New York City Department of Environmental Protection

# Filtration Avoidance Annual Report

**for the period January 1 through December 31, 2012**

**March 2013**

***Prepared in accordance with the July 2007 Filtration Avoidance Determination***


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# 1. Introduction

In 2012, New York City continued to implement a broad array of initiatives as part of the City's source water protection program. It marked the 16th year of program implementation since the signing of the landmark Watershed Memorandum of Agreement (MOA) in 1997. Further, January 2013 marked the 20th anniversary of the issuance of the first Filtration Avoidance Determination (FAD) for the New York City Department of Environmental Protection's (DEP) Catskill/Delaware Water Supply. Since then, DEP has committed more than $1.5 billion in capital funds, plus significant annual expenses and countless staff hours, to sustain the pristine quality of the source waters of the Catskill and Delaware watersheds.

Founded on the notion that the most cost-effective way to provide high quality water is to protect it at its natural source, DEP's programs have become a national and international model. Each year water and public health professionals come from around the globe to study the City's source water protection strategies. A key element of the success of the program has been the development of strong relationships with watershed communities, locally-based organizations, environmental groups, and federal, state, and local government agencies.

In October 2012, DEP was awarded the 2012 Association of Metropolitan Water Agencies (AMWA) Platinum Award for utility excellence. The Platinum Award recognizes outstanding achievement in implementing the *Attributes of Effective Utility Management* – nationally recognized industry standards that focus on product quality, customer satisfaction, employee and leadership development, operational optimization, financial viability, infrastructure stability, operational resiliency, community sustainability, water resource adequacy, and stakeholder understanding and support. Among other DEP accomplishments, the award cited DEP's comprehensive and innovative source water protection efforts.

The cornerstone of DEP's source water protection program is extensive research by DEP scientists into existing and potential sources of water contamination. As part of DEP's source water monitoring program, tens of thousands of samples are collected annually throughout the watershed. Each year DEP performs hundreds of thousands of laboratory analyses. Based on the information collected through its monitoring and research efforts, DEP has crafted a watershed protection strategy that focuses on implementing initiatives that are both protective (antidegradation) and remedial (specific actions designed to reduce pollution generated from identified sources).

In the late 1980s and early 1990s, DEP's assessment of potential sources of pollutants pointed to several key areas: waterfowl on the reservoirs, wastewater treatment plants discharging into watershed streams, farms located throughout the watershed, and stormwater runoff from development. DEP's protection strategy targets and has had significant success controlling these primary pollution sources, as well as a number of secondary ones.

In 2011, DEP completed its most recent Watershed Protection Program Summary and Assessment (the Assessment) (DEP 2011a), and submitted a revised Long-Term Watershed Protection Plan (the Plan) (DEP 2011b). The Assessment summarized the past five years of implementation of the watershed program, and provided an in-depth analysis of water quality status and trends. All signs point to the continued effectiveness of the City's overall program: source water quality remains high. The Plan laid out DEP's proposed source water protection activities for 2012 through 2017, the second five years of the current FAD. The Plan builds on the existing programs and includes significant commitments to continue implementation in the coming five years. DEP had anticipated that an update to the 2007 FAD, based on the 2011 Plan, would be issued in 2012. While the FAD update did not occur, DEP has continued to implement the core components of the watershed protection program without interruption.

Continued tough economic times keep pressure on resources at DEP. The agency strives to balance the need for strong source water protection and construction and maintenance of critical infrastructure with efforts to keep water rates affordable. During 2012, DEP sought ways to improve efficiency while continuing steady implementation of critical watershed protection projects. While New York City continues to dedicate significant funding and personnel to the watershed program, each program element will continue to be evaluated critically to ensure that resources are being deployed in the most effective and cost-effective way.

This annual report covers the period January 1, 2012, through December 31, 2012, and is compiled to satisfy the requirements of the 2007 FAD. Material in this report is organized to parallel the sections of the FAD.

While the report focuses primarily on the efforts of New York City, it is important to recognize that DEP works in partnership with many agencies, organizations, and communities throughout the region to achieve its goals (Figures 1.1 and 1.2). These partnerships are vital to the continued success of the source water protection program and recognize the need to strike a balance between protecting water quality and the fact that the watershed is home to tens of thousands of people. The contributions of many of these groups are acknowledged throughout this report. The other private, governmental, community, academic, and non-profit entities that share a role in this complex effort are too numerous to list. However, DEP gratefully acknowledges their ongoing help and support.

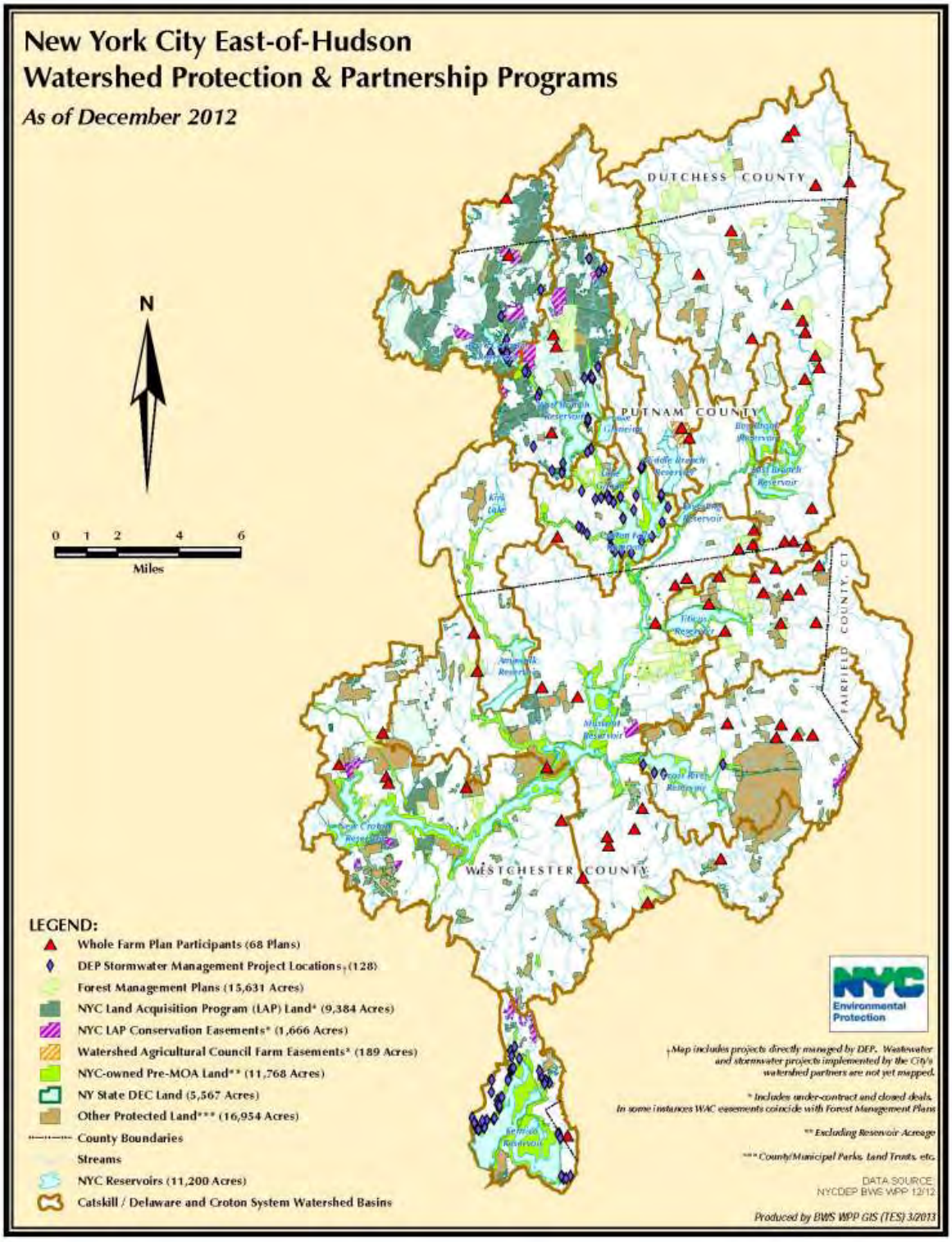


Figure 1.1. New York City East of Hudson Watershed Protection and Partnership Programs as of December 2012.

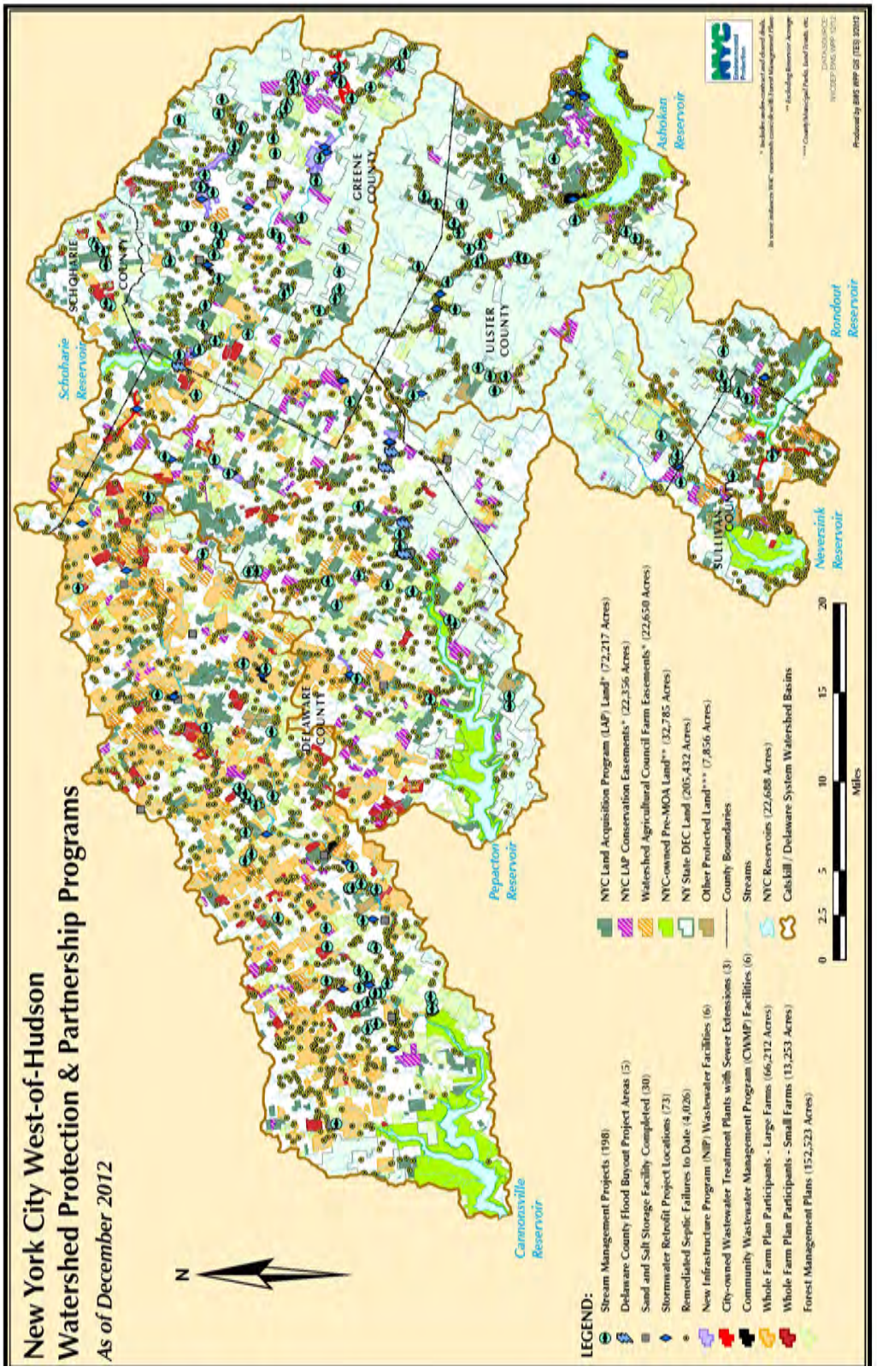


Figure 1.2. New York City West of Hudson Watershed Protection and Partnership Programs as of December 2012.

# 2. Federal and State Objective Water Quality Compliance

During 2012, DEP continued its comprehensive water quality monitoring efforts. New York City's (the City's) sampling program is far more extensive than is required by federal or state law. Each year, the City collects tens of thousands of samples in the watershed and in the distribution system. In 2012, DEP collected 50,165 samples and conducted 579,460 analyses. Of these, 30,236 samples were collected and 355,647 analyses were completed within the City. Once again, the results were impressive: the City complied with the objective criteria of the Surface Water Treatment Rule (SWTR) (USEPA 1989), and only 0.3% of the 9,873 in-City compliance samples analyzed pursuant to the Total Coliform Rule (TCR) were total coliform positive. All samples were negative for *E. coli*. Since 1995, DEP has collected more than 190,229 TCR compliance samples, and only 14 of them have tested positive for *E. coli*.

On the tenth of every month, DEP provides both USEPA and NYSDOH with the results of its enhanced monitoring program, developed to comply with the requirements of the SWTR, the TCR, and other federal regulations that have been in effect since 1991. The City, as an unfiltered surface drinking water supplier, must meet these objective criteria. The information provided below summarizes compliance monitoring conducted during the year.

## 2.1 SWTR Monitoring and Reporting

SWTR monitoring includes raw water monitoring for fecal coliform concentrations, turbidity, and disinfection/contact time (CT) values; entry point monitoring for chlorine residuals; distribution system monitoring for chlorine residuals and coliform bacteria levels; and quarterly monitoring in the distribution system for trihalomethanes and haloacetic acids. In 2012, with the exception of a single turbidity sample, all monitoring samples complied with thresholds defined by the SWTR.

### 2.1.1 Raw Water Fecal Coliform Concentrations (40 CFR Section 141.71 (a)(1))

Both the Catskill and Delaware Aqueduct effluents from Kensico Reservoir exhibited fecal coliform concentrations in water prior to disinfection at levels less than or equal to 20 fecal coliforms $100ml^{-1}$ in at least 90% of the samples collected during the year, as calculated by six-month running percentages. In fact, the running percentage of samples for the Catskill and Delaware Systems never fell below 93.9% and 93.5%, respectively.

As shown in Figures 2.1 and 2.2, in 2012 the six-month running percentages of positive raw water fecal coliform samples at both the Catskill and Delaware Aqueduct effluents from Kensico Reservoir were well below the maximum percentage of positive samples allowed under the SWTR.

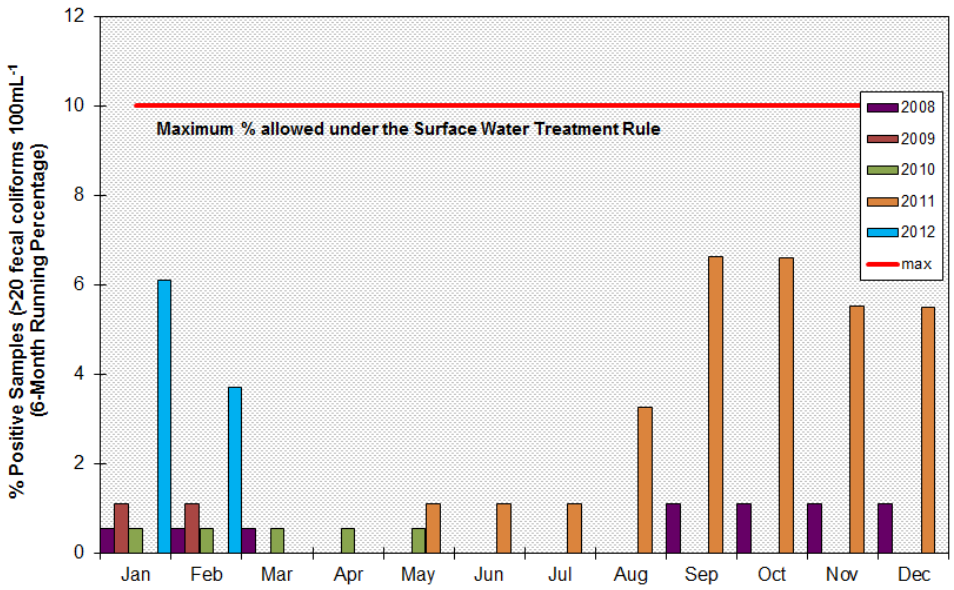


Figure 2.1. Positive fecal coliform samples, Kensico-Catskill System, 2008-2012.

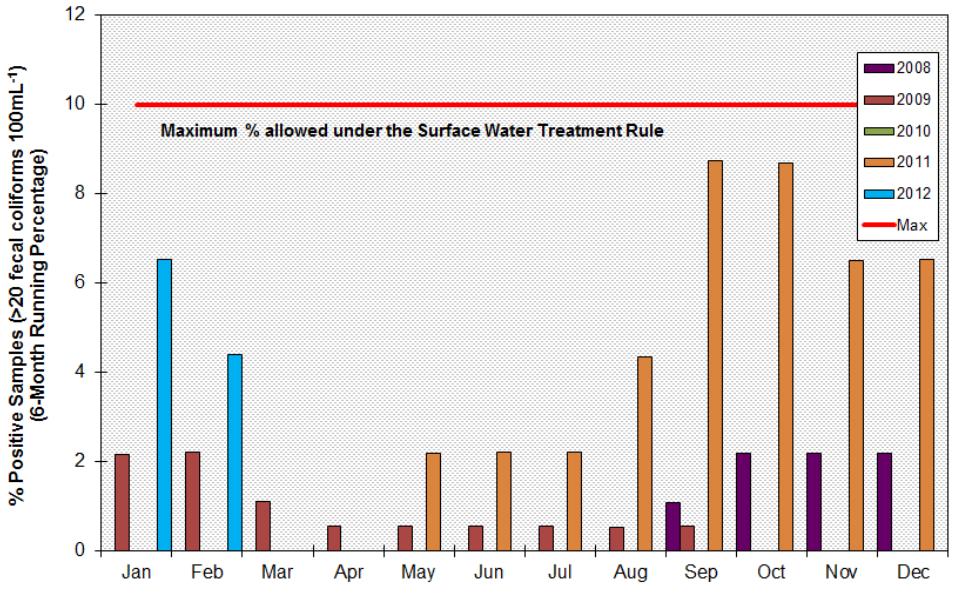


Figure 2.2. Positive fecal coliform samples, Kensico-Delaware System, 2008-2012.

### 2.1.2 Raw Water Turbidity (40 CFR Section 141.71(a)(2))

Both the Catskill and Delaware Aqueduct effluents from Kensico Reservoir exhibited turbidity levels less than or equal to 5 NTU in water prior to disinfection for the entire 2012 calendar year, with one exception. As a result of high winds from Hurricane Sandy, the 4-hour turbidity compliance sample collected at 8:00 pm at Delaware Shaft 18 on October 29 had a turbidity of 6.0 NTU (Figure 2.3). An hour and a half previously, at 6:31 pm, Operations had begun the process of placing Kensico Reservoir on float mode in an effort to reduce turbidity, but because of the time it took to complete bypass operations, it was not possible to prevent the violation from occurring. The violation lasted for approximately 105 minutes, after which turbidity decreased to less than 5 NTU. The highest turbidity value recorded during that time was 10.7 NTU. (Note that because this was not a compliance measurement, i.e., one of the measurements taken at 4-hour intervals that must be reported to NYSDOH, it is not reflected in Figure 2.3.) In accordance with the New York State Sanitary Code 10 NYCRR Section 5-l.77, DEP notified NYSDOH within 24 hours of this exceedance. A Tier 2 Treatment Technique Violation was issued by NYSDOH on November 5, 2012.

