkeeper.*

Canada geese on the Hudson River.
Photo by John Lipscomb/Riverkeeper

Septic System Failures

There are hundreds of thousands of septic systems[25] in the Hudson-Mohawk watershed[26]. All but the largest require no state permit, and despite the availability of voluntary EPA management guidelines,[27] only a handful of communities regulate operation and maintenance of systems at private homes. The failure rate has been estimated at 10% nationwide,[28] and as high as 70% in some communities. The local failure rate is unknown, but the state has identified failing septic systems as a top water quality issue.[29] Most failures are identified when the pooling of sewage in yards or odors are reported to a county Department of Health—which typically occurs long after the system has been polluting groundwater, and potentially nearby surface water. Routine inspection and maintenance would catch these problems earlier, at lower cost to homeowners and the environment.

The EPA recommends community level management of septic systems in areas with increased risk to water, ranging from homeowner education to the creation of public septic districts. Key concepts include:

- **inventorying existing systems and their level of performance at a minimum;**
- **requiring operating permits for large systems and clusters of systems;**
- **requiring discharge permits for systems that discharge to surface waters;**
- **increased requirements for certification and licensing of practitioners; and,**
- **elimination of illicit discharges to storm drains or sewers.**

Wildlife

Even in relatively urbanized areas of the Hudson River Estuary watershed, our waterways provide habitat for geese, deer and other animals. Fecal contamination from many types of animals, with notable exceptions such as cattle, generally poses less of a risk than fecal contamination from humans. The degree to which fecal indicators reflect wildlife sources is not known, but given the degree of human development in the watersheds we have studied, and the increase in contamination seen in more urbanized watersheds relative to less urbanized watersheds, Riverkeeper's working assumption is that human and human-related sources (agriculture, pets) are often dominant.

RIVERKEEPER'S WATER QUALITY MONITORING

Riverkeeper's Water Quality Program conducts the most comprehensive study of fecal contamination in the Hudson River estuary and its watershed.

Carol Knudson, of Columbia University's Lamont-Doherty Earth Observatory, takes a water sample from the Hudson River.
Photo by Leah Rae/Riverkeeper

Riverkeeper samples for fecal contamination using *Enterococcus* (Entero), the only Environmental Protection Agency (EPA)-recommended indicator for use in both fresh and salt waters.[32] The EPA has estimated that as many as 3.5 million Americans are sickened each year from contact with recreational water,[33] primarily due to pathogens associated with sewage and other fecal contamination. (*See Appendix A*) While Entero is not usually harmful, it indicates that disease-causing pathogens associated with fecal contamination are likely to be present.

Since 2008, in collaboration with our science partners at CUNY Queens College and Columbia University's Lamont-Doherty Earth Observatory, Riverkeeper has sampled 74 locations on 150 miles of the Hudson River Estuary between New York Harbor and Waterford, monthly from May to October. The samples were processed using an IDEXX Enterolert[34] system aboard the Riverkeeper patrol boat, the *R. Ian Fletcher*. In addition to Entero, we measure basic water quality parameters including temperature, salinity, turbidity, chlorophyll and dissolved oxygen. In 2014, Riverkeeper also supported research projects conducted by our science partners, including DNA-based surveys of the broader Hudson River microbial community, and measures of carbon dioxide and methane.

Building on this core study, Riverkeeper has begun working with a variety of community groups and individuals to sample Entero at tributary and water access points—148 locations in 2014. Tributary samples presented here were processed in Riverkeeper's lab. Only tributary studies with at least two seasons of data are reported here. All data are available at riverkeeper.org.

Riverkeeper's sampling protocols in the Hudson River Estuary and its tributaries are consistent with Quality Assurance Project Plans[35] approved for the 2014 sampling season by the New England Interstate Water Pollution Control Commission.

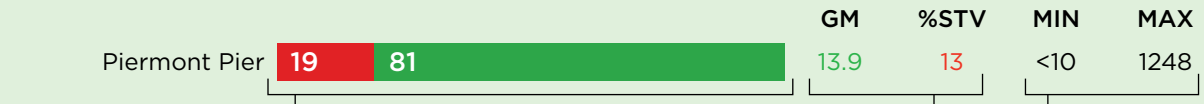
Also presented are data at water access points gathered by New York City Water Trail Association, The River Project, and more than 20 partners. These samples are processed at five labs—The River Project, O'Mullan Lab/CUNY Queens College, McGillis Lab/Columbia Earth Institute, Durand Lab/LaGuardia Community College and the Bronx River Alliance.

Riverkeeper bases assessments of water quality on the EPA's science-based 2012 Recreational Water Quality Criteria,[36] which define recommended concentrations of Entero per 100 ml of water ("Entero count") consistent with "primary contact recreation," which includes swimming, bathing, surfing, water skiing, tubing, skin diving, water play by children and other activities where ingestion of water or full immersion of the body is likely.[37] The EPA guidelines used here are designed to prevent more than 32 illnesses per 1,000 people,[38] and are protective regardless of whether the fecal contamination source is primarily human or animal.[39] They are recommended for use in any waters designated for primary contact recreation, even if there are no designated public beaches.[40]

HOW TO READ RIVERKEEPER'S DATA CHARTS

Riverkeeper uses Environmental Protection Agency (EPA) Water Quality Criteria to understand data gathered.

Riverkeeper samples the water less frequently than the EPA recommends. Our GM and STV calculations are based on our entire study period, using monthly sampling, rather than monthly calculations based on at least weekly sampling. While we assume they will have similar a probability distribution, our reported GM and STV values will be less sensitive to changes in water quality, and we support higher frequency sampling.



Managing Swimming Areas

The red bar shows the percentage of single samples that exceeded an Entero count of 60, the EPA-recommended Beach Action Value. Above this level, the EPA recommends public notification, and possible temporary beach closure.

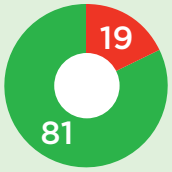
Regulating Water Quality

The Geometric Mean (GM) and the Statistical Threshold Value (STV) are measures of the degree and frequency of contamination. They describe the maximum allowable Entero counts to protect the health of swimmers, as measured by multiple samples over time at any given location.

To avoid exposure to chronic contamination, the GM, a weighted average, should not exceed 30. To avoid exposure to occasional high levels of contamination, no more than 10% of those samples should exceed 110, the STV. In our figures, failures of either criterion are listed in red. If a site fails one or both criteria, steps should be taken to reduce pollution.

Range

The minimum (Min) and maximum (Max) refer to the lowest and highest Entero counts observed at each site. A greater-than or less-than symbol indicates a sample beyond the detection limits of our lab.



BAV data are displayed both as bar and pie charts.

On the Web

Visit riverkeeper.org/water-quality for:

- Results of every sample at every location
- Charts for comparing results in dry and wet weather
- Maps showing watershed areas and sampling locations
- Tools for watershed research
- Reports
- Also see our Boat Blog at riverkeeper.org/blog/patrol for ongoing updates.

FINDINGS: HUDSON RIVER ESTUARY

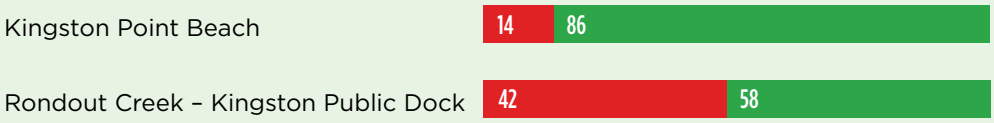
Based on analysis of more than 3,100 Enterococcus samples taken from 74 locations in the Hudson River estuary since 2008, Riverkeeper and scientists at CUNY Queens and Lamont-Doherty Earth Observatory have identified several patterns.

1

Contamination Varies

Contamination varies from location to location

On any given day the water quality may vary at different locations, even those near one another. Water quality may be suitable for swimming at one location, and exceed safe-swimming guidelines at another. The bar charts show percentage of samples above the EPA-recommended Beach Action Value and can be used to compare frequency of contamination.



Contamination varies over time at all locations

At all locations, we have measured bacteria at levels that exceed safe-swimming guidelines at times. At all locations, we have also measured water quality fit for swimming at times. The min/max figures are a quick way to see how widely contamination levels vary at any given site.

	Min	Max
Kingston Point Beach	<1	219
Rondout Creek – Kingston Public Dock	5	>2,420

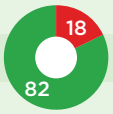
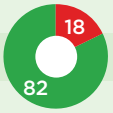
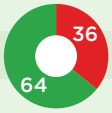
Sites vary in both frequency and degree of contamination

The more frequently a location has fecal contamination, the greater the chance of exposure. The greater the degree of fecal contamination at the time of exposure, the greater the chance of getting sick. A site with infrequent but very high levels of contamination poses an elevated risk, just as a site that is frequently contaminated to a lesser degree. Water at a site with a high Geometric Mean (GM) has a high average level of contamination. Water at a site with a high percentage of samples above the Statistical Threshold Value (STV) has frequent episodes of high contamination. All Riverkeeper sample sites that fail the GM criterion also fail the STV criterion. But several fail only the STV criterion, because average contamination levels are not excessive, but occasional spikes of high-level contamination present a risk.

	GM	%STV
Kingston Point Beach	8.9	7
Rondout Creek – Kingston Public Dock	65.6	36

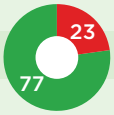
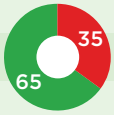
2 Contamination is Greater in Tributaries

Both the frequency and degree of contamination tend to be higher in tributaries.

Site Type	BAV	GM	%STV
Estuary Mid-Channel		9	12
Estuary Near Shore		14	12
Tidal Tributaries		35	29

3 Rain Increases Contamination

The frequency and degree of fecal contamination increases during and after rainfall. Overall the percentage of Hudson River Estuary samples, 2008-2014, that failed EPA safe-swimming guidelines increased from 12% in dry weather to 35% after rain. The response to rain is most pronounced in areas of the Hudson affected by combined sewer overflows (CSOs), and in tributaries. Rain also correlates with spikes of contamination along some urban waterfronts, suggesting streetwater runoff and/or infrastructure failures there may be important sources in some areas. (*For more, see Rain Analysis, next page.*)

Site Type	BAV	GM	%STV
All Weather		16	16
Wet		29	26
Dry		10	7

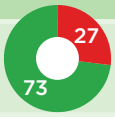
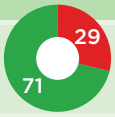
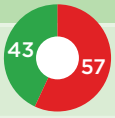
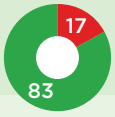
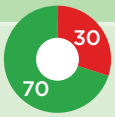
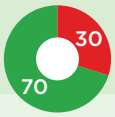
FINDINGS: HUDSON RIVER ESTUARY/RAIN ANALYSIS

Rain has a profound effect on water quality in the Hudson River estuary. The failure rate against the Environmental Protection Agency's Beach Action Value increases from 12% in dry weather to 35% during and after rain (defined as at least 0.25 inch of rain, cumulative, in the three days prior to sampling).