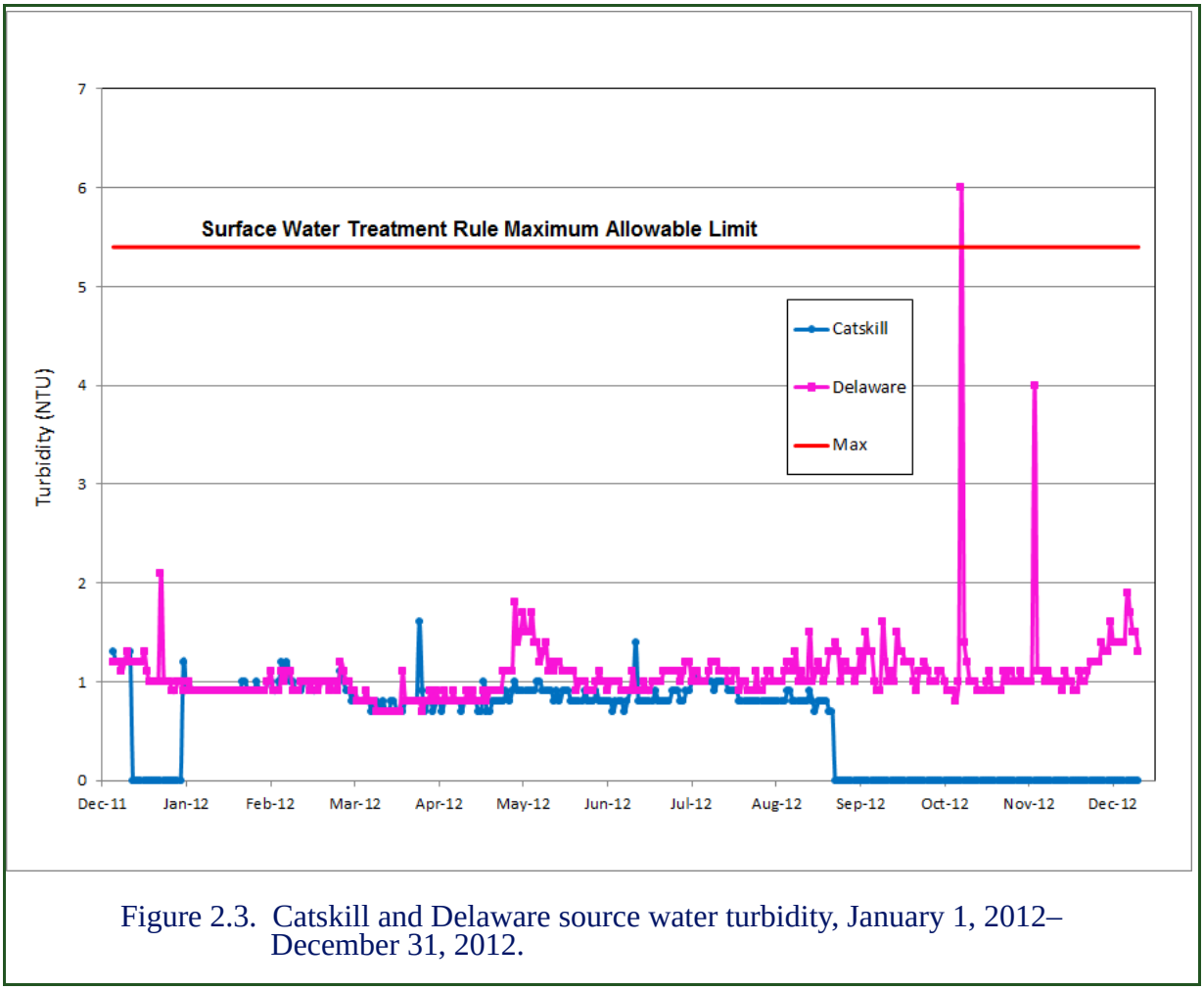


Figure 2.3. Catskill and Delaware source water turbidity, January 1, 2012–December 31, 2012.

### 2.1.3 Raw Water Disinfection/CT Values (40 CFR Sections 141.71(b)(1)(i) and 141.72(a)(1))

CT values recorded each day during the year for the Catskill and Delaware Systems produced net inactivation ratios greater than or equal to 1.0. The actual lowest net inactivation ratio in 2012 was 1.3 for the Catskill System and 1.0 for the Delaware System.

### 2.1.4 Entry Point Chlorine Residual (40 CFR Sections 141.71(b)(1)(iii) and 141.72(a)(3))

Chlorine residuals were maintained at concentrations at or above 0.20 mg $L^{-1}$ at all distribution entry points during the year. The lowest chlorine residual measured at an entry point was 0.31 mg $L^{-1}$.

### 2.1.5 Distribution System Disinfection Residuals (40 CFR Sections 141.71(b)(1)(iv) and 141.72(a)(4))

All chlorine residuals for the 14,867 samples measured within the distribution system during the year were detectable.

### 2.1.6 Trihalomethane Monitoring (40 CFR Section 141.71(b)(6)) and HAA5 Monitoring (40 CFR Section 141.171)

The analysis for trihalomethanes, performed on a quarterly basis, resulted in a maximum total trihalomethane (TTHM) value of 55 µg $L^{-1}$. The analysis for haloacetic acids, also performed on a quarterly basis, resulted in a maximum haloacetic acid five (HAA5) value of 64 µg $L^{-1}$.

The highest TTHM quarterly running average during the year, recorded during the first quarter, was 53 µg $L^{-1}$ for the Catskill/Delaware Distribution Area, a level below the regulated level of 80 µg $L^{-1}$. The highest HAA5 quarterly running average during the year, recorded during the first quarter, was 51 µg $L^{-1}$, a level below the regulated level of 60 µg $L^{-1}$.

## 2.2 Total Coliform Monitoring

### 2.2.1 Monthly Coliform Monitoring (40 CFR Section 141.71(b)(5))

Within the distribution system, coliform monitoring indicated monthly levels of total coliforms below the 5% maximum set forth in the TCR (Figure 2.4). The number of compliance samples analyzed for total coliform was 9,873, of which 30 were total coliform positive. All resamples were coliform negative with four exceptions, two in July from the same location and two in September from different locations. The second round of resampling was coliform negative for all locations. All samples were *E. coli* negative for the year. The annual percentage of compliance samples that were total coliform positive was 0.3% and the highest monthly average was 0.96%.

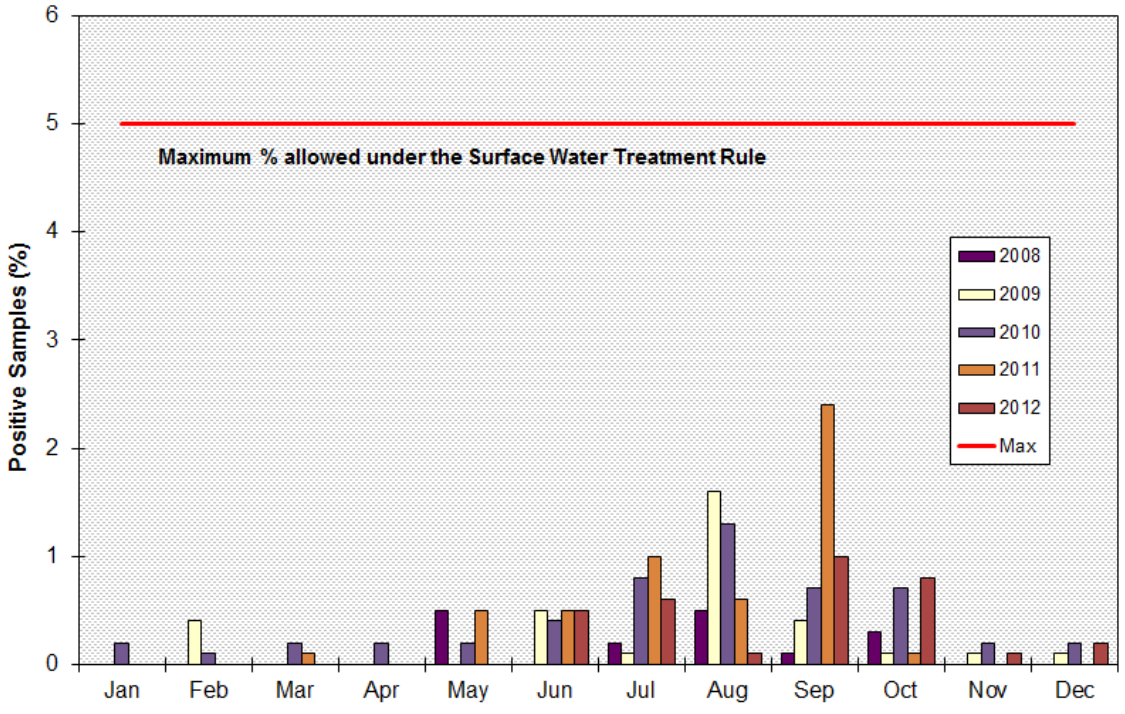


Figure 2.4. Positive total coliform samples, NYC distribution system, 2008-2012.

### 2.2.2 Chlorine Residual Maintenance in the Distribution System

During the year, DEP continued a number of programs to ensure adequate levels of chlorine throughout the distribution system. These included: (1) maintaining chlorination levels at the distribution system's entry points, (2) conducting spot flushing when necessary, and (3) providing local chlorination booster stations at remote locations. Four permanent chlorination booster stations were operated during the year to improve the chlorine residual levels for the Fort Tilden, Roxbury, and Breezy Point areas (Rockaway Peninsula) in Queens; City Island in the Bronx; Floyd Bennett Field in Brooklyn; and Staten Island. As a result of these steps, detectable chlorine residuals were maintained throughout the distribution system in 2012.

# 3. Environmental Infrastructure

## 3.1 Septic Programs

### 3.1.1 Septic Rehabilitation and Replacement Program

Since 1997, New York City has committed $54.6 million in funding to rehabilitate, replace, and upgrade septic systems serving single- or two-family homes in the City's West of Hudson (WOH) watershed.

The Septic System Rehabilitation and Replacement Program is managed by the Catskill Watershed Corporation (CWC), a local not-for-profit organization created to manage watershed partnership and protection programs. It includes the following sub-programs: the Priority Area Program, the Hardship Program, and the Reimbursement Program.

The Priority Area Program is an inspection and repair program implemented geographically based on the proximity of septic systems to reservoirs and watercourses. The program was implemented by the CWC in July 1999 in the 60-Day Travel Time Area and has since expanded sequentially to include septic systems located within 250 feet of a watercourse. In 2012, the CWC funded the repair or replacement of 275 failing or likely-to-fail septic systems through this program.

The Hardship Program funds septic repairs in areas not covered by the Priority Area Program for applicants who meet certain income eligibility criteria. In 2012, the CWC funded the repair or replacement of five failing septic systems under the Hardship Program. In 2012, the CWC funded the repair or replacement of seven failing septic systems through this program.

The Reimbursement Program reimburses home owners who repair or replace failing septic systems in areas not covered by the Priority Area Program, depending on funding availability. Presently, home owners who fixed failing septic systems outside the priority areas between July 2, 1999, and December 19, 2012, are eligible for reimbursement. In 2012, the CWC funded the repair or replacement of seven failing septic systems under the Reimbursement Program.

Under the various sub-programs discussed above, the CWC funded the repair or replacement of 287 septic systems in the WOH watershed in 2012. Since the program's inception, 4,081 failing or likely-to-fail septic systems have been repaired, replaced, or managed.

### 3.1.2 Septic Maintenance Program

The Septic Maintenance Program is a voluntary program intended to reduce the occurrence of septic system failures through regular pump-outs and maintenance. Under the program, the CWC pays 50 % of eligible costs for pump-outs and maintenance. In 2012, the CWC

subsidized 153 septic tank pump-outs, bringing to 840 the number of septic tank pump-outs subsidized since the program's inception.

### 3.1.3 Alternate Design Septic Systems Program

The Alternate Design Septic Systems Program (ADSSP) is a $3 million program to pay for the importation of fill material and/or pumping apparatus used in the construction of septic systems that have been required by DEP or its delegate solely to achieve compliance with the New York City Watershed Rules and Regulations (WR&R) (2010). No ADSSP activity occurred during 2012. Since 2001, the CWC Board has authorized the transfer of $1,999,000 in ADSSP funding to other, more active, watershed protection and partnership programs.

### 3.1.4 Other Septic Programs

The Small Business Septic System Rehabilitation and Replacement Program (SBSSRRP) helps pay for the repair or replacement of failed septic systems serving small businesses (those employing 100 or fewer people) in the Catskill/Delaware watershed. Eligible business owners are reimbursed 75 % of the cost of septic repairs, up to a maximum of $40,000. To be eligible, failing commercial septic systems must be 250 feet or less from a watercourse or 500 feet or less from a reservoir or within the 60-day Travel Time Area. The small business owner is responsible for securing an approved DEP design and for the construction of the septic system remediation. The small business owner then seeks reimbursement for these costs from the SBSSRRP. The SBSSRRP does not require, nor does it pay for, pump-outs or other intermediary measures that may be required by state or local regulatory agencies. Appropriate pump-outs or other measures are required by DEP when a Notice of Violation (NOV) is issued to commercial systems.

In 2012, five small businesses received reimbursement for the repair or replacement of a failing septic system under the program. Nine failing septic systems had been replaced under the program through the end of December 2012.

The Cluster Septic System Program funds the planning, design, and construction of cluster systems in select communities in the WOH watershed. There was no project activity in this program during 2012.

## 3.2 New Sewage Treatment Infrastructure Program

The New Sewage Treatment Infrastructure Program (NIP) provided funds to allow for the study, design,+ and construction of new wastewater projects in seven communities: Andes, Roxbury, Hunter, Windham, Fleischmanns, Phoenicia, and Prattsville. As noted in the project summaries below, the NIP concluded in 2012.

The Andes wastewater treatment plant (WWTP) project is complete.

The Roxbury pump station and force main project from the Hamlet of Roxbury to the Grand Gorge WWTP is complete. The Hubbell Corners Supplemental Service Area project is complete.

The Hunter WWTP project is complete.

The Windham WWTP project is complete.

The Fleischmanns WWTP project is complete.

The Town of Shandaken will not be completing a NIP wastewater project in the Hamlet of Phoenicia. On August 21, 2012, pursuant to the terms of the Agreement between the Town of Shandaken and the New York State Environmental Facilities Corporation (EFC), dated March 21, 2005, EFC issued a Notice of Default to the Town for its failure to comply with the Agreement. The Notice of Default was based on the Town's failure to establish a sewer district within six months of the commencement of the Design Period. Under the Agreement, the Town had 30 calendar days to commence actions to cure the default and "diligently prosecute" such actions. The Town did not take any actions to cure the default during this period and EFC notified the Town on October 3, 2012 that the Agreement would terminate in 10 business days. The Agreement terminated on October 18, 2012.

The Prattsville WWTP project is complete.

## 3.3 Community Wastewater Management Program

The Community Wastewater Management Program (CWMP) provides funding for the design and construction of community septic systems, including related sewerage collection systems, and/or the creation of septic maintenance districts, including septic system replacement, rehabilitation and upgrades, and operation and maintenance of the district.

To date, CWMP projects have been completed in Bovina, DeLancey, Bloomville, Hamden, Boiceville, and Ashland. CWMP projects are under design in the Hamlets of Lexington, and South Kortright, and under construction in the Hamlet of Trout Creek.

In May 2012, DEP approved a request from the Town of Lexington to revise the Lexington CWMP project to incorporate the wastewater flow from the Lexington Hotel into the community septic system rather than treating this flow through a stand-alone septic system. The Town of Lexington held the public hearing required to establish the sewer district for the community septic system on September 29, 2012. DEP received the 65% collection system drawings on July 18, 2012 and provided comments on the submittal on September 21, 2012. DEP received the 65% wastewater treatment facility (WWTF) design drawings and specifications on October 30, 2012 and provided comments on the submittal on December 4, 2012. The 65% WWTF design drawing submittal was delayed while the project engineer awaited pertinent

information and appropriate documentation about the pretreatment unit from Orenco Systems. The public referendum on sewer district formation was held on December 8, 2012 and the referendum was approved by voters.

The Town of Stamford completed the SEQR process for the South Kortright project in June 2012. The Town formed the South Kortright Sewer District and adopted a Sewer Use Law (SUL) on August 8, 2012 for the proposed project to collect wastewater and pump it to the Village of Hobart WWTP for treatment. An easement coordinator has been hired for the project. The State Historic Preservation Office issued a No Adverse Effect letter for the project on November 15, 2012. In response to comments from NYSDEC, a revised Hobart WWTP Capacity Evaluation report was submitted on December 11, 2012. Submission of the 65% design for the South Kortright large diameter gravity sewer collection system is expected in the first half of 2013.

In Trout Creek, 95% design plans for the community septic system project were received in January 2012 and DEP issued design approval for the project in July 2012. Construction bids for the project were opened on August 23, 2012. At a special Town Board meeting on August 28, 2012, the low bid was accepted and Notice of Award was issued to LaFever Excavating. A preconstruction meeting was held on October 19, 2012. Construction started on November 5, 2012 with removal of native soil and placement of fill material for the treatment site absorption beds (Figure 3.1). Absorption bed cut and fill material was installed before winter shut down of the project on December 14, 2012. Work will resume in spring 2013.

Figure 3.1. Site preparation of absorption beds in Trout Creek.

## 3.4 Sewer Extension Program

DEP continued to implement the Sewer Extension Program during 2012. Highlights of program activities in communities with projects still underway in 2012 are described below.

***Town of Shandaken (Planned Sewer Extension to the City's Pine Hill Sewer System)***

The planning and design of this sewer extension, located just south of the former Village of Pine Hill along NYS Route 28, is complete and has been approved by NYSDEC.

Prior to DEP's preparation of a construction contract, the Town of Shandaken was required to adopt an SUL and procure all of the necessary project easements. During the reporting period, the Town completed both of these activities, adopting a new SUL in January 2012 and securing all of the remaining sewer lateral easements in July 2012.

DEP is currently obtaining all of the applicable local and state permits. It is anticipated that DEP will let bids on the construction in 2013.

### *Town of Hunter (Planned Sewer Extension to the City's Tannersville Sewer System)*

The planning and design of the sewer extension along County Route 23C and Showers Road continued to move forward during the past year. In 2012, the Town of Hunter obtained the final remaining easements that are required to construct the extension. DEP reviewed and provided comments, the project's 90% design plans and specifications. The project's design plans were submitted to NYSDEC for review and approval in October 2012. Once the plans are approved, DEP can finalize the bid package.

DEP is currently obtaining all of the applicable local and state permits. It is anticipated that DEP will let bids on the construction in 2013.

### *Village of Margaretville and Town of Middletown (Planned Sewer Extensions to the City's Margaretville Sewer System)*

In 2012, DEP made progress in addressing planning and design issues, assessing the project's potential environmental impacts, and determining an acceptable method of construction for planned sewer mains and laterals along three roads in the project area—Harold Finch Road, Rosa Lane, and Hard Hack Drive. These activities resulted in revisions to the project's 60 and 90 % design plans and specifications.

DEP and its consulting firm conducted on-site field investigations to determine whether dwarf wedgemussels (endangered mussel) or northern wild monkshood (threatened plant), exist within the project area. Neither species was found in or near the project area.

Pursuant to the New York City Watershed Memorandum of Agreement (MOA) (1997), the Town and Village must adopt a new SUL and procure all of the remaining easements DEP requires for the project. The Town adopted an amended SUL in July 2012. The Village's SUL still needs to be amended in order to come into full compliance. The Town and Village also continued to contact residents from whom DEP needs lateral access/construction easements.

The project's design plans were submitted to NYSDEC for review and approval in October 2012. Once the plans are approved, DEP can finalize the bid package.

## 3.5 Wastewater Treatment Plant Upgrade Program

As part of the MOA, the City agreed to fund the upgrades of all existing non-City-owned WWTPs in the watershed. (As reported in previous annual reports, upgrades of City-owned WWTPs, which account for more than one-third of WWTP flow in the Catskill/Delaware watershed, proceeded on a separate track and were completed in 1999.) The upgrades will provide highly advanced treatment of WWTP effluent. The task of coordinating these complex projects with the 37 WWTP owners in the Catskill/Delaware watershed is enormous. Many of the owners are restaurateurs, hoteliers, camp operators, school administrators, and managers of recreational facilities, not professional WWTP operators and construction specialists. DEP has proceeded diligently with this vast undertaking and provided step-by-step guidance on a host of engineering, operating, contracting, and regulatory issues.

DEP has entered into a contract with the EFC that identifies a wide range of tasks to be performed by both DEP and EFC to ensure comprehensive management of the overall WWTP Upgrade Program. DEP's and EFC's tasks have included, but are not limited to: program start-up, establishing contracts with each WWTP owner, providing technical assistance to each WWTP owner and its consulting engineer, change order administration, construction oversight, funds management (including invoice review and reconciliation), and extensive project management. DEP and EFC have continued to provide technical and program guidance to each of the owners and their engineers to assist them through the process of upgrading each facility.

The upgrade of non-City-owned WWTPs is divided into two distinct programs, the Regulatory Upgrade Program and the SPDES Upgrade Program (West of Hudson only). Although the two are separate, the Upgrade Agreement between EFC and the WWTP owner encompasses both.

The Regulatory Upgrade Program is designed to assist WWTPs meet requirements imposed solely by the WR&R. Treatment technologies required by the Regulatory Upgrade Program include, but are not limited to: phosphorus removal, sand filtration with redundancy, back up power, back up disinfection, tertiary treatment via microfiltration (or DEP-approved equivalent), effluent flow metering and alarm telemetering.

The SPDES Upgrade Program is designed to assist certain WWTPs in meeting the conditions of their current State Pollution Discharge Elimination System (SPDES) permits. Equipment that is unreliable or reaching the end of its useful life is eligible for replacement under this program. Certain SPDES improvements conducted at a facility after November 2, 1995, are also eligible for reimbursement under this program.

All FAD-related non-City-owned WWTPs have achieved functional completion and begun operation, in compliance with the WR&R. Thirty-seven of these plants are located in the Catskill/Delaware watershed and represent 100% (3.95 MGD) of the total WOH flow. Nine of

them are in the Croton Falls/Cross River basin (in the Croton watershed) and represent 100% (1.34 MGD) of that basin's flow.

In addition to the nine EOH FAD WWTPs, the Upgrade Program is upgrading 60 EOH non-FAD WWTPs. The status of the 69 is as follows: 54, representing 94% of the total EOH flow, have achieved functional completion (this number includes the 9 FAD-related WWTPs); 4, representing 2.2% of the flow, are in the construction phase; 6, representing 2.3% of the flow, are waiting to be decommissioned; 4, representing less than 1% of the flow, are in negotiations to be decommissioned; representing less than 1% of the flow, is in design.

By the end of 2012, DEP had committed more than $404 million to the Regulatory Upgrade Program and $6 million to the SPDES Upgrade Program. In addition, DEP continues to fund the Operation and Maintenance of the non-City-owned WWTPs to comply with the WR&R (currently in the amount of $13 million per year). Beyond funding these activities, this commitment involves the preparation of invoices and, most importantly, obtaining and reviewing documentation for budgeted lines.

## 3.6 Stormwater Programs

### 3.6.1 Stormwater Cost-Sharing Programs

Costs of stormwater measures incurred as a result of complying with the WR&R are paid for by the Future Stormwater Controls Program to the extent they exceed costs sustained because of compliance with state and federal requirements. The program provides funding for the design, construction, and maintenance of stormwater measures included in stormwater pollution prevention plans and individual residential stormwater plans for new construction commencing after May 1, 1997.

Two separate programs have been developed to offset additional compliance costs incurred as a result of the implementation of the WR&R. The West of Hudson Future Stormwater Controls Program is administered by the CWC, and reimburses municipalities and large businesses 100 % and small businesses 50 % of eligible costs. A separate program known as Future Stormwater Controls, paid for by the City, reimburses low-income housing projects and single-family home owners 100 percent and small businesses 50 % of eligible costs.

The City has fully funded the $31.7 million West of Hudson Future Stormwater Controls Program. From this allotment, the CWC has funded $4,736,151 in eligible activity and transferred $16,676,724 to other eligible watershed protection programs. The fund balance was $16,423,435 at the end of 2012, including interest. Table 3.1 provides details for projects approved under the program in 2012.

Table 3.1. 2012 West of Hudson future Stormwater Controls Program projects.

| Applicant | Project | Approval date | CWC funding | Percent funding CWC/DEP |
|---|---|---|---|---|
| Copperhood Inn & Spa | Repair funding for culvert and riprap damaged by Tropical Storm Irene | 1/3/12 | $12,105 | 100% CWC |
| Burton F. Clark | Stormwater controls associated with an addition to student housing in Delhi | 2/7/12 | $4,978.43 | 50%/50% |
| Uram & Greenberg | Stormwater controls at residence | 2/7/12 | $252,274 | 100% CWC |
| Verona Oil (Windham) | Repair funding for damage to stormwater controls associated with parking lot | 3/6/12 | $10,250 | 100% CWC |
| Zen Mountain Monastery | Additional repair funding for damage caused by Tropical Storm Irene to stormwater controls | 6/5/12 | $114,656 | 100% CWC |
| Kenneth Hoffman | Stormwater controls associated with the construction of a driveway and house in a subdivision | 8/7/12 | $8,800 | 100% CWC |
| Delaware Park LTD (Margaretville car wash) | Additional repair funding for damage caused by Tropical Storm Irene to stormwater controls | 8/7/12 | $3,300 | 100% CWC |
| Prattsville Plaza | Stormwater controls associated with strip mall style building and parking lot | 10/2/12 | $220,673 | 50%/50% |

### 3.6.2 Stormwater Retrofit Program

The Stormwater Retrofit Program is administered jointly by the CWC and DEP and has three components: a construction grants (or capital projects) component, a maintenance component, and a planning and assessment component. The program provides funding for the design, permitting, construction, and maintenance of stormwater best management practices to address existing stormwater retrofit runoff in concentrated areas of impervious surfaces, for the purpose of correcting or reducing existing erosion and/or pollutant loading.

The program currently maintains an open application timetable for construction grant project applications, evaluating each application as it is submitted. Funding preference is given to construction grant project applications where a planning and assessment project has already been successfully completed or where a NIP project or CWMP project is in progress. The required "local share" contribution is 15 % of the projected capital construction cost; however, in areas of preference—new infrastructure and community wastewater project areas—the local share requirement has been eliminated to promote the synergistic effect of coordinated project schedules.

From 1999 to 2012, 69 stormwater retrofit projects were completed under the program. Of these, 57 were construction projects, including 1 in 2012, and 12 were planning and assessment projects, including 1 in 2012. Eleven construction projects and three planning and assessment projects remain open. Projects of both types—construction (Tables 3.2 and 3.3) and planning and assessment (Tables 3.4 and 3.5)—that were completed or open in 2012 are presented below.

Table 3.2. Stormwater Retrofit Program construction projects completed in 2012.

| Applicant | Project description | Project cost | Closing date |
|---|---|---|---|
| Town of Walton | Walton Mountain Road (collection, conveyance, sedimentation) | $71,949.33 | 12/31/12 |

Table 3.3. Current open Stormwater Retrofit Program construction projects.

| Applicant | Project area | Project description | Status |
|---|---|---|---|
| Village Of Andes | Delaware County Route 2 and Coulter Road | Installation of collection, conveyance, and sedimentation devices for stormwater drainage from medium density residential, commercial, and county highway surfaces | Awaiting final billing |
| Village of Tannersville | Hunter Foundation | Design and installation of stormwater collection, conveyance, and treatment structures | 90% complete |
| Village of Delhi | Delhi Stormwater Mitigation Measures | Implementation of stormwater mitigation practices to reduce inflow and infiltration into Delhi sanitary sewer collection system | Open |
| Town of Roxbury | Lake Street | Design of stormwater collection, conveyance, and treatment structures | Design |
| Town of Andes | High Street | Design and installation of stormwater collection, conveyance, and treatment structures | Awaiting final billing |
| Town of Ashland | Ashland | Design and installation of stormwater collection, conveyance, and treatment structures | Awaiting final billing |
| Town of Shandaken | Highway Garage | Design of stormwater collection, conveyance, and treatment structures | Design |

Table 3.3. (Cont.) Current open Stormwater Retrofit Program construction projects.

| Applicant | Project area | Project description | Status |
|---|---|---|---|
| Mountain Top Library | Haines Falls Free Library | Design and installation of stormwater collection, conveyance, and treatment structures | Awaiting final billing |
| Town of Shandaken | Pine Hill Design | Design of stormwater collection, conveyance, and treatment structures | Design |
| Town of Tompkins | Trout Creek | Design and installation of stormwater collection, conveyance, and treatment structures | Design |
| Town of Lexington | Lexington | Design and installation of stormwater collection, conveyance, and treatment structures | Design |

Table 3.4. Stormwater Retrofit Program planning and assessment projects completed in 2012.

| Applicant | Amount expended | Closing date |
|---|---|---|
| Town of Roxbury (Grand Gorge) | $34,000.00 | 1/10/12 |

Table 3.5. Current open Stormwater Retrofit Program planning and assessment projects.

| Applicant | Grant amount | Funding round |
|---|---|---|
| Village of Margaretville | $49,900.00 | 2006 |
| Town of Andes | $35,275.00 | 2009 |
| Town of Ashland | $42,491.50 | 2009 |

# 4. Protection and Remediation Programs

## 4.1 Waterfowl Management Program

The Waterfowl Management Program will submit a separate annual report on the date specified in the 2007 Filtration Avoidance Determination (USEPA 2007), which currently is July 31, 2012 but which could change as a result of the 2011 Long-Term Watershed Protection Plan (DEP 2011b).

## 4.2 Land Acquisition

Between the 1860s, when New York City (the City) began to acquire land for construction of what would later be known as the Catskill/ Delaware System, and 1957, when acquisitions of land ended, the City acquired roughly 35,600 acres of land surrounding the reservoirs that were eventually built. As of December 31, 2012, following 16 years of Land Acquisition Program (LAP) activity, the City had protected an additional 126,623 acres in the Catskill/Delaware watershed (including land and conservation easements (CEs) secured by the City as well as farm easements acquired by the Watershed Agricultural Council (WAC)). This represents an addition of more than three times the amount of land that had been acquired previously, in about one-eighth the time and based entirely on voluntary transactions. In many basins, City land holdings have increased dramatically compared with pre-1997 ownership patterns (Figure 4.1). In Rondout, a high priority basin (entirely Priority Areas 1A and 1B), the City has increased the number of acres it controls by a factor of six. In West Branch/Boyd Corners, as well as in Schoharie, acreage under City control has increased by a factor of 12; in Ashokan, City-owned buffer lands have almost tripled in size. Overall, City-controlled land in the Catskill/Delaware watershed (including easements secured by both DEP and WAC) has increased from 35,588 in 1996 to 162,211 acres (including deals yet to close). In 1996, roughly 3.5% of the watershed was owned by the City and another 21% was protected by New York State and others; today, roughly 15.7% is City-controlled, a major component of the 36.9% of the Catskill/Delaware watershed in total that is now under some form of permanent protection. Below are summaries of the main components of LAP's activities.

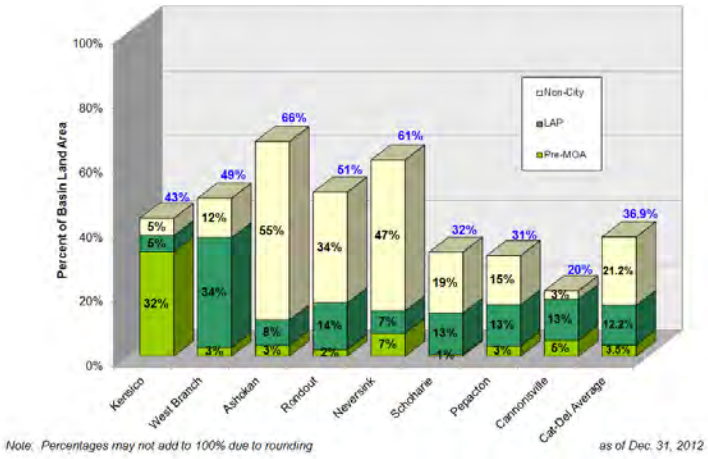


Figure 4.1 Protected lands by basin, through 2012, as a percentage of basin land area, Catskill/ Delaware System.

### 4.2.1 Solicitation/Resolicitation

The 2007 FAD required a solicitation plan for 2011-2012, which was submitted in 2010. Under this plan, DEP's solicitation goal for 2012 was 60,000 acres, which DEP exceeded by 3,475 acres. Total acreage solicited by DEP since signing the Memorandum of Agreement (MOA) in 1997 is now over 477,500 (excluding previously-solicited properties that the City is no longer interested in, and farms solicited by WAC).

### 4.2.2 Purchase Contracts in the Catskill/Delaware System

Overall results for purchase contracts signed and closed in 2012, on both fee simple and CEs, are described below, followed by data related to more specific aspects of the program.

By the end of calendar year 2012, DEP had secured (signed) 1,339 purchase contracts (excluding WAC farm CEs) comprising 103,990 acres throughout the Catskill/Delaware watershed at a cost of $380.7 million, with additional "soft costs" for related site services of about $30 million. Of these, 1,232 contracts totaling 95,128 acres have been acquired (closed), with the remaining acres under purchase contract. During 2012, DEP closed 68 contracts comprising 6,812 acres and signed 67 purchase contracts accounting for 5,377 acres (Figure 4.2, Tables 4.1 and 4.2). The number of acres signed to contract in 2011-12 was significantly lower than in 2009-10 for several reasons: increased landowner interest in selling during the earlier period following the financial and real estate crisis of 2008; the cyclical nature of the real estate market; lower solicitation requirements; and the addition of several new acquisition programs to LAP's range of responsibilities, leaving it with fewer staff resources to dedicate to its core program. Note that if WAC farm CEs are excluded, the acreage signed to contract in 2011-12 is really a return to the baseline seen between 2002 and 2007.

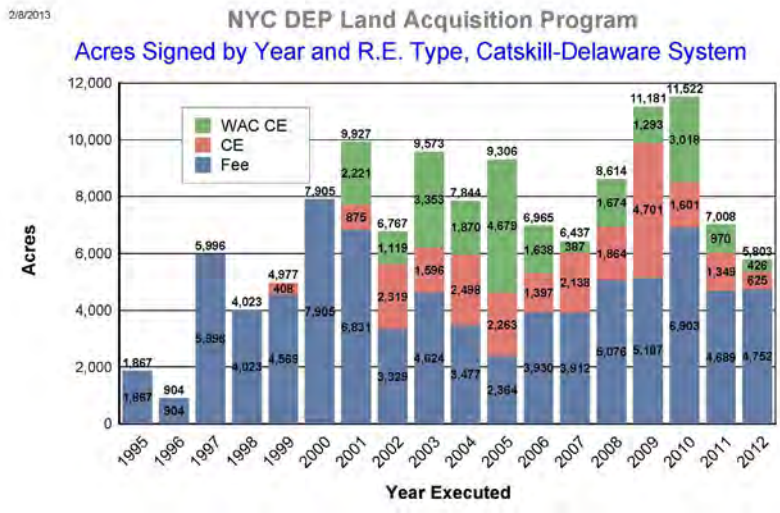


Figure 4.2 Acres signed by year through 2012.

Table 4.1. Contracts signed in the Catskill/Delaware watershed by reporting period and real estate type.

| | Real estate type | Number of contracts | Acres | Average size of project | Purchase price |
|---|---|---|---|---|---|
| Reporting Period: 1995 to 2011 | | | | | |
| | Fee | 1,120 | 75,606 | 68 | $294,348,078 |
| | CE | 152 | 23,007 | 151 | $ 56,945,744 |
| | WAC CE | 121 | 22,223 | 184 | $ 30,722,916 |
| | | 1,393 | 120,836 | 87 | $382,016,738 |
| Reporting Period: 2012 | | | | | |
| | Fee | 62 | 4,752 | 77 | $17,869,771 |
| | CE | 5 | 625 | 125 | $11,484,941 |
| | WAC CE | 2 | 426 | 213 | $ 1,221,945 |
| | | 69 | 5,803 | 84 | $30,576,657 |
| Program-to-date Subtotals | | | | | |
| | Fee | 1,182 | 80,358 | 68 | $312,217,849 |
| | CE | 157 | 23,632 | 151 | $ 68,430,685 |
| | WAC CE | 123 | 22,649 | 184 | $ 31,944,861 |
| **Grand Total** | | 1,462 | 126,639 | 87 | $412,593,395 |

Table 4.2. Contracts closed in the Catskill/Delaware watershed by reporting period and real estate type.

| | Real estate type | Number of contracts | Acres | Average size of project | Purchase price |
|---|---|---|---|---|---|
| Reporting Period: 1995 to 2011 | | | | | |
| | Fee | 1,031 | 68,473 | 66 | $267,984,303 |
| | CE | 133 | 19,843 | 149 | $ 46,546,924 |
| | WAC CE | 111 | 20,755 | 187 | $ 28,547,732 |
| | | 1,275 | 109,071 | 86 | $343,078,959 |
| Reporting Period: 2012 | | | | | |
| | Fee | 52 | 4,007 | 77 | $15,243,719 |
| | CE | 16 | 2,805 | 175 | $ 9,579,914 |
| | WAC CE | 9 | 1,336 | 148 | $ 1,973,092 |
| | | 77 | 8,147 | 106 | $26,796,725 |
| Program-to-date Subtotals | | | | | |
| | Fee | 1,083 | 72,480 | 67 | $283,228,022 |
| | CE | 149 | 22,648 | 152 | $ 56,126,839 |

Table 4.2. (Cont.) Contracts closed in the Catskill/Delaware watershed by reporting period and real estate type.

| | Real estate type | Number of contracts | Acres | Average size of project | Purchase price |
|---|---|---|---|---|---|
| | WAC CE | 120 | 22,091 | 184 | $ 30,520,824 |
| **Grand Total** | | 1,352 | 117,219 | 87 | $369,875,685 |

### *Fee Simple*

During 2012, 62 contracts totaling 4,752 acres were signed by DEP and 52 contracts totaling 4,007 acres were closed by DEP (Tables 4.1 and 4.2). To date, DEP has secured 80,358 acres in fee simple, equal to 77% of the acres protected by DEP (excluding WAC farm CEs).

Figure 4.3 A tributary to Schoharie Reservoir meanders through a 157-acre property in the Towns of Stamford and Gilboa on which the City purchased a conservation easement in 2007. The City now owns the land outright in fee simple after having acquired the property subject to the easement, plus an unencumbered building lot, in 2012 (PIN 8128).

Figure 4.4 A frozen pond whose water will eventually reach Pepacton Reservoir from its location on a 319-acre parcel in the Town of Andes that the City signed to contract in 2012 (PIN 5489). When acquired, this property will connect a 162-acre parcel also signed to contract in 2012 (PIN 2310) with a 105-acre property acquired by the City in 2009 (PINs 7023 and 5533) to form a 586-acre assemblage.

Figure 4.5 A shaded tributary to Pepacton Reservoir as it passes through a 113-acre property in the Town of Andes that the City signed to contract in 2012 (PIN 2630).

### *Conservation Easements*

*DEP*

During 2012, 5 CEs totaling 625 acres were signed to purchase contract by DEP and 16 CEs totaling 2,805 acres were closed by DEP (Tables 4.1 and 4.2). Overall, 157 easements in the Catskill/Delaware watershed totaling 23,632 acres are now closed or under contract, equal to 23% of the acres protected by DEP (excluding WAC farm CEs).

*WAC*

During 2012, WAC signed 2 purchase contracts for 426 acres in farm CEs (Table 4.1). By the end of the year, WAC held easements on 120 farms totaling 22,091 acres (Table 4.2).

The Farm Easement Program—including the costs of all easement acquisitions and program overhead, and the majority of stewardship costs—has been supported by the following allocations from DEP:

- $20 million dedicated in 1999, from the original $250 million LAP fund. This includes $10 million for "agricultural easements" and $10 million for easements on "non-agricultural" (forested) land on farms.
- $7 million dedicated in 2006 from the $50 million Supplementary Fund outlined in MOA Section 7.
- $20 million dedicated in 2007 from the Supplementary Fund.
- $23 million budgeted in 2008 as directed by NYSDOH in a letter dated April 30, 2008. These funds will be dedicated to acquisition of farm CEs under a new program contract negotiated in 2012 and expected to be executed by September 2013.
- Pursuant to the 2010 Water Supply Permit (WSP), DEP has allocated an additional $6 million toward a new Forest Easement Program to be managed by WAC. Upon assignment of the new funds, the total committed to Easement Programs managed by WAC will be $76 million.

### *Riparian buffers*

See Section 4.7 for information on riparian buffers protected through LAP, and Section 4.2.5 below for information on the pending Riparian Buffer Program.

### *Wetlands*

See Section 4.8 for information on wetlands protected through LAP.

## 4.2.3 Transfer of Conservation Easements on Fee Acquisitions to New York State

Thirteen CEs covering 230 LAP-acquired properties representing over 15,600 acres were submitted to NYSDEC in the first quarter of 2012. These easements have not yet been recorded by NYSDEC. Total recorded conveyances to NYSDEC remain at 53 CEs on 656 DEP properties comprising 42,394 acres. This includes two deeds that were recorded during 2012. Counting both recorded and unrecorded easements, the number of DEP easement conveyances to New York State thus far totals 66 CEs on 886 DEP properties comprising 57,994 acres.

### 4.2.4 Technical Program Improvements

During 2012, DEP continued to seek ways to improve and revise program documents and policies, subject to requirements of the MOA, FAD, WSP, and City Charter, to maximize program competitiveness within the marketplace.