Rain affects different types of sampling locations to different degrees. Riverkeeper divides our Hudson River Estuary sampling locations into different categories – mid-channel, near shore, tributary (in or at the mouths of tidal tributaries), and near sewage treatment plant outfalls.

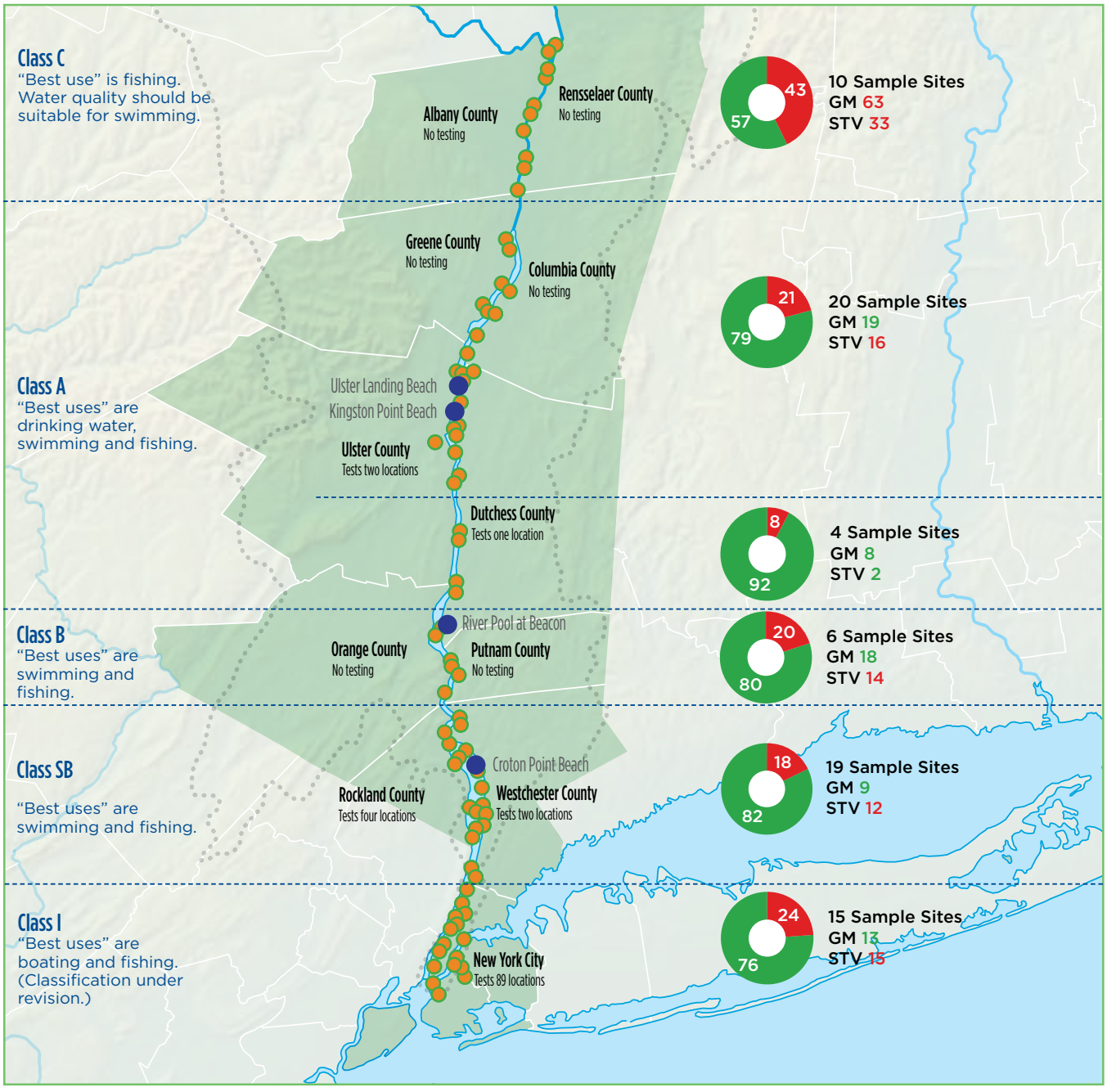
(*See which sites in our Hudson River Estuary study are most affected by rain on pages 20-21.*)

EFFECT OF RAIN VARIES BY TYPE OF SITE

Site Type	# of Sites	BAV	GM	%STV
Mid-Channel				
Wet	19		16	20
Dry			5	3
Near Shore				
Wet	34		24	21
Dry			9	5
Tidal Tributaries				
Wet	16		96	48
Dry			14	12
Sewage Treatment Plant				
Wet	5		25	18
Dry			21	19

FINDINGS: HUDSON RIVER ESTUARY/REGIONAL ANALYSIS

The Department of Environmental Conservation (DEC) classifies waterbody segments based on their "best uses"— a statement of goals, not an assessment of water quality. Classification guides the permitting of pollution discharges with the intention of preserving water quality sufficient to support the designated uses. This chart shows data summarized by region, loosely based[41] on DEC segments. Each site was sampled between 40-45 times[42] between 2008 and 2014.



- **Riverkeeper Test Site**
- **Official Public Swimming Area**
- **Hudson River watershed boundary**
- **Acceptable** = Passes EPA guidelines for safe swimming. (Single-sample Entero counts 60 or less.)
- **Beach Advisory** = Fails EPA's recommended Beach Advisory Value (BAV), and should result in closure of swimming area.

GM = A weighted average of contamination. Red is a failure of EPA criterion.
STV = A measure of frequency of high-level contamination. Red is a failure of EPA criterion.

FINDINGS: HUDSON RIVER TRIBUTARIES/REGIONAL ANALYSIS

Based on an analysis of 1,485 samples taken by community scientists in six Hudson River tributaries, Riverkeeper has identified several patterns.

1

Contamination Levels Differ by Tributary

The level of contamination in non-tidal portion of tributaries, where community scientists sample, is significantly higher than the Hudson itself—with 99% of sites sampled failing EPA-recommended criteria (exceeding GM, STV or both) for safe swimming. But the frequency and degree of contamination vary among tributaries.

Site	# Samples	BAV	GM	% STV
Hudson River Estuary	3,203	23% / 77%	16	16
Catskill Creek*	157	34% / 66%	48	21
Esopus Creek*	150	33% / 67%	37	23
Rondout Creek*	293	68% / 32%	157	55
Wallkill River*	377	87% / 13%	426	81
Sparkill Creek*	288	95% / 5%	844	90
Pocantico River*	220	87% / 13%	396	82

2

The Tidal Portions of Tributaries Are Less Contaminated

Riverkeeper has sampled in the tidal portions of three tributaries – Catskill, Esopus and Rondout creeks – since 2008. Community scientists have sampled the non-tidal portions of the same tributaries since 2012. Contamination levels are generally higher upstream of the first dam, though sources of contamination in the tidal portion may also have a significant effect on water quality.

Site	BAV	GM	% STV
Rondout Creek (Tidal)	67% / 33%	46	26
Rondout Creek (Non-Tidal)*	68% / 32%	157	55
Wallkill River (Non-Tidal)*	87% / 13%	426	81
Esopus Creek (Tidal)	23% / 77%	19	11
Esopus Creek (Non-Tidal)*	33% / 67%	37	23
Catskill Creek (Tidal)	22% / 78%	21	18
Catskill Creek (Non-Tidal)*	34% / 66%	48	21

*Based on data gathered by community scientists.

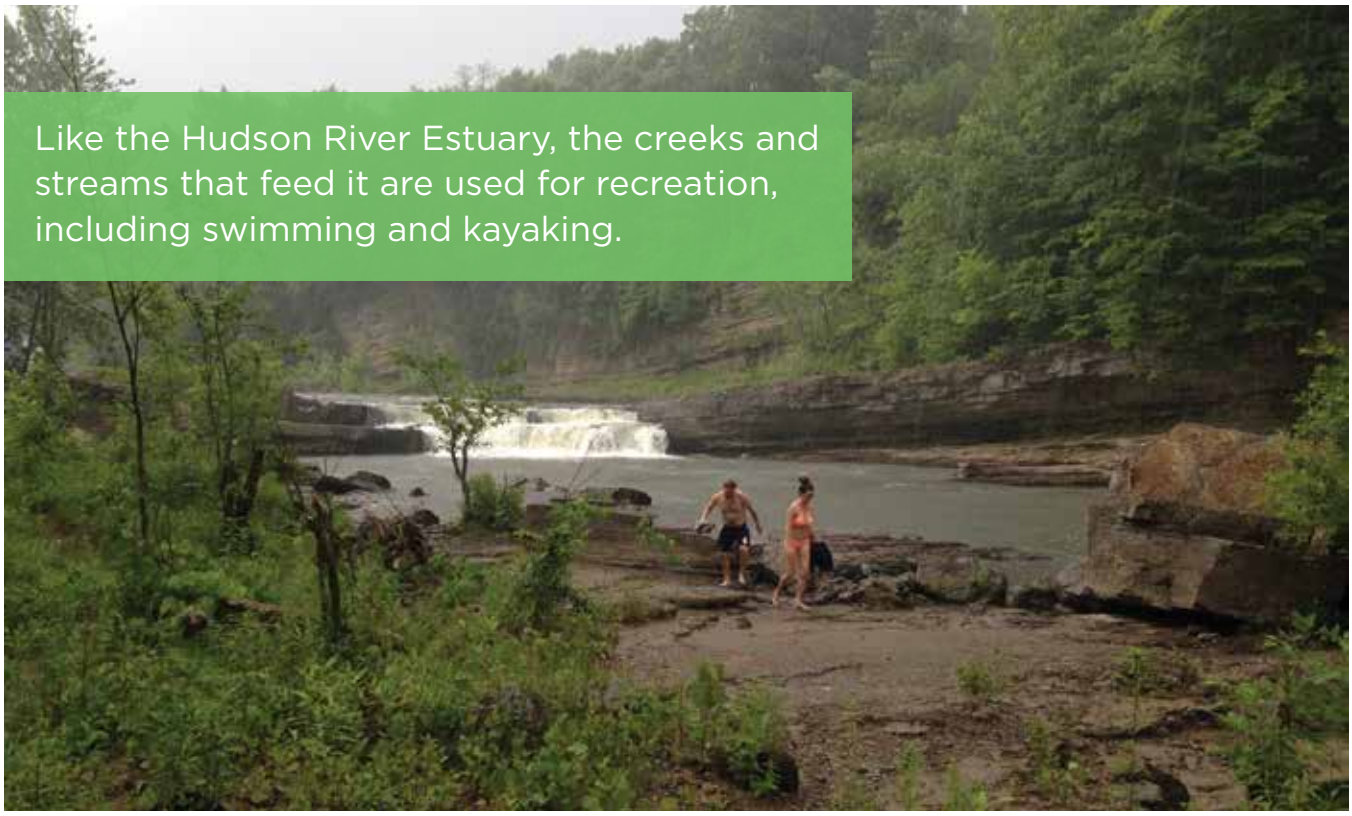
Overall, 99% of tributary sites sampled and 92% of New York City water access points sampled by community scientists failed to meet EPA criteria for safe swimming (exceeding GM, STV or both). At the sites tested, rain, defined as at least a quarter inch cumulative rainfall in the three days preceding a sample, has a great effect on the contamination levels in tributaries, and less dramatic effects at New York City water access points.