- Purchase Contract. Since 2008, many landowners have continued to take advantage of the City's contribution of up to $5,000 offered in the revised model purchase contract for subdivision costs. The incentive appears to have increased the rate of accepted offers from landowners whose properties require subdivision before conveyance of the vacant portion.
- Conservation Easement Policy. DEP continues to hone its policy with respect to criteria for consideration and design of conservation easements.
- Technology. The Watershed Land Information System (WaLIS) is continually being enhanced to support the evolution of components related to the issuance of the 2010 WSP. In particular, the system is now (or will soon be) addressing the need to coordinate DEP activity with the Enhanced Land Trust Program, Riparian Buffer Program, and Forest CE Program. The system can now provide information on natural features criteria, designated hamlet areas, and the constantly growing levels of protection in each sub-basin. These and other upgrades demonstrate how WaLIS offers tremendous productivity enhancement and efficiencies which impact every step of the acquisition process.
- Land Trusts. DEP spent considerable time during 2012 seeking ways to increase the involvement of land trusts in the protection of watershed lands:

  •*Enhanced Land Trust Program (ELTP)*. Several land trusts involved in the development of the ELTP document decided against further involvement in the ELTP once the towns make their "opt in" elections. A few land trusts remained that were interested and eligible to work directly in eligible towns, but not all have proactively pursued solicitations of the subject landowners. One large property owner in the Town of Gilboa did express interest and the appraisal process is moving forward as outlined in the final ELTP process memo, with a town-selected land trust playing the lead role and a second (larger) land trust assisting. The other five eligible properties are either unresponsive, not interested in the ELTP at this time, or have not yet been solicited by the eligible land trust(s). The land trusts that are responsive have indicated that the City should consider moving the remaining properties back into a regular LAP solicitation rotation schedule until the next scheduled town "opt-in" window in 2016.
  •*Riparian Buffer Program*. As specified in the most recent WSP, the Catskill Center for Conservation and Development (CCCD) is spearheading the development of a Riparian Buffer Program feasibility report with input from the City, land trusts and numerous municipal and community stakeholders (known collectively as the Consultative Working Group). CCCD issued a draft report just after the close of 2012. The Consultative Working Group has met several times at DEP headquarters in Kingston, and is scheduled to meet several times more to provide input and guidance on the report before the final report is submitted by May 1, 2013.
  •*Educational Forums*. In July 2012, DEP requested project proposals from local land trusts to develop landowner education efforts in the watershed. DEP received five grant applications from five different land trusts and awarded three grants of

$5,000 each (slightly less in one case) for educational forums to take place by mid-2013. One of these grants will fund a series of educational workshops concerning best management practices (BMPs) at conservation easement sites around the watershed, facilitated by CCCD. The first of these workshops took place this past October, while two are scheduled for the spring and summer of 2013. Three other workshops were funded and will be held in 2013. One of them is hosted by the Land Trust Alliance as a forum for land trust professionals focused on developing sound financial management. Two others, dealing with the "Fiscal Benefits of Land Conservation", will be administered by the Delaware Highlands Conservancy.

•*Transactions*. During 2012, DEP closed on one contract (280 acres) to acquire land directly from a land trust. Discussions on several other projects are ongoing.

### 4.2.5 Pilot Forest Easement Program

The 2007 FAD mandated that DEP fund a $6 million pilot program through which WAC would acquire easements on "forested portions of non-agricultural" land. Negotiations between DEP and WAC began in earnest in late 2007 and finally culminated in an agreement in late 2012. The contract is now being reviewed by various City agencies for expected approval in mid-2013. Pursuant to the FAD, status of efforts to implement the Forest Easement Program was reported under separate cover on June 30, 2011.

### 4.2.6 Water Supply Permit

The current WSP was issued by NYSDEC on December 24, 2010, and authorizes a land acquisition program in the Catskill/Delaware watershed, through 2025, of up to 106,712 acres more than had been acquired as of January 1, 2010 (at which time 102,287 acres had been secured). Between January 1, 2010 and December 31, 2012, LAP acquired 24,333 acres, leaving a "balance" of 82,379 acres remaining for potential acquisition.

### 4.2.7 Funding Status

The 2007 FAD required the City to place a total of $241 million into the LAP segregated account in three separate deposits between 2008 and 2014. The final deposit of $78.5 million was to be made by December 31, 2014, provided the FAD was continued for the second five-year period of its 10-year term and an NYSDEC WSP had been issued authorizing continuation of the LAP during that period.

In 2012, the City deposited $53 million into the segregated land acquisition account. This deposit, together with previous deposits made in accordance with, and in several cases ahead of, the schedule established in the FAD, allowed the City to complete these deliverables two years ahead of schedule.

## 4.3 Land Management

The City has made a significant investment in purchasing water supply lands and CEs. To manage these lands for water quality protection, DEP has developed a comprehensive, long-term plan for land management. Land management activities fall into four major categories, primarily focused on City lands:

- Property management of City water supply lands and CEs
- Beneficial use
- Forest management
- Invasive species management

### 4.3.1 Management of Water Supply Lands and Conservation Easements

***Property Management of City Lands***

All City lands owned in fee simple are inspected as per the DEP Fee-land Monitoring Policy (DEP 2010), which outlines procedures for property inspections and boundary maintenance on City lands. Property inspections are divided into three types: 5-year boundary inspections, focused inspections, and aerial inspections. The type of inspection a property receives depends on its priority, which is assigned based on its location and the various uses conducted on the property (e.g., recreation, land use permit). **"**High priority properties" include parcels on which recreational use is high, where there is a history of encroachments, where there are active land use permits or other projects, or where there are many adjacent landowners. These properties receive a focused inspection annually. "Standard priority properties" are those on which no trespass or encroachments have been observed, or which have little road frontage or low public use. These properties receive a focused or aerial inspection at least once every five years. In addition to focused and aerial inspections, all properties must receive a boundary line inspection every five years. Five-year boundary inspections are the most comprehensive type of inspections and include a traverse of all property boundary lines as well as the interior of the property; this ensures proper monumentation and maintenance of property boundary lines over the long term. Table 4.3 displays the number and acres of inspections completed in 2012. DEP can change a property's priority at any time depending on changing circumstances (such as the discovery of encroachments) or perform additional site visits as needed. All inspections and site visits, along with journal notes, photos, encroachments, and observations, are recorded in WaLIS. Inspections are also scheduled using WaLIS. All City lands are posted as appropriate; signage includes "Posted," "Public Access Area," or "Entry By Permit." Other types of signs may be used depending on the situation.

Table 4.3. Number and acreage of inspections completed in 2012 by DEP field offices.

| DEP field office | Property inspections (number/acres) | 5-year boundary inspections (number/ miles of boundary line) | Site visits |
|---|---|---|---|
| Shokan | 150/9,443 | 69/110 | 14 |
| Downsville | 60/10,780 | 43/131 | 38 |
| Grahamsville | 83/15,103 | 27/102 | 28 |
| Schoharie | 154/3,984 | 56/97 | 88 |
| East of Hudson (EOH) | 169/2,349 | 58/726 | 0 |
| **Total** | 616/41,659 | 253/1,166 | 168 |

### *Conservation Easement Stewardship*

At the end of 2012, DEP had 156 closed easement properties totaling 22,035 acres in the Catskill, Delaware, and Croton watersheds. DEP conducts two annual inspections of all its easements in compliance with the terms of the MOA. DEP continues to expand the use of aerial inspections for CEs because they provide an efficient alternative for inspecting properties, especially the larger ones. Potential violations which could have serious water quality impacts, such as land clearing, construction, and road building, are evident using aerial inspections. Combined with an annual on-the-ground inspection, aerial inspections provide a high level of protection for the City's investment.

The number of easement term violations committed by landowners remains extremely low. Requests to conduct activities that require DEP notice and approval remained low as well. Forestry is the most requested activity on DEP easements: 10 forest activity plans were reviewed and approved in 2012.

### *Watershed Agricultural Council Conservation Easements and Stewardship*

At the end of 2012, the WAC had 119 easement properties totaling 22,166 acres in the Catskill, Delaware, and Croton watersheds. DEP continues to provide an oversight and advisory role with respect to the WAC's farm CE stewardship responsibilities, which continue to increase as the Council's portfolio grows. The WAC, with assistance from DEP, continued developing several stewardship policies in 2012 for the activation of reserved rights, including water resources and stream work, wind turbines, towers and communication devices, locating septic systems, and future acceptable development areas.

### 4.3.2 Beneficial Use

***Recreation***

DEP's water supply lands provide outstanding public recreational opportunities at 19 reservoirs and 2 controlled lakes, and on water supply lands throughout the Catskill, Delaware, and Croton watersheds. These activities represent a way of life that many of the watershed communities want to see continued and are a large contributor to the local economy. Recreational access also expands the stewardship constituency for the water supply system and the lands that protect water quality. Increased involvement by the general public in using City land connects people with nature, helping to educate and foster an appreciation for protecting these natural assets. Some of the activities enjoyed by residents and tourists are deep water and in-stream fishing, ice fishing, boat fishing, hunting, hiking, cross-country skiing, and other similar low-impact activities. Areas open to the public have increased in recent years due to the purchases of additional lands by DEP and by its attempt to allow "expanded recreational opportunities in the City's watershed," a specific goal of the agency's strategic plan 2011-2014 (DEP 2011c). DEP's management priority is to allow those recreational activities that are compatible with water quality.

In 2012, DEP opened an additional 4,416 acres of land to recreation, bringing the total lands and reservoirs available for public use to slightly over 115,000 acres. DEP continued to open West of Hudson (WOH) watershed lands as Public Access Areas (PAAs). On PAAs, users may hunt, hike, fish, or trap without a DEP Access Permit. Many of the new PAA-designated lands were those that had previously been designated as "no trespassing" or "entry by permit." Figure 4.6 provides a breakdown of the acres of land, by category, opened for recreation since 2003.

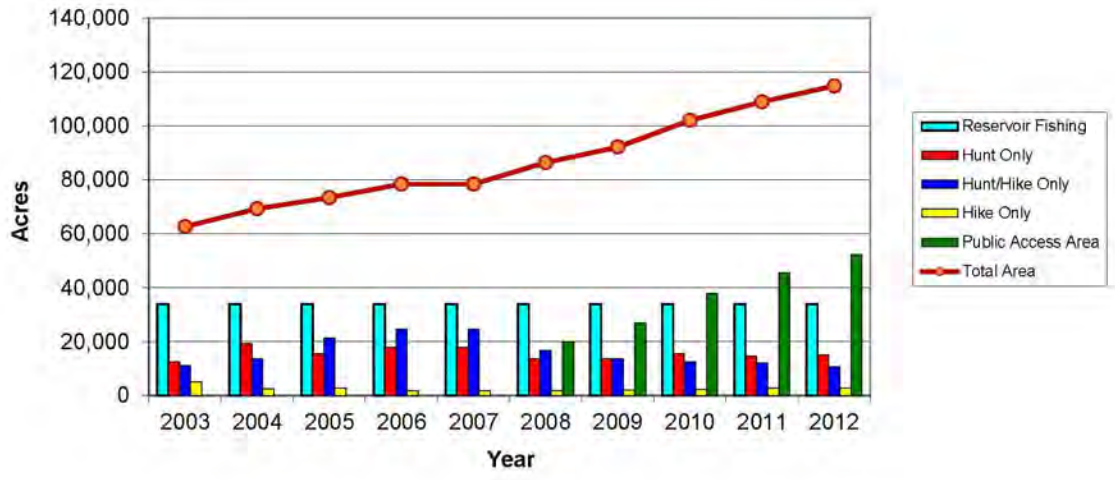


Figure 4.6 New York City-owned water supply land open for recreation as of December 31, 2012. Note that reservoir fishing includes shoreline fishing.

DEP provided revocable land use permits to several partners to construct trails on City land. DEP works with partners to site, construct, and maintain trails in areas that are compatible with water quality protection. Trails are routed so as to avoid natural resources such as wetlands and constructed in a way that does not create erosion and sedimentation. Partners include the Catskill Mountain Club and the Town of Andes, which worked on these projects together, as well as the Finger Lakes Trail Conference.

Figure 4.7 Hiking on DEP land.

In 2012, DEP secured 42 Deer Management Assistance Permits (DMAPs) from NYSDEC. By providing hunters additional opportunities to harvest deer on Ashokan Reservoir lands, the DMAPs will help DEP resource managers reduce the negative impacts on forest regeneration from deer over-browsing. DEP also entered into a partnership with Westchester County's Adaptive Deer Management program to allow hunters access to open reservoir buffer lands adjacent to several county parks, which it is anticipated will achieve the same result as the DMAP program in the Ashokan basin.

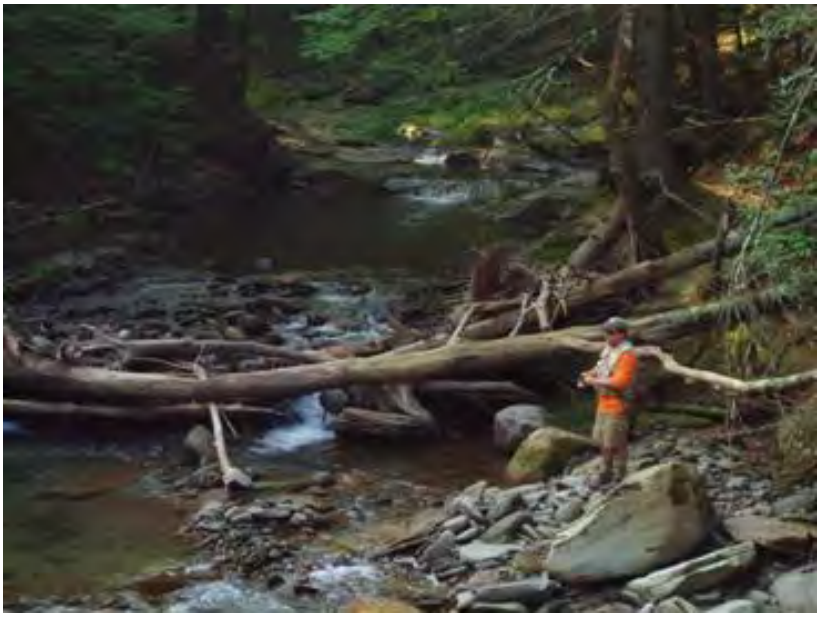

Figure 4.8 Fishing on DEP land.

*Recreational Boating Program*

With the successful completion of the Cannonsville Boating Pilot program in 2011, DEP expanded the recreational boating program to three additional reservoirs: Pepacton, Schoharie, and Neversink. Almost 1,000 boat tags were issued between the four reservoirs, with Pepacton being the most popular. A large percentage of participants were repeat users. Kayaks were by far the most popular vessel used, with canoes second. DEP staff regularly inspected boat launch areas, removed garbage, and performed routine maintenance as needed. Even with this expansion to the new reservoirs, there was little interference with the existing boaters, who keep their rowboats on the reservoirs.

Figure 4.9 Boating on Cannonsville Reservoir.

DEP, along with other partners, is finalizing a report demonstrating that the pilot program was a success and recommending it be expanded to other reservoirs.

***Agricultural Use***

DEP allows its land to be used for agricultural activities through a landowner-lease program, but sets certain conditions on landowners who choose to farm, such as a minimum 25-foot buffer along all streams and wetlands, a prohibition on spreading raw manure during frozen or snow-covered conditions, and, if fertilizers are to be used, an approved nutrient management plan. To help ensure good farming practices are utilized, most of the farmers using City lands are enrolled in the WAC's Whole Farm Plan Program. These plans are generally developed for private land but can be adapted for use on City lands and include various agricultural BMPs such as soil stabilization techniques. The most common agricultural use on City land is the harvesting of hay. In 2012, DEP approved 11 new projects covering 291 acres for a total of 75 projects in 25 different towns covering 1,959 acres.

### 4.3.3 Forest Management

DEP has an active Forest Management Program staffed with four geographically-based foresters and one supervisor/coordinator. The program is responsible for the scientific assessment and active management of forest resources on City land, which includes conducting forest management projects. In 2012, the program continued implementation of the 2011 Forest Management Plan (FMP), developed in conjunction with the USDA Forest Service (USFS) (DEP 2011d) to guide forest management activities on City-owned forest land. In February 2012, DEP com-

pleted development of the FMP Implementation Strategy (IS) to prioritize forest improvements recommended by the FMP.

The FMP recommends silvicultural treatments on approximately 40,000 acres over the next 10 years to help move the forest from the current condition to the "desired" condition, defined by the FMP as one in which forest cover on City land is maximized for long-term water quality protection while the risk of loss of forest cover is minimized. The IS prioritized 18,900 of these 40,000 acres for treatment, following project implementation procedures set forth in the plan's Conservation Practices (CPs).

The CPs are part of the FMP and set the standards for the protection of co-occurring resources such as wetlands, streams, and threatened and endangered species, while allowing for the improvement of forest vigor and resiliency. They also define the Forestry Interdisciplinary Technical Team (FITT) process, a collaborative planning process for projects. During 2012, two semiannual FITT planning meetings were held for long-range planning, bringing together 30+ resource specialists, while field meetings were held to develop site-specific forest management project plans on nine forest management projects.

On October 29, 2012, the watershed was impacted by Hurricane Sandy, causing trees to be uprooted or snapped on sites across the watershed. The majority of the impacts occurred in the eastern portion of the WOH and throughout the EOH watersheds, with the most significant impact in the Kensico basin. Over 150 acres of the impacted areas are currently being planned for restoration through forest management projects.

Emerald ash borer (EAB), a non-native invasive insect, continues to spread westerly through the Ashokan basin, impacting all ash trees. Ash comprises 7% of City-owned forest land. DEP has been collaborating with NYSDEC and the USFS to develop an EAB mitigation strategy for the Ashokan basin. Certain components of this strategy involve development of forest management projects, which are currently in the process of implementation. (For details of the mitigation strategy, see Section 4.3.4.)

The table below lists the number of forest management projects that are currently in each phase of the development process as outlined in the CPs, as well as the number of acres in each process phase (as of December 31, 2012):

Table 4.4. Status of forestry projects.

| CP process phase | Number of projects | Acres |
|---|---|---|
| Initiation | 8 | 648 |
| Planning | 11 | 539 |
| Implementation | 3 | 151 |
| Completion | 1 | 10 |
| **Total** | 23 | 1,348 |

### 4.3.4 Invasive Species Management

#### *Invasive Species Working Group*

The Invasive Species Working Group (ISWG) was formed in 2008 to develop and implement a science-based, comprehensive plan to identify, prioritize, and address invasive species threats to the water supply. The ISWG met twice in 2012 and continued implementation of portions of DEP's Early Detection and Rapid Response Plan (ED/RR) for invasive species.

Elements of the ED/RR plan implemented in 2012 include:

- Development of an outreach and education strategy (E/O strategy) designed to effectively communicate priority messages to the public and DEP staff about DEP's invasive species concerns, methods to prevent or slow the introduction and spread of invasive species, and ways to report potential finds of priority species on City lands to DEP for follow-up. The overarching goals of the E/O strategy are to broaden DEP's understanding of invasive species threats and to increase its capacity to respond to invasive species through prevention and early detection/rapid response on City lands and in the watershed. The plan is intended to guide communication to targeted internal and external audiences that have the potential to introduce, spread, detect, or control invasive species, and will employ a variety of outreach methods depending on the audience.

- Negotiation of a two-year contract with SUNY Oneonta to conduct aquatic invasive species (AIS) surveys for DEP's terminal reservoirs for the purpose of inventorying and mapping AIS occurrences. SUNY Oneonta will also develop and test molecular markers (primers) for select species to make it possible to detect environmental DNA (eDNA). eDNA are fragments of DNA free floating in water which may be amplified by these markers through the use of polymerase chain reaction (PCR) techniques. This detection method may make it possible to conduct broader surveys of reservoirs and lakes for the presence of AIS.

#### *New York State Invasive Species Advisory Committee*

DEP has a seat on the New York State Invasive Species Advisory Committee (ISAC), which was created through state invasive species legislation in 2007 to provide information, advice, and guidance to the New York State Invasive Species Council (ISC) on issues related to invasive species impacts, prevention, regulation, detection, and management in the state. In 2012, the committee continued to provide a forum for the exchange of information among the ISAC's member groups and the ISC. A major task of the ISAC in 2012 was assessing the methods developed to assign regulatory status to invasive species as per the New York State Invasive Species Prevention Act and presenting comments and suggestions to the ISC. DEP attended three ISAC meetings in 2012.

#### *Invasive Species Management*

DEP continued treatment of priority invasive species on City land. A summary of these efforts follows.

*Swallow-wort (Pepacton Reservoir)*

Efforts to eradicate pale and black swallow-wort at one site on the eastern end of Pepacton Reservoir continued in 2012 and an assessment of previous eradication efforts was made. This site has been managed since 2007, and swallow-wort density has now been reduced to a level where it is anticipated that monitoring and as-needed treatments will be sufficient to maintain its low density there. In 2012, eradication was performed in June and September by a certified pesticide applicator using a 4% glyphosate solution (Roundup PROMAX). Management was performed cooperatively with The Nature Conservancy (TNC) under an NYSDEC Terrestrial Eradication Grant issued jointly to DEP and TNC in 2007.

*Emerald Ash Borer (Ashokan Reservoir)*

In 2012, DEP continued to work cooperatively with the DEC and the U.S. Forest Service Forest Health unit in the monitoring and mitigation of emerald ash borer (EAB) in the Hudson Valley, Ulster County and Ashokan watershed. In late 2011/early 2012, DEP and the USFS developed an EAB mitigating strategy for the Ashokan Watershed. The goal is to slow the spread of EAB employing the "SLow Ash Mortality" (SLAM) protocol. The strategy calls for the removal of all large ash trees (greater than 12" DBH) in the Ashokan basin while retaining ash less than 12" DBH. This reduces the effective breeding area of the EAB while retaining EAB on site, slowing its spread. A description of the implementation of the mitigation strategy in 2012 follows.

In February 2012, the six EAB sentinel trees established in 2011 were harvested and sampled, peeling seven to nine 1-meter bolts from each tree following the USFS EAB protocol. Sentinel trees are individual, girdled trees utilized to monitor the spread of EAB. The sentinel trees had been established at approximately 1-mile intervals along the Route 28 corridor, radiating west from the infestation site. EAB was not detected in any samples.

In the same month, all 10 EAB trap trees established in 2011 were felled and bucked (i.e., sawed into shorter lengths) for EAB destruction. The trap trees had been established in groups of three to four trees within one-quarter mile of the Route 28 EAB infestation site. Most EAB trap trees were infested with EAB. Trap trees are ash trees that have been girdled, producing stress that is intended to lure the EAB to the trees, thus slowing their spread. The trap trees are destroyed to kill the insects, prior to the May emergence of the adults.

Based on the sentinel and trap tree results, it was determined that the trap tree protocol was effective in slowing the spread of EAB in the Ashokan watershed. Therefore, in March 2012, 8 clusters of 3 trap trees (total of 24 trees) were established around the Route 28 infestation site and 3 clusters of 3 trap trees (total of 9 trees) were established within one-quarter mile of the Route 28A infestation site on the southeast side of Ashokan Reservoir. In addition, 5 EAB detection trees were established along the Route 28 corridor and 5 detection trees were established along Route 28A for continued monitoring of the western spread of EAB. The detection trees and trap trees are scheduled to be sampled and destroyed in late winter/early spring 2013.

One of the components of the EAB Ashokan mitigation strategy is a forest management project that will remove a large portion of ash trees greater than 12" DBH before they are infested with EAB. This project is under development. Unfortunately, in August 2012, EAB was discovered in the eastern portion of the project area on a peninsula of Ashokan Reservoir, indicating that EAB is spreading across the reservoir.

DEP has also proposed several forest management projects west of Reservoir Road near Ashokan Reservoir, based on forest inventory data and the potential for the spread of EAB.

*Japanese Barberry and Multiflora Rose (West Branch and Ashokan Reservoirs)*

DEP conducted invasive species management in advance of two forest management projects to help ensure the projects met their objective of increased forest regeneration. Foliar application of a 2% glyphosate solution (Razor Pro) was conducted by a certified applicator to control barberry at the Barrett Pond Forest Management Project site in Putnam County (West Branch Reservoir basin) and to control barberry and multiflora rose at the Plank Road Forest Management Project Site in Ulster County (Ashokan Reservoir). Eradication success will be evaluated in spring 2013.

### *Catskill Regional Invasive Species Partnership*

DEP continued to work regionally with partners on aquatic and terrestrial invasive species survey, education, and outreach in the Catskill Region. In 2012, the Catskill Regional Invasive Species Partnership (CRISP) participated in the DEP recreational boating steam cleaning vendor orientation, during which it provided an overview of invasive species that could threaten the water supply. DEP participated in CRISP quarterly meetings, served on the Executive Committee, provided comments on draft strategic documents, and aided in decision making on project funding.

### *Education and Outreach*

In April 2012, DEP gave a presentation at the New England Society of American Foresters annual meeting to disseminate the knowledge gained from implementing the EAB SLow Ash Mortality (SLAM) protocol on Ashokan water supply lands.

On January 11, 2012, DEP and NYSDEC Region 3 forestry staff conducted an EAB outreach program for the NYC Department of Parks at a field session at the Ashokan watershed infestation site on Route 28. Approximately 10 NYC Parks staff learned about the infestation symptoms, detection methods (hands-on training), use of sentinel trees for monitoring, and the use of trap trees to control EAB spread. The field session was followed by an indoor presentation describing the extent of the current Hudson Valley infestation, regional actions, and DEP strategies to mitigate EAB impacts on City lands.

## 4.4 Watershed Agricultural Program

The Watershed Agricultural Program (WAP) is a partnership that supports the development of Whole Farm Plans (WFPs), the implementation of BMPs, and related initiatives that assist watershed farmers. The WAP is administered by the Watershed Agricultural Council (WAC) using core funding provided by DEP along with technical and financial assistance from the USDA. Delaware County Soil and Water Conservation District (SWCD) and Cornell Cooperative Extension (CCE) provide planning and engineering services, educational programs, and other forms of WAP support.

The 2007 FAD requires DEP to report annually on a number of WAP goals and metrics that are summarized in Table 4.5 and the subsequent narrative. For information relating to the WAC Farm Easement Program, please refer to the Land Acquisition Program (Section 4.2).

Table 4.5. Summary of the WAP's accomplishments during 2012.

| Accomplishments | Large farms | Small farms | East of Hudson (EOH) farms |
|---|---|---|---|
| New WFPs completed | 0 | 6 | 6 |
| Number of WFP revisions | 20 | 4 | 10 |
| Nutrient management plans completed | 67 | 32 | 10 |
| Annual status reviews completed on active farms | 173 | 78 | 57 |
| Number of new BMPs implemented | 53 | 51 | 42 |
| Cost of implementing new BMPs | $1,380,483 | $443,442 | $574,705 |
| Number of existing BMPs repaired or replaced | 27 | 7 | 2 |
| Cost of repairing or replacing existing BMPs | $119,714 | $29,901 | $3,425 |
| New Conservation Reserve Enhancement Program (CREP) contracts developed | 1 | 1 | 0 |
| Acres enrolled in new CREP contracts | 19.9 | 9.1 | 0 |
| Number of CREP re-enrollment contracts completed | 1 | 0 | 0 |
| Acres re-enrolled in CREP contracts | 3.1 | 0 | 0 |

### 4.4.1 Whole Farm Planning

Currently in the West of Hudson (WOH) watershed, there are 276 known large farms, including eight new farms that were identified in 2012; two farms previously identified no longer meet program eligibility. Two hundred eleven large farms are still active (76%), of which 193 (91%) are enrolled in the WAP and 184 (87%) have WFPs.

The WAP has also identified 316 potential WOH small farms, of which 224 farms (71%) have been assessed for environmental conditions and 101 (32%) have WFPs, including six that were developed in 2012. Although the 2007 FAD requires that 10 WFPs be developed on small

farms each year, the FAD regulators agreed in February 2011 to lower this metric to 6-10 small farms per year in response to DEP's 2010 WAP Evaluation Report; this is part of the reason why 10 WFPs were not developed during 2012. A secondary reason was the departure of the WAC's Small Farm Coordinator, who accepted a new position in June, thereby creating a significant staff vacancy within the Small Farms Program for several key months of 2012.

In the EOH watershed, the WAP approved six new WFPs, which meets the FAD requirement of 6-10 new plans per year. Sixty-eight WFPs have been completed on EOH farms to date; 59 of these farms (87%) have commenced implementation of their WFPs.

During 2012, the WAP conducted annual status reviews on a total of 308 large, small, and EOH farms, which represents 94% of all active participating farms. As part of this process, the WAP confirmed that 65 large farms, 9 small farms, and 4 EOH farms were inactive.

### 4.4.2 BMP Implementation

As summarized in Table 4.6, the WAP implemented 182 BMPs in 2012 on large, small, and EOH farms at a cost of $2,551,670. To date, 6,236 BMPs have been implemented on all watershed farms at a total cost of $46.2 million. These figures include 4,801 BMPs on large farms ($37.8 million), 936 BMPs on small farms ($3.8 million), and 498 BMPs on EOH farms ($4.2 million).

Table 4.6. Implementation of BMPs on large, small, and EOH farms in 2012.

| NRCS Code | BMP Name | Large farms | Small farms | EOH farms |
|---|---|---|---|---|
| 313 | Waste Storage Structure | 4 | 3 | 3 |
| 314 | Brush Management | 0 | 1 | 0 |
| 317 | Manure Composting Facility | 0 | 0 | 2 |
| 340 | Cover and Green Manure Crop | 2 | 0 | 3 |
| 360 | Closure of a Waste Impoundment | 1 | 2 | 0 |
| 362 | Diversion | 0 | 4 | 2 |
| 382 | Fencing | 15 | 14 | 1 |
| 390 | Riparian Forest Cover | 0 | 0 | 3 |
| 391 | Riparian Forest Buffer | 1 | 2 | 0 |
| 393 | Filter Strip | 3 | 0 | 0 |
| 412/468 | Grassed Waterway/Lined Waterway | 0 | 0 | 2 |
| 500 | Obstruction Removal | 1 | 0 | 0 |
| 512 | Pasture and Hayland Planting | 1 | 1 | 0 |
| 516 | Pipeline | 0 | 5 | 1 |
| 528 | Prescribed Grazing | 2 | 0 | 2 |
| 533 | Pumping Plant | 0 | 0 | 1 |
| 558 | Roof Runoff Management | 1 | 1 | 4 |
| 560 | Access Road | 2 | 3 | 0 |

Table 4.6. (Cont.) Implementation of BMPs on large, small, and EOH farms in 2012.

| NRCS Code | BMP Name | Large farms | Small farms | EOH farms |
|---|---|---|---|---|
| 561 | Heavy Use Area Protection | 4 | 1 | 5 |
| 574 | Spring Development | 4 | 6 | 0 |
| 575 | Animal Trails and Walkway | 5 | 1 | 1 |
| 578 | Stream Crossing | 3 | 3 | 2 |
| 580 | Streambank Protection | 2 | 0 | 0 |
| 584/587 | Gully Stabilization/Structure for Water Control | 1 | 1 | 0 |
| 595 | Pest Management | 3 | 0 | 0 |
| 606 | Subsurface Drain | 1 | 1 | 3 |
| 612 | Tree and Shrub Planting | 5 | 4 | 0 |
| 614/642 | Watering Facility/Well | 4 | 1 | 1 |
| 620 | Underground Outlet | 1 | 1 | 1 |
| 634 | Waste Transfer System | 2 | 0 | 0 |
| 635 | Vegetated Treatment Area | 0 | 0 | 7 |
| 707 | Barnyard Water Management System | 2 | 0 | 0 |
| 3010 | Roofed Barnyard | 1 | 1 | 0 |
| 3110 | Calf Housing | 5 | 0 | 0 |
| 3410 | Manure Spreading Equipment | 4 | 2 | 0 |
| | Total number of BMPs implemented | 80 | 58 | 44 |
| | Total cost of BMPs | $1,500,197 | $473,343 | $578,130 |

### 4.4.3 Nutrient Management Planning

In 2012, 109 new or updated NMPs were completed on active large, small, and EOH farms. A total of 180 large farms are following NMPs, of which 97% are considered current (developed within the last three years).

Also during 2012, the WAP Nutrient Management Credit Program worked with 82 participating farmers who submitted manure spreading records in order to receive $332,512 worth of credits that can be applied towards their nutrient management expenses. An additional 20 farms received federal nutrient management incentive payments by enrolling in the USDA Agricultural Water Enhancement Program (AWEP). Twelve more farms have enrolled in the AWEP in order to receive federal nutrient management incentives in 2013.

### 4.4.4 Conservation Reserve Enhancement Program (CREP)

A total of 2,051.7 acres of riparian forest buffers are currently enrolled in CREP contracts, which includes 29.0 new acres that were enrolled and 3.1 acres that were re-enrolled in 2012. Three contracts expired in 2012, with the landowner declining to re-enroll.

### 4.4.5 Farmer Education Program

The WAP conducted 33 farmer education programs during 2012. A total of 778 people attended, of whom 51% were watershed farmers and 27% were "other" farmers. At least 47% of all WAP participants attended at least one farmer education program. Examples of key programs include the annual Catskill Regional Dairy, Livestock and Grazing Conference; six sheep and goat producer meetings; three calf raising events; one no-till production workshop; one winter crop school; three nutrient management workshops; two grain production group meetings; a beef and poultry production series for beginning farmers; several in-field grazing seminars; two soil health workshops; and numerous tours of farms and agribusinesses.

### 4.4.6 Farm-to-Market Program

The WAC continued to implement its Farm-to-Market Program, which includes the Pure Catskills Buy Local Campaign that reaches more than 50,000 people through its annual print guide, quarterly newsletters, periodic e-bursts, and website (www.purecatskills.com). Other program highlights for 2012 include the annual Farm-to-Market Conference (120 participants); a series of eight farm tours for existing and aspiring farmers sponsored by the Catskills Collaborative Regional Alliance for Farmer Training (CRAFT); implementing a regional "Fresh from the Catskills" marketing campaign for specialty crops; and initiating a pilot online retail store ("Pure Catskills Marketplace") designed to sell regional agricultural and wood products to audiences and consumers beyond the watershed region.

### 4.4.7 WAP Implementation Plan for 2013

The 2007 FAD requires DEP to report on the WAP implementation plan for the subsequent year, including the number and types of BMPs, estimated cost of those BMPs, NMPs to be created or revised, and WFPs to be completed or revised. The WAP plan for 2013 calls for:

- Implementation of 99 BMPs on large farms at a total estimated cost of $1,614,761.
- Implementation of 106 BMPs on small farms at a total estimated cost of $873,728.
- Implementation of 30 BMPs on EOH farms at a total estimated cost of $420,000.
- Completion of new/updated NMPs on 50 large farms, 42 small farms, and seven EOH farms.
- Revision of 25-28 large farm WFPs and development of new WFPs as needed.
- Development of 10 WFPs on small farms and 6-10 WFPs on EOH farms.

### 4.4.8 Related Research Activities

The following WAP-related research papers and books were published during 2012:

Ketterings, Q.M. and K. J. Czymmek. 2012. New York P Index Survey: What caused impressive improvements in NYS P balance? What's Cropping Up? 22:12-15.

Osmond, D. L., D. W. Meals, D. L.K. Hoag, and M. Arabi, eds. 2012. How to Build Better Agricultural Conservation Programs to Protect Water Quality: The National Institute of Food and Agriculture—Conservation Effects Assessment Project Experience. Soil and Water Conservation Society, Ankeny, IA.

Rao, N.S., Z. M. Easton, D. R. Lee, and T. S. Steenhuis. 2012. Economic analysis of best management practices to reduce watershed phosphorus losses. J. Environ. Qual. 41:855-64.

## 4.5 Watershed Forestry Program

The Watershed Forestry Program is a partnership between DEP, the WAC, and the USFS that promotes and supports the economic viability of well-managed working forests as a beneficial land use for watershed protection. The WAC utilizes core DEP contract funds and matching grants from the USFS to support the following initiatives: (1) forest management planning and stewardship, (2) BMP implementation, (3) logger and forester training, (4) model forest program, (5) urban/rural education, and (6) wood products marketing and utilization. The accomplishments of the Watershed Forestry Program are summarized in Table 4.7 and the subsequent narrative.

Table 4.7. Summary of Watershed Forestry Program accomplishments in 2012 and to date.

| | 2012 | To date |
|---|---|---|
| Total number of forest management plans completed | 79 | 1,076 |
| New plans/original enrollment | 55 | 964 |
| Plan updates/re-enrollment | 24 | 112 |
| Riparian plans completed | 55 | 451 |
| Riparian acreage | 1,374 | 14,664 |
| Total acreage enrolled in forest management plans | 14,307 | 197,223 |
| Forested acreage only | 10,740 | 153,385 |
| Total number of forest road BMP projects completed | 47 | 358 |
| New timber harvest roads | 45 | 288 |
| Remediated forest roads | 2 | 70 |
| Total number of portable bridge projects completed | 13 | 113 |
| Short-span cost-shares | 1 | 20 |
| Short-span loans | 8 | 46 |
| Long-span rentals | 0 | 1 |
| Long-span loans | 4 | 32 |
| Arch culverts | 0 | 14 |
| Forestry stream crossing BMP projects completed | 22 | 51 |
| Total Management Assistance Program accomplishments | 39 | 315 |
| Timber stand improvement projects | 25 | 177 |
| Wildlife enhancement projects | 7 | 67 |
| Invasive species control projects | 5 | 35 |
| Riparian improvement projects | 0 | 5 |
| Tree planting/deer fencing projects | 2 | 31 |
| Logger training workshops conducted | 12 | 227 |
| Number of participants | 154 | 2,154 |

### 4.5.1 Forest Management Planning and Stewardship

The WAC continued to fund the development and implementation of voluntary forest management plans by private landowners. This effort includes the first-time enrollment of properties under a WAC plan, the updating of older plans to meet newer WAC specifications, the development of riparian management plans as a subset of forest management plans, and the funding of projects through the Management Assistance Program (timber stand improvements, tree planting and deer fencing, riparian improvements, wildlife improvements, and invasive species control).

During the second half of 2012, the WAC initiated a comprehensive analysis of its forest management planning program based on preliminary research that suggests that having a voluntary WAC plan does not translate into sustainable forest management practices or increased BMP implementation (VanBrakle 2010). However, the same research does indicate that forestry plans enrolled in the NYS Forest Tax Law (the 480-a program, Real Property Tax Law § 480-a) do result in better forest management because landowners who have adopted those plans are required to implement the plans' timber harvesting recommendations or face potential enforcement actions. In addition, although 480-a properties do not demonstrate superior BMP implementation, they likely afford greater watershed protection benefits because of the 10-year commitment required of such properties by the program, which in turn helps to prevent forest fragmentation and parcelization. With this in mind, the WAC forest management planning program is currently undergoing an internal assessment and potential redesign, which will be completed during 2013.

### 4.5.2 BMP Implementation

The WAC continued to fund a variety of BMP implementation projects, including the installation of new timber harvest roads, the remediation of existing forest roads having erosion problems, the installation of stream crossing BMPs on forest roads that approach streams, and the use of temporary portable bridges during active timber harvest operations. The WAC also distributed 30 free samples of BMP technologies to loggers, landowners, and foresters; to date, the WAC has distributed more than 230 free BMP samples, including geotextile road fabric, non-petroleum chainsaw oil, traditional pipe culverts, hay bales, grass seed, straw wattles, erosion control blankets, silt fencing, and rubber belt water deflectors.

In the EOH watershed, the WAC continued to implement its Croton Trees for Tribs Program in partnership with NYSDEC's Hudson River Estuary Program. Thirteen projects were completed during 2012, representing 2.1 acres and 2,061 feet of riparian buffers. To date (since 2010), 28 projects have been completed, representing 6.9 acres and nearly 6,500 feet of riparian buffers, while more than 540 volunteers have planted over 1,800 trees and shrubs.

### 4.5.3 Logger and Forester Training

The WAC continued to partner with Cornell Cooperative Extension (CCE) of Greene County to sponsor and conduct voluntary workshops in support of the NYS Trained Logger Certification (TLC) Program. To promote this effort, the WAC produced an annual logger training cal-

endar, distributed TLC road signs and other materials to watershed loggers, advertised in *Northern Logger* magazine, and participated in the annual Deposit Lumberjack Festival, Catskill Forest Festival, and NYS Woodsman Field Days. Twelve workshops were held in 2012 and attended by 154 participants; one of these workshops was conducted exclusively for 33 BOCES students who have an interest in logging as a possible profession. One hundred nine individuals working in the Catskill/Lower Hudson region were fully certified as of December 31, 2012.

The WAC conducted three separate training workshops for three consulting foresters during 2012. Forty-five foresters are currently trained and approved to write WAC forest management plans, 26 of whom (58%) have written a WAC plan within the last three years.

### 4.5.4 Model Forest Program

The WAC continued to partner with SUNY College of Environmental Science and Forestry, CCE of Delaware and Greene Counties, Frost Valley YMCA, and Clearpool Education Center to coordinate and support four model forests throughout the watershed region: Lennox (Delaware County), Frost Valley (Ulster County), Siuslaw (Greene County), and Clearpool (Putnam County). Each model forest is utilized for education, outreach, demonstration, and research programs, with at least 60 events conducted at all four sites in 2012. The events attracted over 1,750 participants, including loggers, landowners, foresters, international professionals, and teachers and students from the watershed and New York City.