1

Rain Increases Contamination

Sample Site Type	# Sites	BAV	GM	% > STV
Hudson River Estuary				
Dry	74	12% / 88%	10	7
Wet		35% / 65%	29	26
Non-Tidal Tributaries				
Dry*	96	59% / 41%	113	50
Wet*		85% / 15%	465	77
NYC Water Access Points				
Dry*	38	43% / 57%	42	32
Wet*		51% / 49%	61	36

*Data collected by community scientists.



Swimmers in the Rondout Creek near High Falls.

HUDSON RIVER ESTUARY:
DATA BY SAMPLING SITE

NO.	SITE	TYPE	BAV	GM	% STV	MIN	MAX	RAIN RESPONSIVE
1	Hudson above Mohawk River	M	22 78	26.7	20	<1	>2420	●
2	Mohawk River at Waterford	T	68 32	187.5	61	4	>2420	●
3	Hudson River above Troy Lock	M	65 35	119	42	4	>2420	●
4	Congress St. Bridge- Troy	M	41 59	76.4	30	6	>2420	●
5	Albany Rowing Dock	N	45 55	80.4	31	3	>2420	●
6	Dunn Memorial Bridge- Albany	M	55 45	98.8	41	3	>2420	●
7	Island Creek/Normans Kill	T	49 51	102.9	41	2	>2420	●
8	Bethlehem Launch Ramp	N	24 76	32.3	17	1	>2420	●
9	Castleton	N	29 71	31.4	24	<1	1733	●
10	Coeymans Landing	N	26 74	23.3	21	<1	1986	●
11	Coxsackie Waterfront Park	N	23 78	25.9	15	<1	2420	●
12	Gay's Point mid-channel	M	19 81	16.9	19	1	2420	●
13	Athens	N	34 66	43.5	17	5	>2420	●
14	Hudson Landing Ramp	N	28 72	28.9	16	4	>2420	●
15	Catskill Creek– First Bridge	T	26 74	24.8	26	<1	>2420	●
16	Catskill Creek– East End	T	23 77	24	20	1	>2420	●
17	Catskill Launch Ramp	N	16 84	16.8	16	1	>2420	
18	Inbocht Bay	M	10 90	11.3	10	<1	>2420	
19	Malden Launch Ramp	N	12 88	15.4	12	<1	1986	
20	Esopus Creek West	T	22 78	24.9	16	<1	>2420	●
21	Esopus Creek Entrance	T	22 78	21.8	18	<1	>2420	
22	Tivoli Landing	N	9 91	7.2	9	<1	>2420	
23	Ulster Landing Beach	N	12 88	9.5	7	<1	2420	
24	Rondout Creek- Eddyville Anchorage	T	24 76	36	18	1	>2420	●
25	Rondout Creek- Kingston Public Dock	T	42 58	65.6	36	5	>2420	●
26	Rondout Creek- Kingston STP Outfall	O	50 50	91.7	35	2	>2420	
27	Kingston Point Beach	N	14 86	8.9	7	<1	219	
28	Port Ewen Drinking Water Intake	N	7 93	5.1	7	<1	1733	
29	Norrie Point Yacht Basin	N	21 79	22.9	19	1	>2420	●
30	Norrie Point mid-channel	M	7 93	3.6	5	<1	1203	
31	Poughkeepsie Drinking Water Intake	M	2 98	4.5	0	<1	76	
32	Poughkeepsie Launch Ramp	N	9 91	11	0	3	91	
33	Marlboro Landing	N	7 93	10.2	5	1	>2420	
34	Wappingers- New Hamburg	N	15 85	10.5	5	1	411	
35	Beacon Harbor	N	18 82	19.2	9	<1	816	
36	Newburgh Launch Ramp	N	61 39	124.9	55	1	2420	●
37	Little Stony Point	N	5 95	7.9	2	<1	166	
38	Cold Spring Harbor	N	7 93	11.8	2	<1	184	
39	West Point STP Outfall	O	17 83	9.8	7	<1	>2420	
40	Fort Montgomery	N	7 93	13.1	5	<1	>2420	

41	Annesville Creek	T	20	80	11.1	14	<10	2098	
42	Peekskill Riverfront Green Park	N	20	80	15.3	11	<10	4352	
43	Stony Point mid-channel	M	2	98	3.7	0	<10	86	
44	Furnace Brook	T	20	80	11.3	16	<10	4106	
45	Cedar Pond Brook	T	20	80	11.3	18	<10	5794	
46	Haverstraw Bay mid-channel	M	5	95	2.6	0	<10	86	
47	Emeline Beach- Haverstraw	N	7	93	6.5	7	<10	10462	
48	Croton Point Beach	N	4	96	3.7	4	<10	241	
49	Ossining Beach	N	16	84	8.4	11	<10	4611	
50	Nyack Launch Ramp	N	26	74	10.3	16	<10	663	
51	Kingsland Pt. Park- Pocantico River	T	21	79	12.2	21	<10	>24196	●
52	TZ Bridge mid-channel	M	2	98	1.9	2	<10	142	
53	Tarrytown Marina	N	45	55	49.5	21	<10	>24196	●
54	Piermont Pier	N	19	81	13.9	13	<10	1248	
55	Orangetown STP Outfall	O	38	62	32.8	24	<10	10112	
56	Irvington Beach	N	5	95	3.5	5	<10	464	
57	Yonkers mid-channel	M	5	95	3.3	2	<10	410	
58	Saw Mill River	T	59	41	96.6	41	<10	>24196	●
59	Yonkers STP Outfall	O	5	95	5.4	0	<10	85	
60	Dyckman Street Beach	N	12	88	9	2	<10	144	
61	Harlem River- Washington Bridge	M	33	67	22.6	14	<10	1670	
62	GW Bridge mid-channel	M	7	93	4.4	2	<10	134	
63	Harlem River- Willis Ave. Bridge	M	25	75	13.2	18	<10	5635	●
64	North River STP @145th	O	37	63	31.9	26	<10	2987	●
65	125th St. Pier	N	23	77	12	14	<10	272	
66	79th St. mid-channel	M	7	93	4.7	2	<10	161	
67	Pier 96 Kayak Launch	N	18	82	7.7	5	<10	331	
68	Castle Point, NJ	N	9	91	9	7	<10	231	
69	East River at Roosevelt Island	M	20	80	6.5	9	<10	275	
70	Newtown Creek- Metropolitan Ave. Bridge	T	55	45	102.8	45	<10	>24196	●
71	Newtown Creek- Dutch Kills	T	41	59	29.1	31	<10	>24196	●
72	East River mid-channel at 23rd St.	M	13	88	5.4	8	<10	399	
73	The Battery mid-channel	M	7	93	4.5	2	<10	134	
74	Gowanus Canal	T	58	42	90.6	42	<10	>24196	●

Data gathered by Riverkeeper, CUNY Queens and Lamont-Doherty Earth Observatory of Columbia University.

■ **Acceptable** = Passes EPA guidelines for safe swimming. (Single-sample Entero counts 60 or less.)
■ **Beach Advisory** = Fails EPA's recommended Beach Advisory Value (BAV), and should result in closure of swimming area. (Single-sample Entero count greater than 60.)

GM (Geometric Mean) = Weighted average of Entero counts that dampens the effect of very high or low values. A GM of 30 or more indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
STV (Statistical Threshold Value) = Percentage of samples with Entero count above 110. Greater than 10% failure rate indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.

Min = The lowest Entero count recorded at this site. / **Max =** The highest Entero count recorded at this site.