Additional activities worth noting from 2012 include a post-harvest inventory of silvicultural treatment blocks at Frost Valley, completion of a timber harvest at Siuslaw, completion of invasive species management plans and clearing/maintenance of interpretive trails at both Siuslaw and Clearpool, establishment of two demonstration projects at Clearpool (deer exclosure/forest regeneration and black swallow-wort removal), and completion of a wetlands inventory at Clearpool that was conducted by DEP during the summer and fall.

### 4.5.5 Urban/Rural Education

The WAC continued to partner with the CCCD and Common Ground Educational Consulting to implement an urban/rural school-based education program consisting of the Green Connections School Partnership Program, Watershed Forestry Bus Tour Program, and the Catskill Stream and Watershed Education Program (CSWEP). The annual Watershed Forestry Institute for Teachers was not held during 2012; instead, a reunion event was conducted in December at Frost Valley for about 20 teachers, who learned about new opportunities while receiving enhanced training from the USFS.

The 2012 Green Connections Program was conducted in the spring for 408 students from eight partner schools: four in the watershed and four in New York City. The 2011-2012 CSWEP also concluded in the spring, with 409 students participating from 30 classrooms in nine watershed schools. The 2012-2013 CSWEP is currently underway with about 400 students participating.

The Watershed Forestry Bus Tour Program held two funding rounds in 2012, with 17 grants awarded out of 40 applications. Eighteen bus tours were completed for approximately 973 participants, primarily New York City school groups but also from urban forestry organizations such as Trees New York. One bus tour in particular was organized by DEP for about 50 non-formal educators who work in New York City and teach all kinds of audiences about water quality protection, water conservation, and environmental stewardship.

In addition to school-based education, the WAC also partnered with CCE Greene County to implement a Forest Land Owner Education Program that includes a "You and Your Forest" informational letter series and a watershed-focused enhancement of the Cornell Master Forest Owners (MFO) Program. The "You and Your Forest" letter series was initiated in 2008 and in 2012 consisted of seven different eight-page letters that were sent to 50 watershed landowners every two weeks between February and June. The MFO Program consists of trained volunteer landowners who interact with fellow landowners to conduct property site visits (woods forums) and other forestry educational programs that teach their peers about the importance of long-term forest management. A kick-off meeting was held in March for 12 MFOs, and throughout the year more than five woods forums were held and numerous public events were attended, which resulted in 17 MFO visits being requested for landowners within the watershed and 30 MFO visits being requested for non-watershed properties.

### 4.5.6 Wood Products Marketing and Utilization

The WAC continued to administer and support the "Catskill WoodNet" marketing website (catskillwoodnet.org), which represents 88 businesses that utilize or sell locally harvested wood from the Catskill region. In support of this website, the WAC continued to publish a bi-monthly e-newsletter that routinely reaches 500-600 people. During 2012, the Catskill Woodnet website received 1,735 unique visitors, which is slightly higher than the 1,471 unique visitors during 2011. The WAC is currently focusing the bulk of its economic development efforts on developing an online retail store ("Pure Catskills Marketplace") that will sell products from both farm and forestry operations that participate in either the Pure Catskills or Catskill Woodnet campaigns. The pilot launch of this new website is planned for 2013.

## 4.6 Stream Management Program

The Stream Management Program (SMP) made considerable progress in 2012 toward protecting and restoring stream system stability and ecological integrity by facilitating the long-term stewardship of streams and floodplains. The overwhelming focus of the SMP this year was aiding the recovery of watershed communities from Tropical Storm Irene in August 2011. The impacts of Tropical Storm Irene were so substantial (exceeding the 500 year or 0.2% chance event in the Schoharie watershed, for example) that for the first time since the program's inception, watershed leaders and communities sought formal assistance from the City for mitigating future flood hazards. Flood hazard mitigation has always been a component of the SMP. For example,

prior to Tropical Storm Irene, the SMP had funded 37 stream projects (exceeding $13 million in funding) that addressed a flood hazard mitigation objective, had initiated the update of flood insurance rate maps for the watershed communities, and two of its partner SMPs had established floodplain management subcommittees to advance flood hazard mitigation priorities. In 2012, the SMP collaborated with regional stakeholders to forge a new programmatic framework for improved floodplain management and flood hazard mitigation. By the close of 2012, a framework had been developed and substantial progress made in defining the program's new elements.

The SMP also focused throughout 2012 on advancing flood recovery projects in partnership with the Natural Resources Conservation Service (NRCS) Emergency Watershed Protection Program (EWP), substantially advancing the surveys necessary to complete new floodplain maps for WOH communities, extending education, outreach and training opportunities, expanding the Catskill Stream Buffer Initiative (CSBI), and completing stream restoration projects.

Significant accomplishments of 2012 include:

- Conducted extensive training in the Post Flood Emergency Stream Intervention Protocol throughout the watershed, reaching 600 people, including the regional offices of both NYSDOT and NYSDEC.
- Partnered with the NRCS EWP to commence design and construction of 38 EWP projects, including leveraging $3.2 million in City SMP funding for an additional $12.8 million for the watershed. Delaware County Soil and Water Conservation District (DCSWCD), sponsoring 26 of the projects, was awarded Partner of the Year by the NRCS for its ambitious utilization of the EWP program.
- Constructed five stream restoration projects (three jointly funded by EWP), including Chichester Site 1 (Stony Clove, Ashokan basin), the Holden Project (Batavia Kill, Schoharie), Apple Hill (East Kill, Schoharie basin), West Branch Neversink River at Claryville (West Branch Neversink, Neversink basin), and Rondout Creek at Clair Road (Rondout Creek, Rondout basin). Together, these projects restore stability to more than one mile of watershed stream.
- Completed 35 CSBI projects that planted 11 acres addressing 2.4 linear miles of buffer;.
- Substantially completed the surveys necessary to produce preliminary floodplain maps for watershed communities in 2013.

### 4.6.1 Stream Management Plans and their Implementation

Publication of the Neversink Stream Management Plan in 2011 completed the set of mainstem stream management plans for the WOH watershed. Stream management plans can be viewed at www.CatskillStreams.org/Stream_Management_Plans.html. Adoption of these plans is necessary for watershed communities to be eligible for Stream Management Implementation Program (SMIP) funding through their local, basin-scale, SMP teams; it will also be required for communities to obtain SMP funding for local flood hazard mitigation analysis and planning. Every year, each team updates its Action Plan, which covers a two-year period and outlines its priority projects for the period, including SMIP funded projects.

As reported in 2011, the SMP approved transfer of all remaining SMIP funds to be used to leverage FEMA Flood Hazard Mitigation program and NRCS EWP program funding following Tropical Storm Irene. For this reason, only three small new SMIP projects were awarded in 2012, described below. At this time, several previously awarded SMIP projects are on hold pending completion of the EWP projects in 2013.

### *Delaware Basin*

DCSWCD, in partnership with the Delaware County Planning Department (DCPD), continued to implement the recommendations of the East and West Branch Delaware River Stream Management Plans through the Project Advisory Committee (PAC) and its subcommittees. The PAC worked closely with the program on floodplain management, flood hazard mitigation, highway infrastructure, recreation, and education and outreach. This year the program continued to strengthen its links with local floodplain administrators, emergency management officials, highway superintendents, agricultural extension, planning boards, chambers of commerce, and community leaders by sponsoring regular meetings and training for these officials, thereby extending support for improved stream management. Examples of this extension include support for and participation with the work of the Middletown Flood Commission to address flood issues in the Village of Margaretville and Fleischmanns; the Walton Flood Commission, including preparation of the Third Brook Management Plan; the East and West Branch Delaware Recreation Committees to plan for and design improved recreation access points along navigable sections of these rivers and downstream DEP reservoirs; and DCPD staff overseeing the successful County All Hazard Mitigation Plan update.

The DCSWCD's Emergency Stream Intervention Protocol, designed to properly clear streams of flood debris, was extended to Delaware County leaders, NYSDOT, and the regional offices of NYSDEC in 2012, training a total of 450 people. DCSWCD and DCPD also provided training to local surveyors and floodplain administrators in the current requirements and proposed amendments to the new National Flood Insurance Program. The sum total of these efforts has made the Delaware Watershed Stream Corridor Management Program a key resource for the county and a driving force for science-based stream and floodplain management throughout the region.

Beginning in December 2011, DCSWCD and NRCS teams were deployed to flood damaged sites to determine site eligibility for the EWP program and prepare damage survey reports (DSRs) that calculate the benefits and costs of each project. The teams visited nearly 50 sites and ultimately received NRCS's approval for 21 DSRs involving work at 31 sites, leveraging up to $1.495 million in matching funds from DEP (25% cost share). Although only one EWP project was constructed in 2012, the designs for the remaining 30 sites have advanced and will be completed in 2013. The Village of Fleischmanns, which suffered extensive damage during the 2011 flood events, is a focal point for DEP assistance, with DEP's engineering contractor Malone and

MacBroom LLC providing design and hydraulic modeling support at the eight project sites along Vly Creek and Bush Kill.

The DCSWCD was selected as the NRCS New York Partner of the Year for its dedicated work on the EWP program on behalf of the county. The total estimated project costs, including the portion of Delaware County outside of the NYC watershed, exceeded $5.2 million. NRCS noted that "this level of program utilization simply could not have occurred without the assistance of our partners at the DCSWCD Stream Team."

SMIP grant project progress included the completion of the Roxbury Mountain Road culvert and the purchase of dewatering pumps by Delaware County Department of Public Works (DPW) for use in its in-stream work. DPW also used $197,996 in SMIP grant funds to leverage funds from the Army Corps of Engineers for the study of medium hydraulic structures (culverts) in the watershed. Additional funds were approved for analysis of flood hazards in the Town of Middletown in 2013 and for the purchase of additional seed and mulch materials for the hydroseeder shared by town highway departments. Full descriptions of the SMIP projects funded can be found at www.CatskillStreams.org/grants.

### *Ashokan Basin*

As with the other SMP basin-scale programs, the Ashokan Watershed Stream Management Program's (AWSMP) 2012 combined focus was primarily on leveraging the NRCS EWP funding for priority stream restoration/EWP projects; aiding the watershed municipalities in planning for future flooding; and stepped up education, outreach, and training to support this planning. Although the AWSMP awarded no new SMIP grants in 2012, full descriptions are available at www.CatskillStreams.org/grants.

As described in Section 4.6.2, in 2012 the NRCS proposed a new benefit cost formula for determining project eligibility that included the potential economic impact of sediment loading from stream erosion. Using this formula, 24 sites were identified as having some merit for using EWP funds to mitigate impacts of eroding stream banks and adjacent hill slopes, and in some instances imminent threats to transportation infrastructure. The total number of sites and the 220-day timetable for execution of EWP projects exceeded the fiscal and administrative capacity of the AWSMP and sponsoring towns. The $1.3 million of remaining AWSMP funds are sufficient to complete the top five projects and will leverage an additional $3.8 million from the NRCS.

Three sites are located on the Stony Clove (Chichester Site 1, Chichester Site 2-3-9, and the confluence of Warner and Stony Clove Creeks) and the fourth is on Warner Creek Warner Creek Site 5). Designs were completed for these four sites in 2012, and one (Chichester Site 1) was constructed and is described in Section 4.6.4. The fifth project is located on the Beaver Kill in the Town of Woodstock, and is currently on hold.

As in the other basins, flood hazard mitigation efforts advanced in Ashokan. The Shandaken Area Flood Assessment and Remediation Initiative (SAFARI) is the SMIP-funded flood hazard mitigation committee headed by the Town of Shandaken. SAFARI continued working throughout 2012 with the consulting firm Tetra Tech Inc. to develop a flood hazard mitigation plan expected to be completed in summer 2013. The results of the SAFARI effort will position the Town of Shandaken to be ready to access future AWSMP funding to implement recommended projects or pursue advanced engineering analysis once updated floodplain maps are completed. The third annual Ashokan Watershed Conference ("People, Streams, and Floods: Lessons from Irene") was also geared to help the 100 public and municipal attendees understand the impacts of the recent major floods and the need to be better prepared.

In March, the AWSMP, in coordination with the Schoharie watershed SMP, DEP, and Trout Unlimited, offered three day-long training sessions on post-flood emergency stream response intended for professional contractors and municipal heavy equipment operators. Over 150 participants received instruction on the basics of stream process and BMPs for restoring stream channel dimensions under emergency response conditions.

The Cornell Cooperative Extension of Ulster County (CCE-UC) co-sponsored the second Catskill Environmental Research and Monitoring Conference at Belleayre Mountain in October. This two-day conference convened research scientists and natural resource managers for presentations of their ongoing environmental studies in the Catskills; educational overviews of geology, climate, and impacts of climate change on the Catskill environment; and discussions regarding future research. CCE-UC was the principal funder among the many partners to produce this biennial event.

A visit to www.ashokanstreams.org provides access to newsletters issued in 2012 detailing various volunteer efforts (e.g., stream cleanups and planting), interpretive stream hikes for the public, descriptions of streams in the watershed, updates on the CSBI's riparian buffer enhancement projects, and fact sheets. In 2012, three fact sheets were produced for use throughout the WOH watershed: Guide to Large Woody Debris Management, Flood Preparedness Guide, and Guide to Native Riparian Plants of the Catskills. Additionally, the Ulster County Soil and Water Conservation District established a source for future supplies of willow to support bioengineering projects and completed a comprehensive stream feature inventory assessment of Bush Kill in the Town of Olive. Finally, the AWSMP hosted a very successful Family Fish and Fun Day at Kenneth Wilson State Park in July.

### *Schoharie Basin*

Throughout 2012, the Greene County Soil and Water Conservation District (GCSWCD), Schoharie County Soil and Water Conservation District, and the Schoharie Watershed Advisory Committee (SWAC) continued implementation of stream management plans within the Schoharie Reservoir basin. Partnerships in 2012 were strengthened through the process of flood recovery

following Tropical Storm Irene. To this end, the GCSWCD and DEP worked with FEMA to secure funding for the repair of nine stream restoration projects, and with NRCS to design and implement seven EWP projects. The GCSWCD, NYS Emergency Management Office, and DEP also facilitated the FEMA Hazard Mitigation Program for the buyout of 21 properties in the Schoharie Basin.

Following Tropical Storm Irene, the SMP engaged its river engineering consultant, MMI, to work with the heavily damaged Town of Prattsville in its flood recovery efforts by modeling the flood hazard mitigation benefits associated with a range of potential projects. MMI met with the community twice in 2012 and projects identified by the study were included in a Long Term Recovery grant application to the Department of State, which was subsequently funded. MMI completed its draft report at the close of 2012, and in 2013 will bring its results to the Town of Prattsville for their potential use in flood hazard mitigation long term.

In 2012, three awards were given to cover the cost share for two EWP projects, and for the restoration of a riparian site where a house was being removed through the FEMA buyout program in Conesville. GCSWCD utilized New York State funds to cover the cost of the two EWP projects. Therefore, the only SMIP allocation in 2012 was to the site restoration in Conesville. The remaining funds will be utilized to advance a flood hazard mitigation analysis and 2013 EWP projects.

In 2012, seven SMIP-funded projects were completed: the Batavia Kill Stream Restoration at Holden, East Kill Stream Restoration at Apple Hill, East Kill Stream Restoration at Nikolaidis, Manor Kill Environmental Study Team, Windham Path Multi-Use Trail on the Batavia Kill, Lexington Pocket Stream Access Park, and the Mountaintop Better Site Design Plan. The Manor Kill Environmental Study team successfully involved youth and their families in water quality monitoring and testing, taxonomy, riparian zone restoration, invasive species identification, and public presentation skill building. The Mountaintop Better Site Design Planning effort led each community through a comparison between its local codes and model development principles, using a consensus building approach. This SMIP project was cost-shared with a $50,000 CWC Local Technical Assistance Program grant.

In total, 21 SMIP projects have been completed, two are ongoing (engineering funds made available to towns for culvert design and funding for road ditch seeding) and the remaining 12 are in process. Through the SMIP program, a total of 35 proposals have been funded with $1,685,735.50. Full descriptions of the projects funded can be found at www.CatskillStreams.org/grants. The stream restoration projects are further described in Section 4.6.4. GCSWCD also successfully continued the Schoharie watershed education and outreach program that is designed around three key events developed by the basin's Education and Outreach subcommittee: the sixth annual watershed summit, second annual watershed month, and the fifth annual Batavia Kill stream celebration. In 2012, the watershed summit was attended by 100 stakeholders and focused

on flood hazard mitigation at the local level and floodplain management. May was Schoharie Watershed Month, which provided opportunities for over 300 Mountaintop residents and visitors to participate in a variety of public events focused on stream stewardship and watershed appreciation. The Batavia Kill Stream celebration was put on hold for 2012 to allow staffing and resources to be focused on the heavy storm recovery construction schedule. Finally, as reported above in the Ashokan basin, the GCSWCD co-hosted two workshops for approximately 150 contractors and highway personnel in emergency stream work.

***Rondout/Neversink Basin***

The magnitude of flooding caused by Tropical Storm Irene in the Rondout/Neversink watersheds ranged from an approximately 50-year (2% chance) flood in some parts of the basin to between the 100-year (1% chance) and 500-year (.02% chance) flood in others, so flood debris cleanup was a first priority. The year began with coordination of debris cleanup, under the rapidly executed Catskill Watershed Corporation "Debris Cleanup Program," at seven riparian sites in the two basins. This work included developing, bidding, and managing a contract for the recovery of fuel tanks and construction debris from floodplains, and clearance of several large woody debris channel obstructions. Some of the extracted large woody debris was incorporated as root wad revetment into the restoration projects described in Section 4.6.4.

After massive flood events, a call for dredging is expected, because the public generally believes that gravel deposits are the cause of the flooding they have just experienced and dredging the solution. In June, a standing-room-only public meeting was held at a Claryville fire department to respond to the growing community calls for widespread channel dredging. The goals and structure of the Rondout/Neversink Stream Program (RNSP) were explained, and program staff encouraged the community to wait for a detailed hydraulic engineering analysis, building on the forthcoming FEMA floodplain maps, to determine which management practices would effectively reduce flood elevations and be cost-effective and sustainable, laying the groundwork for the emerging Local Flood Hazard Mitigation Analysis initiative. The need to be responsive to concerns led the RNSP staff to turn their attention to hands-on projects. The focus of the RNSP work in 2012 was to advance and complete restoration projects, debris removal, and CSBI projects.

Prior to Tropical Storm Irene, the RNSP had been preparing to bring the Neversink stream management plan to the Towns of Denning and Neversink for adoption. The RNSP staff made a strategic decision to postpone adoption until an update of the plan, reflecting the post-Tropical Storm Irene stream and floodplain condition, could be performed. This rapid reconnaissance was accomplished in December 2011, and the revision of the Neversink stream management plan was completed during 2012. Priority assessments recommended by the plan were accomplished in summer 2012, including detailed geomorphic assessments of bank erosion sites on the East Branch of the Neversink River. During plan revision, the project team convened meetings of the Watershed Advisory Group in the spring and fall, building community understanding of how adoption of the plan would lead to eligibility for SMIP grants. The SMIP grants program will be

initiated in the next contract with Sullivan County SWCD. An infrastructure subcommittee was initiated in January, and subsequent meetings in March and November helped define their component of the SMIP grant program. Similar meetings were held with the Education and Outreach Subcommittee. Two public meetings were hosted in December to share the revised management unit recommendations with the communities, interactively prioritize the general recommendations in the plan, and begin building a flood hazard database through completion of a landowner survey. These public meetings were well attended, with vigorous discussion about differing approaches to mitigate flooding, especially in Claryville.

Within the Rondout/Neversink basin, a single EWP project, on Rondout Creek at Clair Road, was identified. With the RNSP's coordination and leadership, the project moved from design to construction within the year. This project is described in Section 4.6.4.

By year's end, the revised stream management plan was being prepared for summary publication and distribution to the community. The plan was adopted by the Towns of Denning and Neversink February 2013.

The successful collaboration with the Tri-Valley School District continued, marked by further development of the Plant Materials Center to propagate and grow out plant stock for CSBI riparian planting projects, and involvement of the students in these plantings as part of their Conservation Class curriculum. In spring 2012, Sullivan County 4-H brought the stream simulation model into the classroom to teach students about stream processes, demonstrate stream dynamics, and show them how to run the model. The students demonstrated the model at two community fairs, where they instructed the public on healthy stream function and BMPs.