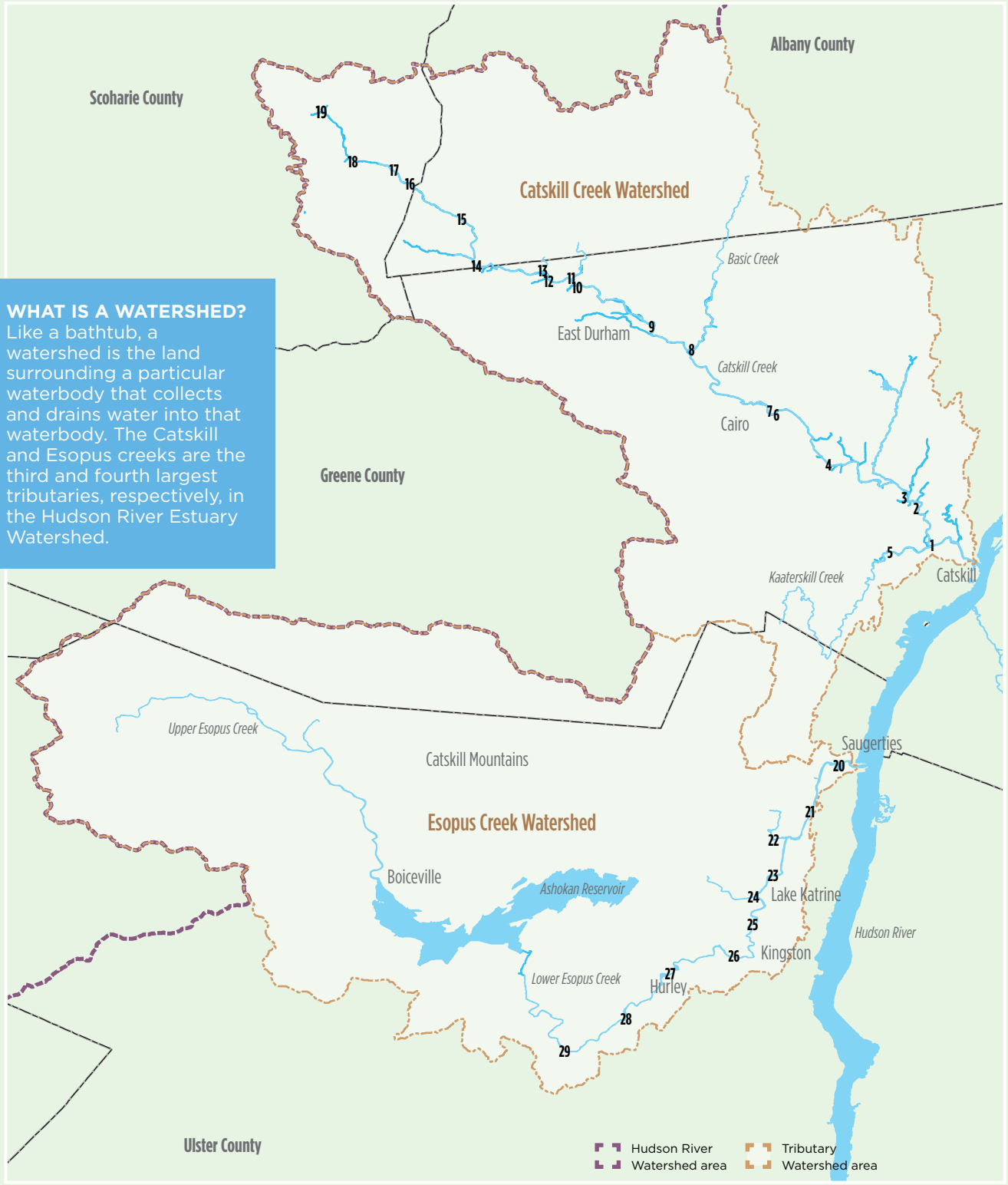
M = Main Channel / **N =** Near Shore / **O =** Sewage Treatment Plant Outfall / **T =** Tributary

● = Sites where rain has the most pronounced influence on water quality (an increase in GM of at least 30 comparing dry samples to wet)

HUDSON RIVER WATERSHED:
DATA BY SAMPLING SITE

CATSKILL CREEK AND ESOPUS CREEK

WHAT IS A WATERSHED?
Like a bathtub, a watershed is the land surrounding a particular waterbody that collects and drains water into that waterbody. The Catskill and Esopus creeks are the third and fourth largest tributaries, respectively, in the Hudson River Estuary Watershed.

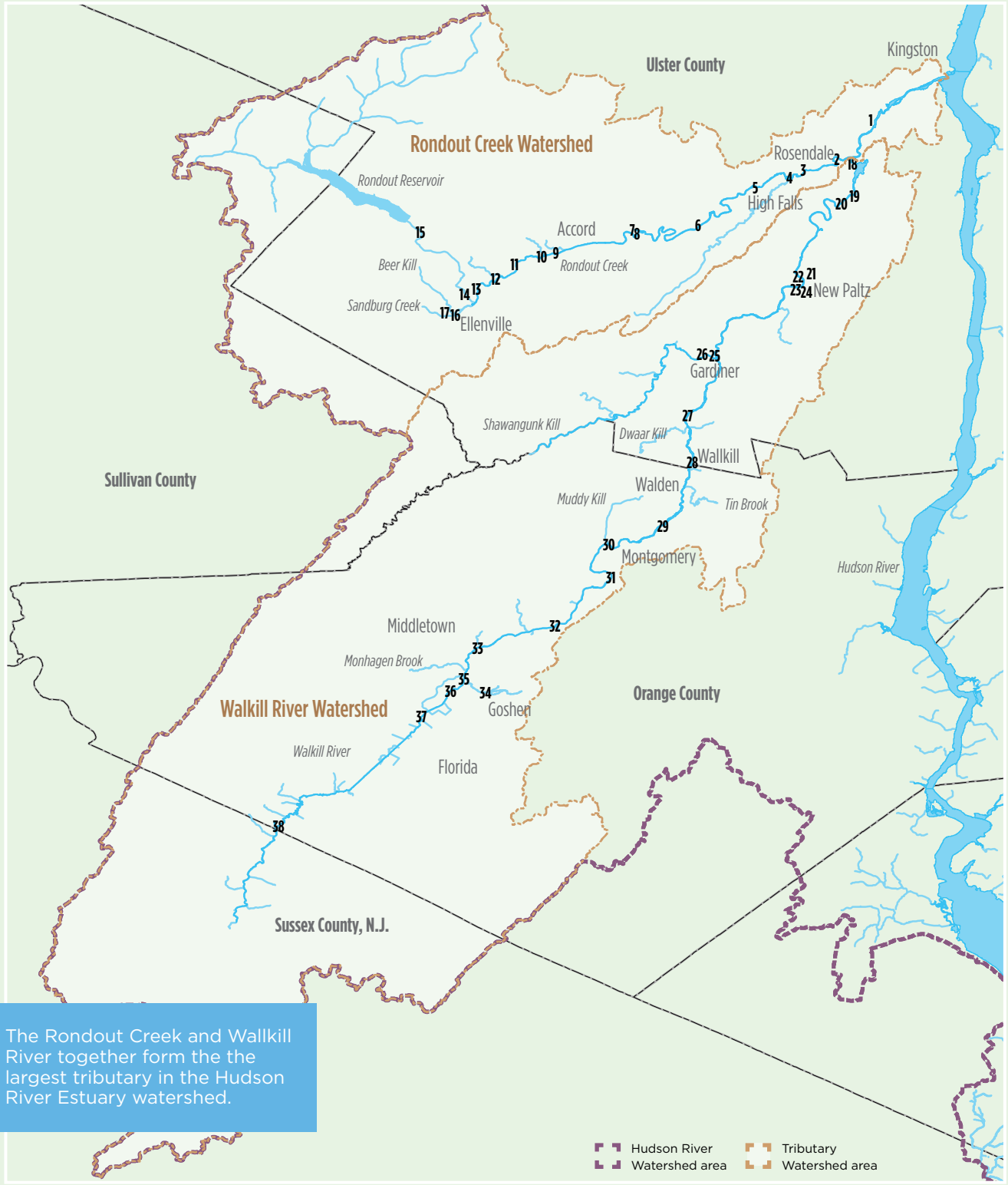


No	Site Name	# Samples	BAV	GM	% STV	Min	Max
CATSKILL CREEK							
1	Jefferson Heights – West Main Street	17	29% / 71%	27	12%	2	>2420
2	Cauterskill – Rt 23 Bridge swimming hole	16	19% / 81%	29	13%	3	>2420
3	Leeds – Fire Department intake	17	47% / 53%	59	24%	1	1986
4	South Cairo Bridge	17	47% / 53%	72	35%	7	>2420
5	Cauterskill – Kaaterskill Creek tributary	6	17% / 83%	60	17%	12	>2420
6	Cairo – Below STP outfall	6	17% / 83%	25	17%	3	1300
7	Cairo – Above STP outfall	6	33% / 67%	29	17%	3	816
8	Freehold – Basic Creek tributary	6	50% / 50%	94	17%	32	1553
9	East Durham – Route 67/67A swimming hole	6	33% / 67%	88	33%	11	>2420
10	Durham – Dean's Mill swimming hole	6	33% / 67%	52	17%	16	>2420
11	Durham – Ten Mile Creek tributary	6	33% / 67%	34	17%	1	1300
12	Oak Hill – Brandow Memorial Park	6	17% / 83%	48	17%	19	>2420
13	Oak Hill – Above Oak Hill	6	33% / 67%	52	17%	12	>2420
14	Potter Hollow – Route 145/81 fishing access	6	17% / 83%	28	17%	3	>2420
15	Preston Hollow – Cheese Hill Road fishing access	6	33% / 67%	44	17%	6	>2420
16	Livingstonville – CCC Camp Road fishing access	6	33% / 67%	68	33%	4	2420
17	Livingstonville – Route 145	6	50% / 50%	88	33%	12	1986
18	Livingstonville – Stone Store Road	6	50% / 50%	151	33%	17	>2420
19	Middleburgh – The Vlaie fishing & boating access	6	33% / 67%	41	17%	17	206
ESOPUS CREEK							
20	Saugerties Village Beach	19	26% / 74%	27	21%	1	517
21	Mt Marion – USGS Streamgage	19	42% / 58%	44	32%	2	921
22	Lake Katrine – Plattekill Creek tributary	6	33% / 67%	51	33%	13	365
23	Lake Katrine – Leggs Mill Bridge	19	53% / 47%	43	32%	3	816
24	Lake Katrine – Sawkill Creek tributary	6	67% / 33%	78	33%	12	548
25	Lincoln Park – Orlando Park	19	42% / 58%	54	26%	4	1300
26	Kingston – Washington Avenue Bridge	19	16% / 84%	34	16%	6	921
27	Hurley – Wyncoop Rd Bridge Fire Dept intake	19	32% / 68%	32	26%	1	>2420
28	Marbletown – Route 209 fishing access	5	100%	26	0%	16	36
29	Marbletown – Tongore Park swimming beach	19	16% / 84%	24	11%	2	1300

See "How to Read Riverkeeper's Data Charts," Page 11
All data gathered by community scientists.

■ **Acceptable** = Passes EPA guidelines for safe swimming. (Single-sample Entero counts 60 or less.)
■ **Beach Advisory** = Fails EPA's recommended Beach Advisory Value (BAV), and should result in closure of swimming area. (Single-sample Entero count greater than 60.)
GM (Geometric Mean) = Weighted average of Entero counts that dampens the effect of very high or low values. A GM of 30 or more indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
STV (Statistical Threshold Value) = Percentage of samples with Entero count above 110. Greater than 10% failure rate indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
Min = The lowest Entero count recorded at this site. / **Max =** The highest Entero count recorded at this site.

RONDOUT CREEK AND WALLKILL RIVER



The Rondout Creek and Wallkill River together form the the largest tributary in the Hudson River Estuary watershed.

No	Site Name	# Samples	BAV	GM	STV	Min	Max
RONDOUT CREEK							
1	Eddyville – Creek Locks fishing access	18	72% / 28%	149	50%	12	>2420
2	Tillson – NY Thruway Crossing	18	61% / 39%	151	44%	10	3448
3	Rosendale Trestle swimming hole	18	78% / 22%	246	72%	26	>2420
4	Rosendale – AJ Snyder Field swimming hole	18	78% / 22%	270	72%	21	>2420
5	High Falls swimming hole	18	67% / 33%	124	39%	8	>2420
6	Alligerville – Route 6 Bridge swimming hole	18	56% / 44%	119	50%	10	>2420
7	Accord – Rochester Creek tributary	18	61% / 39%	149	61%	14	3448
8	Accord – Route 209 & River Street	18	72% / 28%	117	56%	9	>2420
9	Kerhonkson – 42nd Street Bridge	18	72% / 28%	172	61%	9	>2420
10	Kerhonkson – Route 44/55 Bridge	18	83% / 17%	204	56%	29	>2420
11	Wawarsing – Foordemoore Road Bridge	18	89% / 11%	211	61%	41	>2420
12	Wawarsing – Port Ben Road	18	78% / 22%	212	67%	45	>2420
13	Napanoch – State Prison	18	72% / 28%	195	50%	37	2420
14	Napanoch – Route 209	17	71% / 29%	236	65%	13	>2420
15	Wawarsing – Below Rondout Reservoir	18	22% / 78%	35	17%	6	548
16	Ellenville – Sandburg Creek tributary	6	67% / 33%	163	50%	47	1120
17	Ellenville – Beer Kill tributary	18	61% / 39%	148	56%	7	>2420
WALKILL RIVER							
18	Tillson – Coutant Rd below Sturgeon Pool	18	44% / 56%	88	33%	2	>2420
19	Rifton – Cow Hough Road fishing access	18	72% / 28%	180	56%	10	>2420
20	Tillson – Rt 32 Bridge fishing access	18	67% / 33%	256	67%	15	4611
21	New Paltz – Mill Brook tributary	17	94% / 6%	560	82%	32	3076
22	New Paltz – Springtown Road boat launch	18	89% / 11%	397	83%	20	10462
23	New Paltz – Saw Mill Brook tributary	18	100%	598	94%	80	>2420
24	New Paltz – Plains Road boat launch	18	83% / 17%	297	72%	25	10462
25	Gardiner – USGS Streamgage	19	84% / 16%	383	79%	14	>2420
26	Gardiner – Shawangunk Kill tributary	18	89% / 11%	368	78%	36	9804
27	Shawangunk – Galeville Bridge	18	100%	506	89%	78	>2420
28	Shawangunk – Orange/Ulster Line fishing access	18	83% / 17%	221	67%	2	>2420
29	Montgomery – Riverfront Park fishing access	18	89% / 11%	571	89%	28	>2420
30	Montgomery – Benedict Farm Park floating dock	18	94% / 6%	504	89%	54	6488
31	Montgomery – I-84 Crossing	18	100%	712	83%	78	>2420
32	Middletown – Stony Ford Road	18	89% / 11%	505	89%	28	>2420
33	Middletown – Cemetery Road	18	100%	738	100%	137	6131
34	Goshen – Rio Grande tributary at Heritage Trail	18	100%	1369	100%	192	>2420
35	Goshen – Echo Lake Road	18	94% / 6%	533	94%	44	3784
36	Goshen – Route 6/17M	18	94% / 6%	712	89%	60	6867
37	Wawayanda – Pellets Island Bridge	18	94% / 6%	635	94%	32	4884
38	Unionville – National Wildlife Refuge	17	71% / 29%	260	65%	24	>2420

See "How to Read Riverkeeper's Data Charts," Page 11
All data gathered by community scientists.

■ **Acceptable** = Passes EPA guidelines for safe swimming. (Single-sample Entero counts 60 or less.)
■ **Beach Advisory** = Fails EPA's recommended Beach Advisory Value (BAV), and should result in closure of swimming area. (Single-sample Entero count greater than 60.)
GM (Geometric Mean) = Weighted average of Entero counts that dampens the effect of very high or low values. A GM of 30 or more indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
STV (Statistical Threshold Value) = Percentage of samples with Entero count above 110. Greater than 10% failure rate indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
Min = The lowest Entero count recorded at this site. / **Max =** The highest Entero count recorded at this site.

SPARKILL CREEK AND POCANTICO RIVER

The Sparkill Creek and Pocantico River are tributaries within the Hudson River watershed.

No	Site Name	# Samples	BAV	GM	STV	Min	Max
SPARKILL CREEK							
1	Piermont – Pirelli Park	10	30% / 70%	29	10%	<10	420
2	Piermont – Old Draw Bridge	18	94% / 6%	748	94%	31	>24196
3	Piermont – Skating Pond	18	100%	1454	100%	173	>2420
4	Sparkill – Route 340	18	100%	1305	100%	219	>2420
5	Tappan – Moturis	18	100%	1945	100%	238	>24196
6	Rockleigh, NJ – Sparkill Brook tributary	18	94% / 6%	1027	94%	50	>2420
7	Tappan – State Line	18	94% / 6%	1056	94%	49	>2420
8	Tappan – Oak Tree Road	18	94% / 6%	1082	89%	29	>2420
9	Tappan – Route 303	19	95% / 5%	922	95%	48	>2420
10	Orangeburg – Orangetown STP	17	94% / 6%	1005	94%	37	>2420
11	Orangeburg – Route 303/340	18	94% / 6%	1065	94%	49	>2420
12	Blauvelt – Blauvelt Arm tributary	18	100%	571	89%	96	>2420
13	Blauvelt – Clausland Arm	18	94% / 6%	772	89%	42	>2420
14	Blauvelt – Tackamack tributary	18	83% / 17%	184	56%	6	>2420
15	Orangeburg – Tackamack tributary	18	89% / 11%	341	67%	6	>2420
16	Blauvelt – Spruce Street	18	100%	1132	94%	89	>2420
17	Blauvelt – Marsico Court	18	89% / 11%	668	83%	30	>2420
POCANTICO RIVER							
18	Sleepy Hollow – Philipsburg Manor	18	89% / 11%	479	78%	7	>2420
19	Sleepy Hollow Cemetery	18	94% / 6%	457	83%	21	>2420
20	Sleepy Hollow – Rockefeller Park	18	83% / 17%	361	83%	13	>2420
21	Sleepy Hollow – Gory Brook tributary	18	78% / 22%	434	78%	6	>2420
22	Sleepy Hollow – DEP Spillway	18	89% / 11%	404	78%	28	>2420
23	Sleepy Hollow – Rockefeller Brook	5	100%	952	100%	281	>2420
24	Briarcliff Manor – Below Pocantico Lake	18	78% / 22%	314	78%	2	>2420
25	Briarcliff Manor – Caney Brook tributary	18	78% / 22%	475	67%	30	>2420
26	Briarcliff Manor – Above Pocantico Lake	18	89% / 11%	508	78%	50	>2420
27	Briarcliff Manor – Long Hill Road	18	72% / 28%	345	72%	13	>2420
28	Briarcliff Manor – North County Trail	18	89% / 11%	327	78%	24	>2420
29	Briarcliff Manor – Stone Creek Lane	18	83% / 17%	485	83%	24	>2420
30	New Castle – Echo Lake	17	71% / 29%	198	53%	12	>2420

See "How to Read Riverkeeper's Data Charts," Page 11
All data gathered by community scientists.

■ **Acceptable** = Passes EPA guidelines for safe swimming. (Single-sample Entero counts 60 or less.)
■ **Beach Advisory** = Fails EPA's recommended Beach Advisory Value (BAV), and should result in closure of swimming area. (Single-sample Entero count greater than 60.)
GM (Geometric Mean) = Weighted average of Entero counts that dampens the effect of very high or low values. A GM of 30 or more indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
STV (Statistical Threshold Value) = Percentage of samples with Entero count above 110. Greater than 10% failure rate indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
Min = The lowest Entero count recorded at this site. / **Max =** The highest Entero count recorded at this site.

NEW YORK CITY AREA

The East River, Harlem River, Newtown Creek and Gowanus Canal are part of the Hudson River Estuary.

* Yonkers sites are not depicted here, due to space.

No	Site Name	# Samples	BAV	GM	STV	Min	Max
NEW YORK CITY							
1	*Yonkers – JFK Marina boat launch	53	42% / 58%	37	28%	<10	6488
2	*Yonkers Paddling and Rowing Club	54	46% / 54%	44	24%	<10	>24196
3	*Yonkers – Saw Mill River, daylighted section	37	100%	697	100%	160	>24196
4	Inwood Canoe Club floating dock	53	32% / 68%	25	21%	<10	4884
5	Washington Heights – W 154th St, Riverside Park	18	78% / 22%	128	61%	10	862
6	West Harlem Piers Park kayak dock	36	56% / 44%	64	39%	<10	5247
7	Upper West Side – West 72nd Street kayak launch	24	58% / 42%	46	17%	<10	537
8	Upper West Side – Pier 96, Hudson River Park	16	19% / 81%	18	6%	<10	132
9	Hell's Kitchen – Pier 84, Hudson River Park	38	39% / 61%	43	24%	<10	2046
10	Hell's Kitchen – Pier 66, Hudson River Park	57	28% / 72%	19	16%	<10	2254
11	West Village – Pier 40 dock, Hudson River Park	59	14% / 86%	10	10%	<10	19863
12	Tribeca – Pier 26 dock, Hudson River Park	40	15% / 85%	17	13%	<10	1234
13	Hoboken – Pier 13	19	42% / 58%	44	16%	10	2187
14	Hoboken Cove Beach boathouse	18	50% / 50%	70	39%	<10	1455
15	Inwood – Harlem River, Muscota Marsh rowing dock	19	32% / 68%	49	21%	<10	6867
16	Inwood – Harlem River, P.J. Sharp Boathouse	39	51% / 49%	44	33%	<10	2603
17	NY Botanical Garden – Bronx River boat access	16	63% / 37%	99	50%	<10	>24196
18	Soundview – Bronx River, Starlight Park dock	31	94% / 6%	346	81%	20	>24196
19	Hunts Point Riverside Park Beach, Bronx River	32	94% / 6%	421	69%	41	>24196
20	Randall's Island – Bronx Kill, east landing	16	75% / 25%	152	69%	<10	15531
21	Randall's Island – Bronx Kill, west landing	27	85% / 15%	225	56%	20	>24196
22	Flushing Meadows – Willow Lake	13	92% / 8%	291	69%	10	1455
23	Flushing Bay, World's Fair Marina	58	43% / 57%	38	40%	<10	>24196
24	Astoria – East River, Hallets Cove beach	54	69% / 31%	105	46%	<10	3076
25	Long Island City – East River, Anable Basin dock	53	34% / 66%	32	21%	<10	24196
26	Long Island City – East River, Gantry State Park	18	22% / 78%	25	6%	<10	687
27	Greenpoint – Newtown Creek, N Brooklyn Boat Club	57	46% / 54%	39	30%	<10	19863
28	Alphabet City – East River, Stuyvesant Cove landing	58	47% / 53%	45	29%	<10	5172
29	Brooklyn Navy Yard – East River, Wallabout Channel	54	43% / 57%	42	28%	<10	>24196
30	Lower East Side – East River, Pier 42	58	28% / 72%	20	24%	<10	2143
31	Dumbo – East River, Main Street beach	49	35% / 65%	26	22%	<10	591
32	Financial District – East River, Brooklyn Br. beach	50	24% / 76%	22	8%	<10	305
33	Brooklyn Heights – East River, Pier 2 kayak dock	19	11% / 89%	5	11%	<10	201
34	Brooklyn Heights – East River, Pier 4 beach	19	37% / 63%	34	21%	<10	512
35	Red Hook – Valentino Pier beach	53	43% / 57%	47	26%	<10	1789
36	Gowanus Canal, 2nd Street boat launch	57	74% / 26%	241	58%	<10	>24196
37	Gowanus Canal, 4th Street, Vechtes Brook	20	85% / 15%	353	85%	<10	4106
38	Gowanus Canal, 2nd Avenue rain garden	37	81% / 19%	314	57%	10	>24196
39	Canarsie- Paerdegat Basin, Sebago Canoe Club	22	41% / 59%	65	32%	<10	>24196