### 4.6.2 Flood Recovery

Emergency flood response transitioned to long-term flood recovery in 2012. At the community scale, the SMP and its partners provided technical and funding assistance to communities and towards the local cost share and design of NRCS EWP Projects. At the same time, SMP and its partners worked at the watershed scale with a regional Flood Hazard Mitigation Working Group to forge a programmatic response to Tropical Storm Irene that provides communities a way forward to mitigate flood hazards. In September 2012, this working group reached an "agreement in principle" that identified a framework for enhanced flood hazard mitigation in the WOH watershed.

The approach will use the powerful hydraulic models developed as part of FEMA's flood studies to analyze the ability of various projects to mitigate the inundation hazard posed by flooding. (This analysis is called a Local Flood Hazard Mitigation Analysis, or LFHMA.) Initially, the focus will be on inundation hazards in villages, hamlets, and population centers. NYC Watershed Stream Management Programs will provide funding for consultants to perform the LFHMA and associated planning services through their SMIPs. Stream Management Programs will also

provide technical, administrative, coordination, and outreach support and guidance to communities undertaking this effort.

As scoped, participating communities would be guided by a consultant to evaluate the relative hazard mitigation impact of a full range of projects. For example, floodplain restoration would be evaluated, as would the potential relocation of select structures or the elimination of hydraulic constrictions. To advance toward funding, a project would have to demonstrate a flood hazard mitigation benefit, and a water quality benefit as well. This process will also enable communities with projects identified previously in their County Flood Hazard Mitigation Plans to quantitatively evaluate the benefits of those projects. Once demonstrated by the LFHMA to provide sufficient benefit, locally sourced funds to advance projects to design and then construction would derive from existing SMP SMIP funds, a new CWC Flood Hazard Mitigation Implementation Fund (CWC FHM Fund), or other outside sources, where available.

Following completion of the agreement in principle in September, the SMP partners developed a draft template scope of work for the LFHMA that was near completion by the close of 2012. The scope of services defines the activities and deliverables expected of consultants who would advise communities under the program. In fall 2012, DEP and the CWC had also begun drafting the rules for the new CWC FHM Fund. This program is expected to roll out in 2013.

### *Emergency Watershed Protection Program*

In addition to FEMA's efforts, the federal government also plays a substantial role in flood recovery throughout the United States through the NRCS EWP. The NYC watershed region is no exception. The programmatic partnership between the SMP and NRCS was taken to a new level following Tropical Storm Irene, owing to the availability of SMP funding to serve as the local match (for the first time), and to a new formula derived by the NRCS to factor suspended sediment into the benefit cost analysis that determines project eligibility. For the first time, eroding stream banks in remote areas, not adjacent to infrastructure or homes, became eligible for this federal program, solely because of their contribution to suspended sediment in a public drinking water supply. The EWP program was activated on April 1, 2012 and project selection progressed through spring and summer 2012. The availability of SMP funds to serve as the local match varied considerably from basin to basin. Where possible, the use of SMP funds was approved. Projects were selected based on the availability of local cost share, degree of threat to infrastructure and private property, and degree of erosion/contribution to suspended sediment.

The SMP teams and NRCS evaluated more than 100 potential project sites for eligibility. In the final evaluation, the NRCS approved a total of $16.2 million in federal funds for 55 project sites in the WOH watershed. A total of $3.2 million has been committed to 38 individual projects by DEP. Advancing these projects to design has been the overwhelming focus of the SMP and its partners in 2012. Five projects were constructed in 2012 and the remaining projects are scheduled to be constructed in 2013 (Table 4.8).

Table 4.8. Summary of NRCS EWP projects sponsored in 2012 in the WOH watershed.

| Basin | Number of projects | Completed 2012 | Construction 2013 |
|---|---|---|---|
| Ashokan | 4 | 1 | 3 |
| Delaware | 26 | 1 | 25 |
| Rondout/Neversink | 1 | 1 | 0 |
| Schoharie | 7 | 2 | 5 |
| Total Funding | 38 | 5 | 33 |

The NRCS EWP remains a challenging partnership program for the SMP. The EWP is a single objective program—protecting capital assets like infrastructure and homes, while the SMP is a multi-objective program—designing for sediment transport and considering asset protection as only one of several objectives. This requires longer design and construction terms than the 220-day window required by EWP. DEP and its partners continue to work with NRCS to build greater flexibility into their program in an effort to integrate a wider array of practices that fulfill multiple objectives and adopt a more comprehensive analysis of stream process issues during the design of projects.

### *CWC Debris Removal Program*

Following the historic flooding associated with Tropical Storms Irene and Lee, woody and. man made debris were strewn throughout the stream network of the WOH watershed. Through the FEMA program, much of the debris was removed immediately around public infrastructure, but debris located more than 100 feet upstream and downstream of the infrastructure was ineligible for FEMA funding. In order to address this concern, the CWC and DEP developed a funding program focused on removal of the hazardous debris lying outside of FEMA's eligibility zones. The CWC debris removal program also provided funding to address the man made garbage that had been deposited during the storms and which constituted an aesthetic issue in an area where the economy depends on tourism. In some instances the man made garbage included hazardous debris such as oil and propane tanks, but it also included tons of other garbage that reduced the aesthetic quality of the Catskills.

Between January and June 2012, the debris program funded 87 debris removals, which included approximately 113 individual sites. DEP and CWC staff reviewed and approved components of each proposal, eliminating any requests, or portions of requests, that fell outside the scope of the program. As of December 31, 2012, 75 of the approved projects were completed, with the remaining 12 under contract to be completed (Table 4.9).

Table 4.9. Summary of the Catskill Watershed Corporation's post-Tropical Storm Irene debris program.

| Basin | Approved projects | Denied projects | Completed 12/31/12 | Total cost |
|---|---|---|---|---|
| Ashokan | 43 | 12 | 42 | $ 469,342.59 |
| Schoharie | 24 | 7 | 20 | $ 352,910.00 |
| Delaware | 18 | 16 | 12 | $ 223,449.00 |
| Neversink/Rondout | 2 | 1 | 1 | $ 45,109.80 |
| Total | 87 | 36 | 75 | $1,090,811.39 |

### 4.6.3 Floodplain Mapping and Streams Geodatabase

FEMA continued work under its contract with Risk Assessment, Mapping and Planning Partners (RAMPP) for the mapping of floodplains in the WOH watersheds through 2012. FEMA is remapping floodplains along nearly 486 miles of stream, with over 192 miles mapped as detailed studies under the $7 million Cooperative Technical Partnership between DEP and FEMA Region II. FEMA is assisted in the outreach and education effort by NYSDEC 's Floodplain Management Section, which coordinates quarterly Map Steering Committee meetings in the Catskill and Delaware basins. Training with Map Steering Committees during 2012 included presentations on map development processes such as hydrologic and hydraulic analyses, information for floodplain administrators on elevation certificates, substantially damaged structure determination, and the Community Rating System. A series of three meetings is planned for the map release and review process in 2013.

Survey work for detail study reaches was completed for the Esopus, Neversink, Rondout and Schoharie basins in 2012. Survey crews also completed most reaches for the East and West Branch Delaware basin, with the exception of three stream segments that were added to the study as a change order. Hydrologic analysis was completed for all basins except the West Branch Delaware. FEMA expects RAMPP to complete hydraulic analyses and base map production for a late spring 2013 preliminary map release in the Catskill basin, followed by a late summer map release in the Delaware basins. FEMA is also providing DEP with complete copies of the digital hydraulic models, flood surveys, and all reports and photos related to the studies for future use by communities engaged in LFHMA activities.

FEMA's survey contractor also worked with DEP, NYSDEC, and local surveyors to establish 50 pairs of permanent survey monuments across the WOH watershed for use by surveyors who produce elevation certificates for home owners involved with the National Flood Insurance Program (NFIP). This product was added to the project at DEP's request in an attempt to reduce the cost of participation in the NFIP. The monuments also will facilitate the monitoring of stream channel conditions by stream management professionals.

In 2012, the SMP assisted in the quality review of a new GIS stream alignment layer in the National Hydrography Dataset (NHD) produced by a DEP GIS consultant. This new layer replaces the 20-year-old map layer of streams that was developed from obsolete USGS quad sheets. The new layer, based on LiDAR topography and its comprehensive database, will greatly improve mapping and modeling capabilities. The layer will also support an update of the functional capability of the streams geodatabase and expansion of the extent of geodatabase coverage. The new alignment was used by FEMA in the floodplain mapping contract.

FEMA has provided DEP with the cross section survey data from the flood studies for incorporation into the streams geodatabase. DEP's Americorps intern processed over 2,300 cross sections and has been characterizing the channel bankfull dimension using Rivermorph geomorphic software. This characterization will provide stream managers with a greater ability to determine channel stability using the GIS. The stream GIS manager and intern also assisted with the quality review of new 2-foot contour map coverage for the watershed.

### 4.6.4 Stream Projects

The 2007 FAD requirement to complete a set of five stream restoration projects by May 2012 was accomplished in 2011 and reported in the 2011 FAD Annual Report. In 2012, the SMP and its partners worked creatively to leverage existing project funding for federal funding from the NRCS EWP program, the FEMA Flood Hazard Mitigation Program, and NYSDEC. It is beyond the scope of this report to document progress on each project; instead, the most significant are highlighted. The projects substantially completed in 2012 are listed in Table 4.10 and mapped in Figure 4.10. For additional photographs and details on many stream projects, visit www.CatskillStreams.org/projects..

Table 4.10. Stream Management Program projects active in 2012.

| Basin | Project ID | Type of project | Name of project | Funding sources |
|---|---|---|---|---|
| Schoharie Basin | | | | |
| | S-45 | Full channel restoration | East Kill, Apple Hill | DEP, NRCS, ACOE |
| | S-46 | Full channel restoration | Batavia Kill, Restoration at Holden | DEP, FEMA |
| Delaware Basin | | | | |
| | D-30 | Stormwater and infrastructure | Roses Brook, Roxbury Mountain Road Culvert | DEP |
| | D-46 | Streambank stabilization | Johnson Hollow Brook, VanValkenburg Farm | DEP |
| | D-47 | Streambank stabilization | Marvin Hollow, DSR-D-TW-03 | DEP, NRCS |
| Ashokan Basin | | | | |
| | A-12 | Full channel restoration | Stony Clove Creek, Chichester Site 1 | DEP, NRCS |

Table 4.10. (Cont.) Stream Management Program projects active in 2012.

| Basin | Project ID | Type of project | Name of project | Funding sources |
|---|---|---|---|---|
| Rondout Basin | | | | |
| | R-6 | Streambank stabilization | Rondout Creek, Claire Road | DEP, NRCS, FEMA |
| Neversink Basin | | | | |
| | N-2 | Full channel restoration | West Branch Neversink, habitat restoration | DEP |

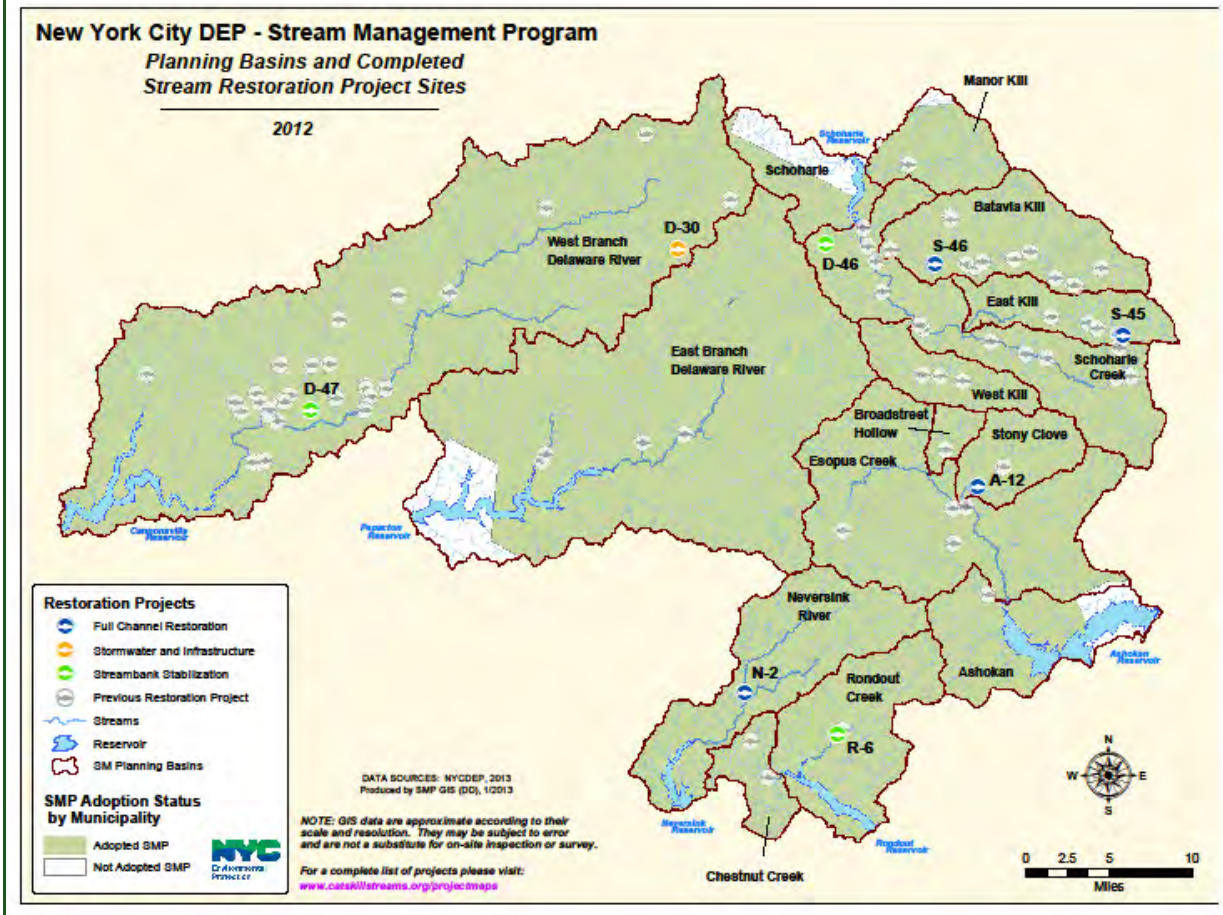


Figure 4.10 SMP restoration projects substantially completed in 2012.

### *Delaware Basin*

On Roses Brook in the West Branch Delaware basin, SMIP funding enabled a substantial hydraulic constriction to be addressed by upgrading an undersized culvert with a state-of-the-art bottomless three-sided concrete box culvert, designed to handle the flows of water and sediment associated with the 1% chance storm event. The enlarged box culvert will facilitate sediment

transport, thereby reducing the need to remove gravel and debris from the upstream side of the bridge. The natural streambed bottom will promote fish passage continuity (Figures 4.11 and 4.12).


Figure 4.11 Roses Brook: condition pre-construction.


Figure 4.12 Roses Brook: condition post-construction.

On Johnson Hollow Brook, the DCSWCD and DEP worked with the WAP technical team to design and construct a streambank stabilization project on the VanValkenburg Farm. Constructed rock riffles were installed to provide grade control for an entrenched headwater section of this Schoharie basin stream. This project will enable the WAP to enroll 6 acres of riparian land into the CREP easement program, and marks a resumption of the efforts to address stream issues on lands being considered for CREP participation (Figures 4.13 and 4.14).

Figure 4.13 Johnson Hollow Brook: condition before restoration.

Figure 4.14 Johnson Hollow Brook: condition after restoration.

### *Ashokan Basin*

A set of stream restoration projects are being advanced in the Stony Clove sub-basin to address sources of fine sediment. These projects are collectively labeled “the Chichester reach”, identified by the Stony Clove stream management plan as a high priority reach for restoration given the extent of stream and adjacent hill slope erosion of glacial deposits loaded with silt and clay. Prior to Tropical Storm Irene, this reach extended from the Silver Hollow bridge downstream to the Route 214 bridge in Chichester. Tropical Storm Irene greatly exacerbated incision upstream of the Silver Hollow bridge, so that the reach now extends up to the confluence with the Stony Clove’s first main tributary, Warner Creek. In 2010, DEP and the AWSMP commissioned MMI to conduct a comprehensive diagnostic assessment of this reach and develop conceptual approaches to treatment. In 2011, MMI completed designs on four stream restoration/bank stabilization projects planned for construction in 2011-2012. Flooding caused by Tropical Storms Irene and Lee postponed construction to 2012, yet allowed for the NRCS EWP program to help sponsor the cost of the projects. In late summer 2012, Site 1 was constructed and completed at a cost of nearly $1 million. EWP funding covered approximately 60% of the cost.

At the Chichester Site 1 restoration project site, a mass failure was present on the left bank (facing downstream) approximately 400 feet downstream of the Silver Hollow Road bridge (Figure 4.15). The project site was identified as (1) a significant point source contributor of fine sediment; (2) an unstable reach propagating instability both up and downstream; (3) an ongoing property loss problem for the primary landowner; and (4) an officially recognized and supported project site by the Town of Shandaken, as part of its effort to reduce the sediment supply delivered to the creek in the flood prone village of Phoenicia, approximately two miles downstream.

The project constructed a 550-foot-long floodplain bench along the left bank at the site of the mass failure that includes rock and root wad revetment for erosion protection (Figure 4.16). The mass failure area and the adjacent floodplain bench were graded and planted with a mix of native herbaceous/shrub/tree species to reconnect the longitudinal gap in the riparian buffer, and the right bank was protected with rip-rap revetment. Four in-stream structures were used to hold the bed grade and keep the thalweg in the stream center to reduce bank erosion. Two constructed riffles span the channel and create bed stability by preventing stream down cutting and subsequent bank instability. Channel roughness was also increased by placement of boulder clusters. Within two weeks of construction a modest flood occurred in the Stony Clove basin, but the project fared well, with minimal erosion.

Figure 4.15 Chichester Site 1 before restoration.

Figure 4.16 Chichester Site 1 after restoration.

### *Schoharie Basin*

*East Kill Restoration at Apple Hill (includes Nikolaidis and Apple Hill SMIP projects)*

This stream restoration project is located in the upper East Kill off Colgate Road in East Jewett, NY. The project reach included two large active mass failures approximately 300 feet long and several hundred feet of exposed streambank with a high fine sediment content. Historic channel instability, caused by ineffective land management and flooding, triggered both mass failures and accelerated stream instability in the reach. Historic efforts to control the reach included berming, stream dredging, and bank armament. Soil borings confirmed that the upstream mass failure generated serious risk to two homes, a barn, and septic system, causing risk to humans, property and water quality (Figure 4.17).

The project mitigated the hazard to the homes by realigning the channel away from the slope and providing armament of the toe of the slope. Project components included the realignment and resizing of 3,500 feet of channel, the installation of 23 rock structures, and installation of extensive bioengineering treatments and riparian plantings over the 11-acre site. These efforts will improve water quality, reduce risk to humans and property, reduce erosion and excessive sediment loading, restore floodplain function, and improve aquatic and terrestrial habitat. Due to the extensive damage to the barn's foundation, the home owner demolished and removed the structure from the slope and a new septic system was installed on the newly stabilized slope. The lower high bank failure was also stabilized by re-grading the bank to a lower stable slope, realigning the channel away from the toe of the slope, and installing slope drains to remove excessive water in the slope. Several rock structures and bioengineering treatments were also installed to provide long term stability to the bank (Figure 4.18). The project was a collaboration of the GCSWCD, DEP, SWAC, the Army Corps of Engineers, and NRCS.

Figure 4.17 East Kill at Apple Hill prior to restoration.

Figure 4.18 East Kill at Apple Hill following restoration.

*Batavia Kill Restoration at Holden*

Based on GCSWCD's historical monitoring, this 3,500 foot project reach was characterized as being highly unstable, a condition that was ongoing for many years and likely due to a combination of factors, including geomorphic setting and past land use practices (Figure 4.19. Project construction began in August 2011 but was interrupted and postponed until fall 2012, due to Tropical Storm Irene. The project, completed in 2012, involved stream bank and channel excavation to achieve stable geometry and installation of in-stream stabilization structures, including 5 J-hooks, 9 rock vanes, and 3 cross vanes. A variety of vegetative treatments was installed on the project site following construction, including live willow fascines, live willow stakes, willow brush layering, willow posts, and native seeding and mulching. Additionally, a mix of 6,000 native tree and shrub species adapted to streamside conditions was planted along the restored stream channel (Figure 4.20).

Figure 4.19 Batavia Kill at Holden prior to restoration.

Figure 4.20 Batavia Kill at Holden following restoration.