See "How to Read Riverkeeper's Data Charts," Page 11
All data gathered by community scientists.

■ **Acceptable** = Passes EPA guidelines for safe swimming. (Single-sample Entero counts 60 or less.)
■ **Beach Advisory** = Fails EPA's recommended Beach Advisory Value (BAV), and should result in closure of swimming area. (Single-sample Entero count greater than 60.)
GM (Geometric Mean) = Weighted average of Entero counts that dampens the effect of very high or low values. A GM of 30 or more indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
STV (Statistical Threshold Value) = Percentage of samples with Entero count above 110. Greater than 10% failure rate indicates water does not meet EPA's recommended criteria for safe swimming, and appears in red.
Min = The lowest Entero count recorded at this site. / **Max =** The highest Entero count recorded at this site.

ACTION AGENDA

Our goal is not just to assess water quality — but to improve it. That will take actions from a broad set of stakeholders.

Swimmers in the Hudson River at Croton Point. *Photo Courtesy Toughman Triathlon*

1

IMPROVE MONITORING AND PUBLIC NOTIFICATION

County Health Departments and the Department of Environmental Conservation (DEC) need staff, budget and leadership from the Governor and Legislature to effectively protect the public's use of recreational water.

- **Sample water quality at least weekly[43] at public beaches and river pools**, expand testing in other waters designated for primary contact recreation, and post the data online immediately.
- **Develop models for public bathing areas based on high-frequency sampling data**, such as those in use today on Great Lakes, Long Island Sound and Atlantic coast beaches in New York. [44, 45]
- **Increase New York State's budget for monitoring pathogens in ambient water**, so impairments can be identified or verified and documented in the Waterbody Inventory and Priority Waterbodies List, and/or the 303(d) list of impaired waters.
- **Require wastewater treatment facility operators to test receiving waters**, in addition to testing the facilities' effluent.
- **Expand the Sewage Pollution Right to Know Law** to include all discharges of raw or partially treated sewage, with no exceptions, and set penalties to ensure compliance.

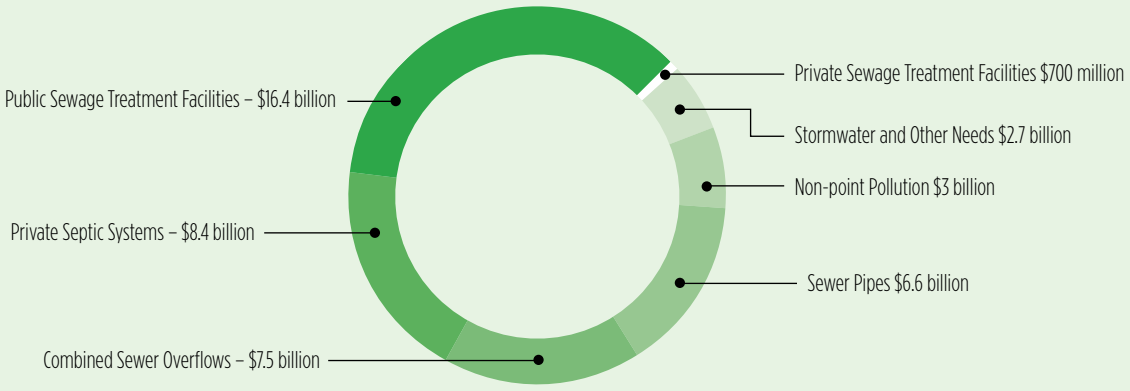
2

INVEST IN CLEAN WATER

The need for investments in wastewater infrastructure statewide, including for managing streetwater and farm runoff, has been estimated at $45 billion over 20 years.[46] The Governor and Legislature need to increase resources for DEC and other state and local partners.

- **Increase annual wastewater infrastructure funding by $800 million** to meet the documented annual need,[47] and exempt water and sewer investments from the 2% tax cap to remove a barrier to longterm investment.
- **Increase funding for the Environmental Protection Fund** to cover pollution control[48] and watershed planning.[49] Watershed plans should be consistent with the goals of the EPA's 9-element watershed planning process.[50]
- **Implement CSO Long Term Control Plans**, and re-invest where necessary if fully implemented plans fail to result in water quality that meets safe-swimming standards.
- **Adopt asset management strategies**, including mapping of wastewater and stormwater systems, so communities invest wisely in maintenance.
- **Disinfect effluent from sewage treatment facilities that lack disinfection**, including both public and private facilities, and prioritize UV disinfection over chlorination.
- **Implement best management practices for farms and animal feeding operations (AFOs)**, including runoff, erosion and manure management; and protection of streams and stream buffers.
- **Implement septic management programs** to ensure proper operation and maintenance.
- **Organize and support watershed groups** to effectively advocate for water quality protection and restoration.

NEW YORK STATE WASTEWATER INFRASTRUCTURE NEEDS



Source: NYS Department of Environmental Conservation, "Wastewater Infrastructure Needs of New York State," 2008

Urban Swim swimmers. *Photo courtesy Greg Porteus/Launch 5*

3

ENFORCE LAWS AND IMPROVE REGULATION

The Clean Water Act provides powerful tools for cleaning our waters. The DEC needs the resources and leadership from the Governor and Legislature to implement the law.

- **Restore and increase funding for the DEC Division of Water**, which has 30% fewer staff and about one-seventh the budget, in today's dollars, as it did a quarter century ago.[51]
- **Restore inspection, compliance and enforcement staff and budgets.** Over the last decade, staff reductions have disproportionately affected DEC's divisions of enforcement (down 18.6%) and air and water quality management (down 16.8%).[52]
- **Verify water quality impairments documented by citizen scientists**, list waters as appropriate on Priority Waterbodies List to give communities access to state grants or low-cost loans, or the 303(d) list to prioritize source trackdown and elimination.
- **Tighten existing State Pollution Discharge Elimination System (SPDES) permits** where discharges may cause exceedance of water quality standards, and increase effluent monitoring requirements to ensure compliance.[53]
- **Set protective recreational water quality standards consistent** with EPA recommendations.

Andy Juhl of Columbia University's Lamont-Doherty Earth Observatory works aboard the Riverkeeper patrol boat in 2014.
Photo by John Lipscomb/Riverkeeper

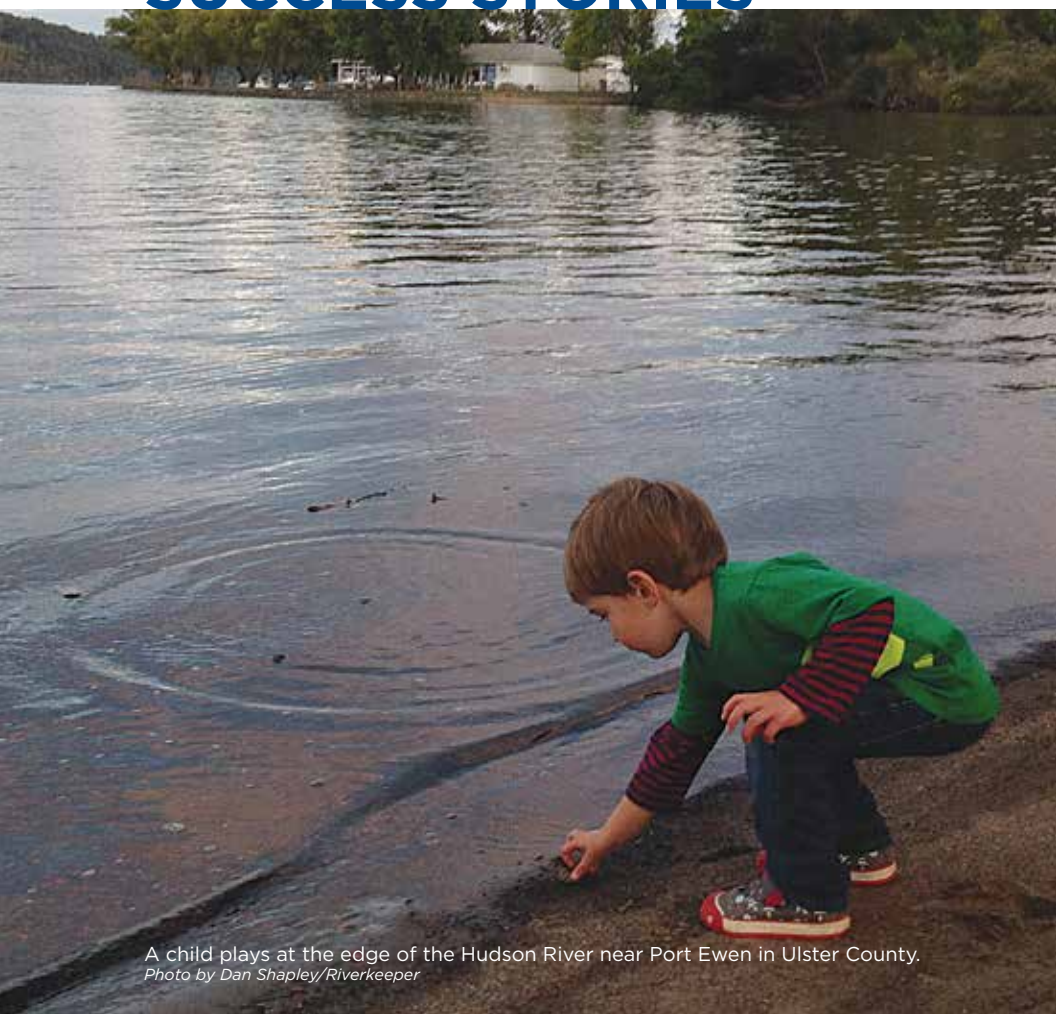
4

CONTINUE RESEARCH AND DEVELOP NEW SCIENCE-BASED TOOLS

Nationally, the scientific community needs to continue to address gaps in our understanding of water quality, how to test and model it, and how to restore waters. Some key needs include:

- **Increase Understanding of Fecal Indicators** – Study sediment transport, residence time and association with pathogens over time.
- **Develop New Fecal Indicators** – Both near-real time bacteriological tests and viral fecal indicators could be valuable tools in source trackdown and beach management.
- **Develop and Use Source Trackdown Techniques** – In waters where complex mixes of contaminant sources are suspected, the challenge of prioritizing projects to reduce pollution would be eased with source trackdown procedures and techniques.
- **Define Secondary Contact Standards** – People engaged in boating and other activities that involve wading and skin contact, but not fully body immersion or ingestion of water should know if primary contact recreation standards are applicable.
- **Understand Other Wastewater Contaminants** – Research is needed into the ecological and human health effects of wastewater-derived contaminants, including pharmaceuticals, personal care products and industrial wastes.

SUCCESS STORIES



A child plays at the edge of the Hudson River near Port Ewen in Ulster County.
Photo by Dan Shapley/Riverkeeper

Striped bass anglers dot the water in Newburgh Bay on the Hudson River in May 2014.
Photo by John Lipscomb/Riverkeeper

We follow a simple mantra: "Let the data do the talking." Where the data show problems, solutions often follow. It should be noted that in none of these cases were lawsuits filed or threatened; the Water Quality Program uses advocacy and communications as its main tools for effecting change. Here's a look at some of the accomplishments that have resulted, in whole or in part, from gathering and publicizing water quality data:

Infrastructure Investment

- The Governor and Legislature created a new $200 million grant program for drinking water and wastewater infrastructure in the FY2015 budget.
- The CSO Long Term Control Plan for the Capital District set as its goal "swimmable" water quality.
- Westchester County committed to a $9.9 million upgrade to a failing pumping station in Tarrytown.
- The Town of Catskill approved a sewer line extension to the hamlet of Leeds to replace failing septics there.
- The Town of Orangetown approved a $100,000 fix for a 50-year-old failing pump station on the Sparkill Creek.

Enforcement

- New York City found and eliminated an illegal sewer hookup that was contaminating Hallets Cove on the East River.
- The Department of Environmental Conservation prosecuted a polluter for an illegal hookup to a storm drain on the Catskill Creek.
- The City of Newburgh identified and eliminated several illegal sewer hookups to storm drains that had been contaminating the Hudson River.

Susan Antenen and James West sample the Pocantico River.
Photo by Tracy Brown/Riverkeeper

Public Notification

- The Sewage Pollution Right to Know Law has resulted in the public reporting of thousands of discharges, and the first-ever electronic public alerts.
- The Capital District and Kingston now report publicly online when sewage overflows.
- The Village of New Paltz has posted signs at village hall, on the Web and at public access points on the Wallkill River, to notify the public about testing data.

Watershed Protection efforts

- Water quality monitoring was the first project of the Sparkill Creek Watershed Alliance, which grows more sophisticated in its efforts to protect the creek each year.
- A Future of the Wallkill River event organized by the Village of New Paltz, SUNY New Paltz and others kicked off a new watershed protection effort.
- Environmental advisory boards in the Rondout Creek Watershed towns of Wawarsing, Rochester and Rosendale are creating a common stream walk protocol to investigate pollution and other creek issues.
- A new watershed planning effort is taking shape on the Pocantico River, following a Hudson River Watershed Alliance event.
- Several IDEXX Enterolert labs have been purchased to outfit labs in the Hudson River watershed. And Save the Sound, Charleston Waterkeeper, Peconic Baykeeper, EPA in Washington, D.C., and Waterkeepers Nepal have, or are interested in, starting similar sampling programs of their own.

Visit the Boat Blog at riverkeeper.org/patrol for more success stories and updates on the Water Quality Program.

WHAT YOU CAN DO

Kayakers get ready to clean trash from the banks of the Wallkill River as part of the 2015 Riverkeeper Sweep. *Photo by Dan Shapley/Riverkeeper*

At Home

- **Don't flush anything but toilet paper.** Many things—even facial tissues—can interfere with the mechanical or biological function of septic and sewer systems.
- **Inspect and pump your septic system.** If you don't rely on public sewers, it's your responsibility to prevent your waste from contaminating the water. For tips, visit water.epa.gov/infrastructure/septic
- **Conserve water.** The less water used at home, the less processed by the treatment plant. For tips, visit epa.gov/watersense
- **Keep yards and streets clean.** Rain and snow melt flush litter, oils, dog waste, lawn pesticides and fertilizers, and other pollution from our streets and yards into water. Keep your streets clean.

In Your Community

- **Get Involved.** Join your town's conservation advisory council, a watershed protection group, or a community science water quality sampling team.
- **Get Informed.** Sign up to receive Riverkeeper email alerts at tinyurl.com/rvk-eml, and state Sewage Pollution Right to Know discharge alerts at dec.ny.gov/chemical/90315.html.
- **Volunteer.** Join the Riverkeeper Sweep, our annual day of service for the Hudson River, a DEC Trees for Tribs planting or other activity to protect and restore a local stream.

With Riverkeeper

- **Report Pollution.** Timely reports are needed to identify and stop pollution.
- **Advocate.** Visit tinyurl.com/rvk-eml to sign up to receive action alerts.
- **Donate.** Support our work by making a donation at tinyurl.com/rvk-donate to become a Riverkeeper member.

DO NOT FLUSH THESE

- Baby wipes and diapers. Even those marked "flushable" should be tossed in the trash.
- Fats, oils, grease and food scraps. Toss them in the trash, or compost.
- Chemicals. Dispose of harsh cleaners, paints and solvents at community hazardous waste drop-off events.
- Trash. Feminine hygiene products, condoms, paper towels and dental floss should be tossed in the trash.
- Pharmaceuticals. Visit dec.ny.gov/chemical/63826.html to find secure drop off locations or events.

HOW TO MAKE A POLLUTION REPORT

Include these observations in your report:

- Date/Time/Weather Conditions
- Location
- Details – sight/smell/frequency
- Photos, video, narrative
- Your contact information

Send your reports promptly:

DEC Spills Hotline: 1-800-457-7362

Riverkeeper: 914-478-4501, ext 231

Report online: tinyurl.com/rvk-watchdog

APPENDIX
WATERBORNE ILLNESSES AND HUMAN HEALTH

Most waterborne disease-causing microorganisms are found in human and animal feces. A drop of fecal matter can contain millions of microorganisms of many types, some of which are disease-causing pathogens.[54]

The most common types of waterborne illnesses are short-term gastrointestinal infections that cause stomachaches and/or diarrhea. The elderly, children, pregnant women and people with compromised immune systems are at greater risk of getting sick.

A survey by the Center for Disease Control and Prevention found over 4,000 documented illnesses from recreational waters in the U.S. in 2005-2006.[55] However this number is assumed to be low because waterborne illnesses are underreported. The EPA has estimated that as many as 3.5 million Americans are sickened each year from contact with recreational water. People often associate the most common ailments with what they ate for lunch instead of contact with water. Still, reports of illness resulting from swimming are on the rise.

ACUTE AND CHRONIC HEALTH EFFECTS ASSOCIATED WITH WATERBORNE PATHOGENS[56]

TYPE and AGENT	ACUTE EFFECTS	CHRONIC OR ULTIMATE EFFECTS
BACTERIA		
E. coli O157:H7	Diarrhea	Adults: death (thrombocytopenia)
Legionella pneumoniae	Fever, pneumonia	Elderly: death
Helicobacter pylori	Gastritis	Ulcers and stomach cancer
Vibrio cholerae	Diarrhea	Death
Vibrio vulnificus	Skin & tissue infection	Death in those with liver disorders or problems
Campylobacter	Diarrhea	Death: Guillain-Barré syndrome
Salmonella	Diarrhea	Reactive arthritis
Yersinia	Diarrhea	Reactive arthritis
Shigella	Diarrhea	Reactive arthritis
Cyanobacteria (blue-green algae) and their toxins	Diarrhea	Potential cancer
Leptospirosis	Fever, headache, chills, muscle aches, vomiting	Weil's Disease, death (not common)
Aeromonas hydrophila	Diarrhea	
PARASITES		
Giardia lamblia	Diarrhea	Failure to thrive, lactose intolerance, severe hypothyroidism, joint pain
Cryptosporidium	Diarrhea	Death in immune-compromised host
Toxoplasma gondii	Newborn syndrome, hearing and vision loss, brain damage, diarrhea	Dementia and/or seizures
Acanthamoeba	Eye infections	
Microsporidia (Enterocytozoon & Septata)	Diarrhea	
VIRUSES		
Hepatitis viruses	Liver infection	Liver failure
Adenoviruses	Eye infections, diarrhea	
Calici-, Norwalk and small round structured viruses	Diarrhea	
Coxsackie viruses	Encephalitis, aseptic meningitis, diarrhea, respiratory disease	Heart disease (Myocarditis), reactive insulin-dependent diabetes
Echoviruses	Aseptic meningitis	

ENDNOTES

1 Riverkeeper research, based on published result and personal communications with the organizers of 36 swim events.

2 Riverkeeper has documented swimming and other primary contact recreation throughout the Hudson River estuary during 15 years of monthly boat patrols of from New York City to Waterford.

3 Riverkeeper, "Communities Need $12.7 billion in State Aid to Protect Clean Water," analysis of 2015 Multi Year Intended Use Plan for State Clean Water Revolving Loan Fund, http://www.riverkeeper.org/news-events/news/water-quality/communities-need-12-7-billion-in-state-aid-to-protect-clean-water/

4 We use the term "streetwater" instead of "stormwater" because it evokes the mix of contaminants found in urban runoff.

5 We use the term "community science" rather than the more commonly used "citizen science" because it better reflects the community groups that typify the partners we work with.

6 Riverkeeper analysis of State Pollution Discharge Elimination System (SPDES) permits.

7 In addition to New York City and northern New Jersey communities, the DEC identifies 475 regulated municipal separate storm sewer system (MS4) areas in 150 Hudson River Estuary watershed communities. Each has multiple outfalls, and there are also many unregulated separate stormwater systems.

8 An estimated 484,000 septic systems are present in counties that are part of the Hudson-Mohawk watershed, according to unpublished research, presented at the 2014 Community Development Institute, September 2014. Vedachalam, S., Joo, T. and Riha, S.J. Using Geospatial Data to Analyze Trends in Onsite Wastewater Systems Use. Manuscript in preparation. Ithaca, NY: Cornell University.

9 As of 2007, there were 5,326 farms in the Hudson Valley counties between Washington and Saratoga in the north, and Rockland and Westchester in the South, according to "The State of Agriculture in the Hudson Valley," Glynwood, 2010, last accessed at http://www.glynwood.org/files/2011/02/State_of_Ag_2010.pdf

10 Riverkeeper, Boat Blog, "Using the Clean Water Act to Address Pathogen Pollution" http://www.riverkeeper.org/patrol/using-the-clean-water-act-to-address-pathogen-pollution

11 "The size of the DEC workforce declined 10.4 percent, from 3,256 full-time equivalents (FTEs) in SFY 2003-04 to 2,917 FTEs in SFY 2013-14," New York State Comptroller, "Environmental Funding in New York State," December 2014. www.osc.state.ny.us/reports/environmental/environmental_funding_nys_2014.pdf

12 Other Riverkeeper programs focus on identification and reduction of toxic pollution. See http://www.riverkeeper.org/campaigns/stop-polluters/contaminated-sites/

13 EPA Enforcement Compliance History Online (ECHO), analysis February-March 2015. http://echo.epa.gov/

14 ibid

15 ibid

16 State Pollution Discharge Elimination System (SPDES) Permits are renewed every five years (or 10, for groundwater discharges), with full technical reviews done of a subset of permits based on the DEC's Environmental Benefit Permit Strategy. Modifications are proposed for this subset of permits based on "a change in regulations, a change in the operation of the industry or compliance issues." http://www.dec.ny.gov/docs/water_pdf/togs122.pdf

17 New York City Department of Environmental Protection, "2013-2014 MS4 Draft Annual Report," www.nyc.gov/html/dep/pdf/ms4/nycdep_ms4_annual_report_2014_draft.pdf

18 See Endnote 7 Also see http://crreo.newpaltz.edu/ms4 to see outfalls in Dutchess, Orange and Ulster counties.

19 "FIB concentrations in wet weather urban discharges from separate storm sewer systems are typically orders of magnitude above primary contact recreation standards, regardless of the land use." "Pathogens in Urban Stormwater Systems," August 2014, Urban Water Resources Research Council of the Environmental and Water Resources Institute of the American Society of Civil Engineers, Page xix

20 "Pathogens in Urban Stormwater Systems," August 2014, Urban Water Resources Research Council of the Environmental and Water Resources Institute of the American Society of Civil Engineers

21 Based on unpublished research by Dr. Greg O'Mullan.

22 "Pollutants that result from farming and ranching include sediment, nutrients, pathogens, pesticides, metals, and salts." EPA, Nonpoint Source Factsheet http://water.epa.gov/polwaste/nps/agriculture_facts.cfm

23 See Endnote 9.

24 "EPA's research also indicates that some nonhuman fecal sources (cattle in particular) may pose risks comparable to those risks from human sources." EPA, 2012 Recreational Water Quality Criteria, Page 37, http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/RWQC2012.pdf

25 Increasingly, regulators refer to these as "onsite wastewater treatment systems."

26 See Endnote 8

27 EPA, "Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems," http://water.epa.gov/scitech/wastetech/upload/septic_guidelines.pdf

28 EPA, "Frequently asked questions and answers for the Decentralized (Septic) Program," http://water.epa.gov/infrastructure/septic/FAQs.cfm#faq15

29 Top Ten Water Quality Issues in New York State, http://www.dec.ny.gov/docs/water_pdf/305btopten10.pdf

30 "The first step in addressing [fecal indicating bacteria] impairments is to inventory the various [fecal indicating bacteria] sources specific to the watershed, and prioritize human [fecal indicating bacteria] sources first, given the greater public health risks they may present." Urban Water Resources Research Council of the Environmental and Water Resources Institute of the American Society of Civil Engineers "Pathogens in Urban Stormwater Systems," August 2014, , page xix

31 "Human pathogens are present in animal fecal matter, and there is, therefore, a potential risk from recreational exposure to human pathogens in animal-impacted waters that must be accounted for in the 2012 [Recreational Water Quality Criteria]. For waters dominated by nonhuman sources and in the absence of site-specific criteria, EPA recommends that the national criteria be used to develop [Water Quality Standards] for all waters including those impacted by point and nonpoint sources." EPA, 2012 Recreational Water Quality Criteria, page 38 http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/RWQC2012.pdf

32 "EPA recommends using the fecal indicator bacteria (FIB) enterococci and Escherichia coli (E. coli) as indicators of fecal contamination for fresh water and enterococci for marine water." USEPA Recreational Water Quality Criteria, 2012, Page 2, http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/RWQC2012.pdf

33 U.S. Environmental Protection Agency (EPA), Notice of Proposed Rulemaking, NPDES Permit Requirements for Municipal Sanitary Sewer Collection Systems, Municipal Satellite Collection Systems, and Sanitary Sewer Overflows, January 4, 2001, withdrawn January 20, 2001.

34 IDEXX Enterolert, https://www.idexx.com/water/products/enterolert.html

35 "Quality Assurance Project Plan Citizen Science Water Quality Testing Program" and "Quality Assurance Project Plan Hudson River Water Quality Testing Program" are available at http://www.riverkeeper.org/water-quality/testing/

36 EPA, 2012 Recreational Water Quality Criteria, http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/RWQC2012.pdf

37 "Primary contact recreation typically includes activities where immersion and ingestion are likely and there is a high degree of bodily contact with the water, such as swimming, bathing, surfing, water skiing, tubing, skin diving, water play by children, or similar water-contact activities." Ibid. Page 6.

38 Ibid. Page 6

39 Ibid. Page 38

40 "EPA's 2012 RWQC are for all waters in the United States including marine, estuarine, Great Lakes, and inland waters that are designated for primary contact recreation." Ibid. Page 6.

41 The tidal portions of the Catskill, Esopus and Rondout creeks are part of the Hudson River Estuary, which is class A in this stretch, but the creeks are designated Class C. The Gowanus Canal and Newtown Creek are Class SD.

42 Four exceptions include Tarrytown Marina (33 samples), Gowanus Canal (36 samples) and the two Newtown Creek locations (51 samples).

43 "When identifying sampling frequency as part of a state's monitoring plan, a state may consider that, typically, a larger dataset will more accurately characterize the water quality in a waterbody, which may result in more meaningful attainment determinations. Therefore, EPA is recommending that states conduct at least weekly sampling to evaluate the GM and STV over a 30-day period and encourages more frequent sampling at more densely populated beaches." EPA 2012 Recreational Water Quality Criteria, Page 42.

44 See National Association of City and County Health Organizations, "Statement of Policy on Recreational Water Safety" www.riverkeeper.org/wp-content/uploads/2015/03/NACCHO-15-01-recreational-water-safety-march-2015.pdf

45 EPA, "Models for Predicting Beach Water Quality," http://www2.epa.gov/beach-tech/models-predicting-beach-water-quality

46 NYS Department of Environmental Conservation, "Wastewater Infrastructure Needs of New York State" http://www.dec.ny.gov/docs/water_pdf/infrastructurerpt.pdf

47 NYS Comptroller, "Growing Cracks in the Foundation: Local Governments Still Challenged to Keep Up with Local Infrastructure Needs" http://www.osc.state.ny.us/press/releases/sept14/090914b.htm

48 The Environmental Protection Fund lines should be increased for "Wastewater Treatment Improvement Projects," "Non-Agricultural non-point Source Abatement and Control Projects" and "Agricultural non-point Source Abatement and Control Projects."

49 Including the Department of Environmental Conservation's Hudson River Estuary and Water Quality Improvement Project programs, and the Department of State's Local Waterfront Revitalization Program.

50 EPA, "Nine Minimum Elements to Be Included in a Watershed Plan for Impaired Waters Funded Using Incremental Section 319 Funds" http://www.epa.gov/region9/water/nonpoint/9elements-WtrshdPlan-EpaHndbk.pdf

51 DEC Division of Water presentation to Water Management Advisory Committee, Nov. 20, 2014

52 While the number of facilities with water discharge permits in significant non-compliance rose 18.6% from 2010 to 2014, the number of enforcement actions fell 64.2%. NYS Comptroller, "Environmental Funding in New York State," December 2014, www.osc.state.ny.us/reports/environmental/environmental_funding_nys_2014.pdf

53 Sampling frequency for fecal indicating bacteria at municipal wastewater treatment plants is determined by a 1973 agreement between the Environmental Protection Agency and Department of Environmental Conservation that sets limits based on the volume of discharge, with the smallest plants required to test effluent only twice per year. DEC, "Division of Water Technical and Operational Guidance Series (1.3.3) SPDES PERMIT DEVELOPMENT FOR POTWS" Appendix A www.dec.ny.gov/docs/water_pdf/togs133.pdf

54 Rose, J.B., et al., "Microbial Pollutants in Our Nation's Waters: Environmental and Public Health Issues, American Society for Microbiology, Washington, D.C., 1999, p. 8.

55 Yoder, J., et al., Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water Use and Other Aquatic Facility-Associated Health Events, Center for Disease Control, Washington D.C., 2008.

56 Centers for Disease Control and Prevention. Emerging Infectious Diseases, vol. 3, no. 4, Oct-Dec 1997.