Significant work was also completed in 2012 to further engineering designs for the additional five EWP projects, and for repairs to nine stream projects damaged by Tropical Storm Irene. These projects are scheduled to be constructed in 2013. In addition, GCSWCD designed and oversaw construction of a FEMA-funded culvert replacement on Griffin Road in Jewett along the East Kill. FEMA mitigation funding was obtained to increase the size of the culvert to pass the 100-year event. A three-sided concrete arch culvert, 32 feet long, 20 feet wide, and 9 feet high, was installed, substantially mitigating future flood hazards and greatly increasing sediment transport. A single rock cross vane was installed upstream of the new culvert to direct flow through its center. The project also included the installation of various erosion controls, bioengineering practices, and plantings.

In 2012, the Schoharie team planted riparian buffer or restored stream system stability to over 2 miles of Schoharie watershed stream, bringing the total length treated to date to 8.9 miles.

***Rondout/Neversink Basin***

The RNSP was able to integrate funding from the NRCS EWP, FEMA, and the RNSP into a reach scale stream restoration project achieving multiple objectives on Rondout Creek at Clair Road in Sundown, NY. Tropical Storm Irene doubled the width of the creek and stripped away several hundred feet of Clair Road, eroding the bank to within several feet of a home. The NRCS funding protected the residence, the FEMA funding protected the road, and the RNSP funding enabled the natural channel design approach to address the dramatic channel over widening. The RNSP team coordinated the project, including design development (using MMI), bidding, and managing the contract and construction. Total project costs, not including design and construction supervision services (which were funded by the SMP), were $308,218, of which the RNSP provided approximately 50%. The project reused 30 large trees that had been deposited by flood flows on DEP property downstream.

In addition to this project, several large CSBI projects were completed, including 400 feet of bioengineered bank stabilization at the Panasci/Bailey properties near Claryville, and a floodplain regrading and planting project to improve the emergency work performed at the Van Aken property near Sundown immediately following the 2011 flooding. Several other CSBI projects were also completed in the basins, as reported in the CSBI portion of this report, Section 4.7.3.

The FAD deliverable demonstration restoration project on the West Branch of the Neversink River at Frost Valley Road was substantially completed in August, with only final grading and revegetation scheduled for late October and November when bioengineering plant materials became available (following willow dormancy). The project was completed in November (Figures 4.21 and 4.22). This project also incorporated two valuable side collaborations: repair of the Frost Valley Road bridge abutments (Sullivan County DPW separately contracted with the same construction firm to avoid separate mobilization and site restoration costs), and the creation of an access road and stable landing adjacent to the bridge so that the local fire depart-

ment can pump water for fire fighting. On September 18, 2012, a 2% chance flood (the 50-year event) hit this watershed, causing damage to the floodplain bench at the un-vegetated project. Repairs will commence in spring 2013.


Figure 4.21 West Branch Neversink Demonstration Project, before restoration.


Figure 4.22 West Branch Neversink Demonstration Project, after restoration.

## 4.7 Riparian Buffer Protection Program

DEP values the importance of protecting and managing riparian buffers as an important component of an effective overall watershed protection program. To this end, many of DEP's watershed programs, partnerships, and research initiatives actively address the protection, management, and restoration of riparian buffers in the New York City watershed. This section will provide an update on each of the milestones set forth in the 2007 FAD relating to riparian buffer protection, including the progress of existing DEP programs, the Catskill Streams Buffer Initiative, and education and outreach activities.

### 4.7.1 Activities on City-owned or Controlled Land

***Land Acquisition Program***

The Land Acquisition Program (LAP), which is described in detail in the 1997 MOA, seeks to prevent future degradation of water quality by acquiring permanent real property interests. The overarching goal of the program is to ensure that undeveloped, environmentally sensitive watershed lands remain permanently undeveloped, and that the watershed continues in the long term to be a source of high quality drinking water to the City and other upstate consumers. Section 4.2 conveys the comprehensive progress of the LAP in 2012.

While the LAP uses 300-foot boundaries either side of a watercourse to delineate water features under the "natural features criteria," for purposes of this report riparian buffers are defined as land within 100 feet of stream banks, but excluding the length of "shoreline" around reservoirs, ponds, lakes, or wetlands. The best way to protect buffers is to secure fee simple ownership. The next best mechanism is to secure conservation easements (CEs) on privately-held land. Through the end of 2012, 38.4% of the entire 1,049,483-acre Catskill/Delaware watershed was protected by outright ownership or easement held by DEP, the WAC, or NYSDEC, or by other public or private open space entities, such as municipal parks or land trusts. This area includes roughly 34% (25,956.9 acres) of all stream buffers in the watershed. Since 2004, DEP has increased the percentage of protected stream buffers from 7.5% to 15.4%. Table 4.11 presents a breakdown of the total land area in the Catskill/Delaware watersheds by ownership.

DEP also funds the WAC's acquisition of CEs on farms. Such easements allow farming to continue under Whole Farm Plans, while prohibiting agricultural use within 25 feet of streams.

Table 4.11. Catskill/Delaware System[1] riparian buffer[2] summary as of 2/2/2013.

| Land protection category | Total in Catskill/ Delaware System including reservoirs (acres) | % Total Catskill/ Delaware System area | % Total Catskill/ Delaware System stream miles | % Total Catskill/ Delaware System riparian buffers |
|---|---|---|---|---|
| *Publicly-owned or Controlled lands* | | | | |
| NYC-owned non-LAP property (pre-1997 or facility- related) | 61,429.4 | 5.9 | 2.8 | 2.6 |
| NYC-owned LAP property (post-1997, fee simple)[3] | 79,069.7 | 7.5 | 7.8 | 7.8 |
| Land protected by LAP NYC CE[3] | 23,478.4 | 2.2 | 2.5 | 2.4 |
| Land protected by LAP WAC CE[3] | 22,653.0 | 2.2 | 2.7 | 2.6 |
| Total NYC lands and easements | 186,630.6 | 17.8 | 15.7 | 15.4 |
| New York State-owned land | 207,977.8 | 19.8 | 17.2 | 17.6 |
| Other in protected status[4] | 8,814.4 | 0.8 | 1.1 | 1.1 |
| Total Catskill/Delaware public land | 403,422.8 | 38.4 | 34.0 | 34.0 |
| *Private Watershed Lands* | 646,061.6 | 61.6 | 66.0 | 66.0 |
| Total lands in Catskill/Delaware System | 1,049,484.4 | 100.0 | 100.0 | 100.0 |

[1]The Catskill/Delaware System includes all WOH basins plus West Branch, Boyd Corners, and Kensico.

[2]100-foot area on both sides of watercourses, which includes streams and rivers and excludes reservoirs, ponds, and lakes.

[3]Under contract or closed.

[4]"Protected status" means the land is believed to be under some form of permanent ownership by a land trust or municipal government.

### *Natural Resource Management Program*

With regard to the use of DEP land, riparian buffers are strongly considered when reviewing requests from outside parties or instituting projects. For example, DEP allows agricultural use of DEP land, but requires a minimum 25-foot buffer between farming activities and the stream. Proposals that plan on maintaining a buffer greater than 25 feet are given extra points in their rating. DEP reviews all land use permits and proposed projects, including stream crossings for silvicultural projects, for potential impacts to riparian buffers. The SMP and various other DEP staff are solicited for input and have the opportunity to provide suggestions on how to avoid or mitigate these impacts. Additionally, in securing required stream crossing permits, DEP requires that extra measures be taken by foresters to select the BMPs for the stream crossings (e.g., temporary bridges, temporary arch culverts) to mitigate adverse impacts on the stream and floodplain.

### 4.7.2 Activities on Privately-Owned Lands

Privately-owned lands contain approximately 66% of the total riparian buffer acreage (50,343.3) in the Catskill/Delaware watershed. Privately-held riparian lands are most commonly found in the Cannonsville basin (81.8%) and are least common in the West Branch Reservoir basin (42.3%). Many of these riparian buffers are also protected to some degree by various combinations of MOA programs. For instance, Whole Farm Plans and watershed forestry plans have been developed and implemented largely in the Cannonsville and Pepacton basins, where private ownership is greatest. This section describes the ongoing activities of DEP programs that protect and enhance riparian buffers on privately-owned land.

#### *Catskill Streams Buffer Initiative*

The Catskill Streams Buffer Initiative (CSBI) is an important component of the City's efforts to protect and enhance riparian buffers and is an integral component of the SMP (see Section 4.6 for the details of the SMP's activities in 2012). The SMP and its regional partners address riparian buffers through the mapping of riparian vegetation, corridor planning, designing and constructing stream restoration projects, removing invasive plants, and conducting extensive education and outreach. The CSBI works to enhance the extent of riparian buffers where gaps are evident in the landscape and is designed to provide a program for sites not eligible for other programs.

##### *Native Plant Materials*

Plantings are an essential ingredient of natural stream bank stability and an important component of DEP's overall stream management mission to restore ecosystem integrity. Providing Catskill native plant material is thus one of CSBI's unique aspects. In order to do this, plant selection, propagation, and grow-out have and will continue to be carefully considered. As a result of these efforts, local genotype planting stock have become available not only to CSBI, but also other stream restoration projects initiated by DEP and its partners. CSBI coordinators have established plant material holding areas to allow access to stock on an as needed basis. Once they reach these holding areas, the plants are carefully maintained to ensure the appropriate vigor, root strength, and overall health necessary to succeed in streamside restoration activities.

##### *Plant Supply*

After conducting a comprehensive solicitation of plant-related services to over 200 nurseries throughout the Northeast, DEP identified New York City Parks and Recreation's Greenbelt Native Plant Nursery as the best entity to work with to collect, clean, and store Catskill native plant seed, and to propagate this seed for the CSBI.

In 2012, DEP received 7,699 gallon-sized trees and shrubs from Greenbelt. To date, Greenbelt has provided DEP with 72,000 herbaceous plugs, 22,699 gallon-sized trees and shrubs,

and 17,500 tree and shrub tubelings. An existing agreement with Greenbelt will provide an additional 20,000 gallon-sized trees and shrubs through 2013. All of this material originates from the Catskill Mountains, providing locally-native stock that is adapted to regional conditions, giving it a competitive edge for survival, and providing a range of ecological values beyond stream bank stability.

*Implementation*

Five CSBI coordinators at partnering SWCDs, along with one DEP coordinator, provide the base for implementing the program. A landowner reaches out to his local coordinator, a plan is developed for the property, and if the landowner concurs, he is invited to apply for funds and/ or technical assistance to implement the project. Applications are invited twice per year, on November 1 and June 1, to allow for project eligibility field assessments to be conducted during months when the sites are free of snow cover.

*Riparian Corridor Management Plans*

Riparian Corridor Management Plans (RCMPs) provide landowners with a detailed analysis of their property in relation to the broader watershed and to their streamside neighbors. The plans reference stream management plans where they have been completed and document landowner priorities and goals. After analyzing historic information and documents and landowner concerns, CSBI coordinators propose a suite of recommendations that range from BMPs landowners can implement themselves to more substantial practices that require SWCD assistance. In 2012, CSBI coordinators completed 11 RCMPs, bringing the number completed since 2009 to 84. These plans are valuable tools for educating landowners about the importance of riparian buffers and for documenting landowner concerns and property management goals. The process of developing the plans and reviewing them with landowners helps bring landowner and CSBI goals closer together, prompting applications more likely to receive CSBI project approval.

*Projects*

The CSBI program application process yielded 52 applications from interested landowners in 2012. Site visits by CSBI coordinators help filter out applications that are ineligible for the program due to excessive bank erosion or proposed restoration practices that are beyond the scope of CSBI. In 2012, CSBI successfully installed 35 riparian buffer restoration projects, depicted in Figure 4.23. These 35 projects enhanced riparian vegetation on over 11 acres of streamside property and over 2.4 miles of stream bank length. This includes the installation of 11,928 native Catskill plants, and over 4,600 linear feet of bioengineering treatments consisting of native willow species, most of which were harvested from within the watershed. Since the inception of the program, 106 projects have been installed, restoring over 63 acres of riparian buffer spanning over 9 miles of stream length. Through these projects, over 33,000 plants, all grown from Catskill native seed, have been planted within the watershed.

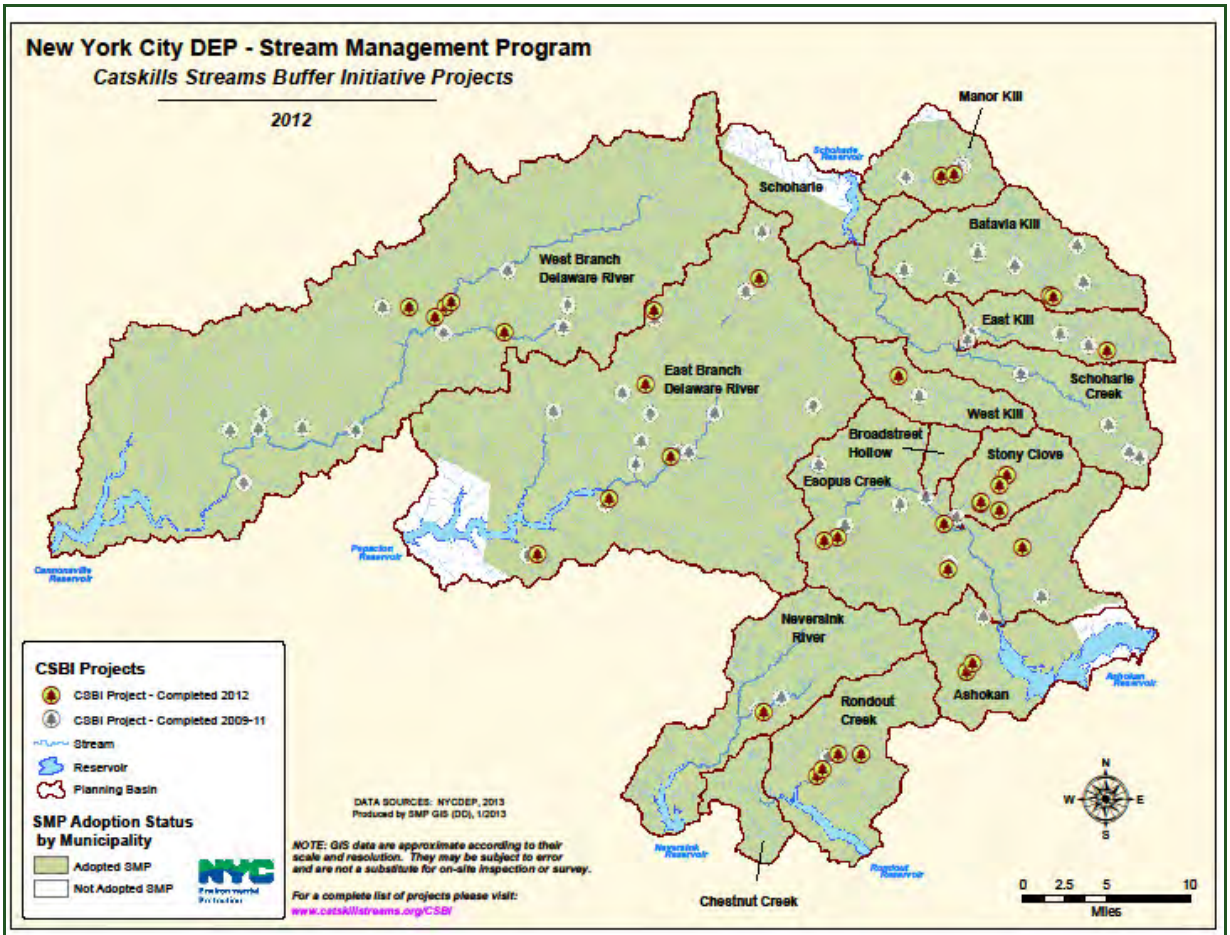


Figure 4.23 Catskill Streams Buffer Initiative projects.

In addition to projects involving the installation of plants, CSBI leads efforts within the watershed to remove significant stands of invasive plant species that threaten the viability of riparian plantings. Five of the CSBI projects from 2012 were specifically focused on the removal of Japanese knotweed from the riparian buffer through stem injection of herbicides and/or mechanical pulling. Riparian planting activities also took place on an additional eight non-CSBI stream restoration projects in 2012, enhancing riparian vegetation by more than 5,000 trees and shrubs and installing over 1.7 miles of bioengineering treatments.

One unique CSBI project highlight in 2012 involved the stabilization and reforestation of a riparian buffer along the East Branch of the Neversink River, using a soil lift and willow brush layering bioengineering technique. This project spanned the eroding bank along two adjacent parcels for a total length of 500 linear feet. The soil lifts, created from coir erosion control materials, provide resistance to the erosive forces brought about by high stream flows. Live native willow cuttings carefully placed between each soil lift provide soil stability through complex root

systems and add roughness to the stream bank to slow flow velocities and further prevent bank erosion. Juvenile trees and shrubs were planted along the top of the stream bank to provide additional root structure and soil stability, as well as buffering from storm water runoff from upland sources (Figures 4.24 and 4.25).

Figure 4.24 East Branch of the Neversink River before construction of bioengineering.

Figure 4.25 East Branch of the Neversink River after construction of bio-engineering.

*Evaluation*

CSBI projects are monitored in the years following installation using a protocol developed specifically for the program. The protocol's goal is to collect data documenting the survival and growth rates of individual plant species, the effectiveness of installation techniques, and the factors that have the greatest influence over project success. CSBI projects will be monitored at regular intervals for a minimum of five years before any conclusions are drawn regarding project success. Ten new monitoring sites were added in 2012, bringing the total number of active CSBI vegetation monitoring sites to 27.

*Riparian Buffer Education and Outreach*

Through partnerships with Ulster County Community College and the State University of New York Research Foundation on behalf of SUNY Delhi, two crews of summer interns provided much of the labor needed to install the various plantings across the WOH watershed. The crews also assisted CSBI coordinators with loading and unloading material, site preparation, transplanting, plant material center maintenance, and vegetation monitoring. DEP and its partners plan to continue to work with these young adults to give them the opportunity to gain firsthand experience with stream restoration.

CSBI engaged the public in a variety of forums in 2012 to support the program's goals as well as DEP's overarching mission. Overall, approximately 28 targeted activities reached well over 500 individuals, ranging from volunteer plantings, tree identification, and local fair demonstrations to riparian workshops for students, families, and streamside landowners. Countless numbers of watershed residents and visitors were also reached through non-targeted

efforts like newsletter and newspaper articles, various native plant and invasive species brochures, and through www.CatskillStreams.org. See Section 4.10 for more information about education and outreach activities.

***Watershed Agriculture Program and Watershed Forestry Program***

See Section 4.4 (Watershed Agricultural Program) and Section 4.5 (Watershed Forestry Program) for information about the riparian buffer protection efforts of the Watershed Agricultural and Forestry Programs, including an update about the Conservation Reserve Enhancement Program, which is described in Section 4.4.

***Riparian Buffer (Acquisition) Program***

The 2010 Water Supply Permit requires the City to implement a Riparian Buffer Program by November, 2014. Over the past year significant progress has been made toward that goal, with the Catskill Center for Conservation and Development currently preparing a feasibility study, to be finalized by May 1, 2013 with input from more than a dozen stakeholders.

## 4.8 Wetlands Protection Program

DEP's Wetlands Protection Strategy, initiated in 1996 and most recently updated in 2012, is designed to preserve the water quality functions of wetlands in the watershed. The strategy includes wetlands mapping and monitoring as well as regulatory and partnership programs. In 2012, DEP continued to review federal, state, and municipal wetland permit applications in the watershed. DEP also continued to protect wetlands through land acquisition and to collect data from reference wetlands throughout the Catskill/Delaware watershed.

### 4.8.1 Permit Review

Through its review of all types of permit applications, DEP seeks to identify and recommend measures to avoid wetland impacts. In cases where impacts are unavoidable, DEP recommends that impacts be minimized and mitigated to the extent practicable. Project plans are often modified in response to DEP's comments, resulting in less wetland and/or adjacent area impact than originally proposed.

In 2012, DEP reviewed 27 wetland permit applications. Fifteen of those applications were submitted pursuant to the New York State Freshwater Wetlands Act (NYS Environmental Conservation Law, Article 24), which regulates state-mapped wetlands as well as adjacent areas to a distance of 100 feet from such wetlands. Twelve municipal wetland applications were reviewed (Figures 4.26 and 4.27, Table 4.12). No federal wetland applications (those applications filed under Section 404 of the Clean Water Act, P.L. 92-500, as amended by P.L. 95-217) were reviewed. This is likely due to minimization of wetland impacts through the local and state permitting process in advance of federal review, and the availability of nationwide permits in the federal program.

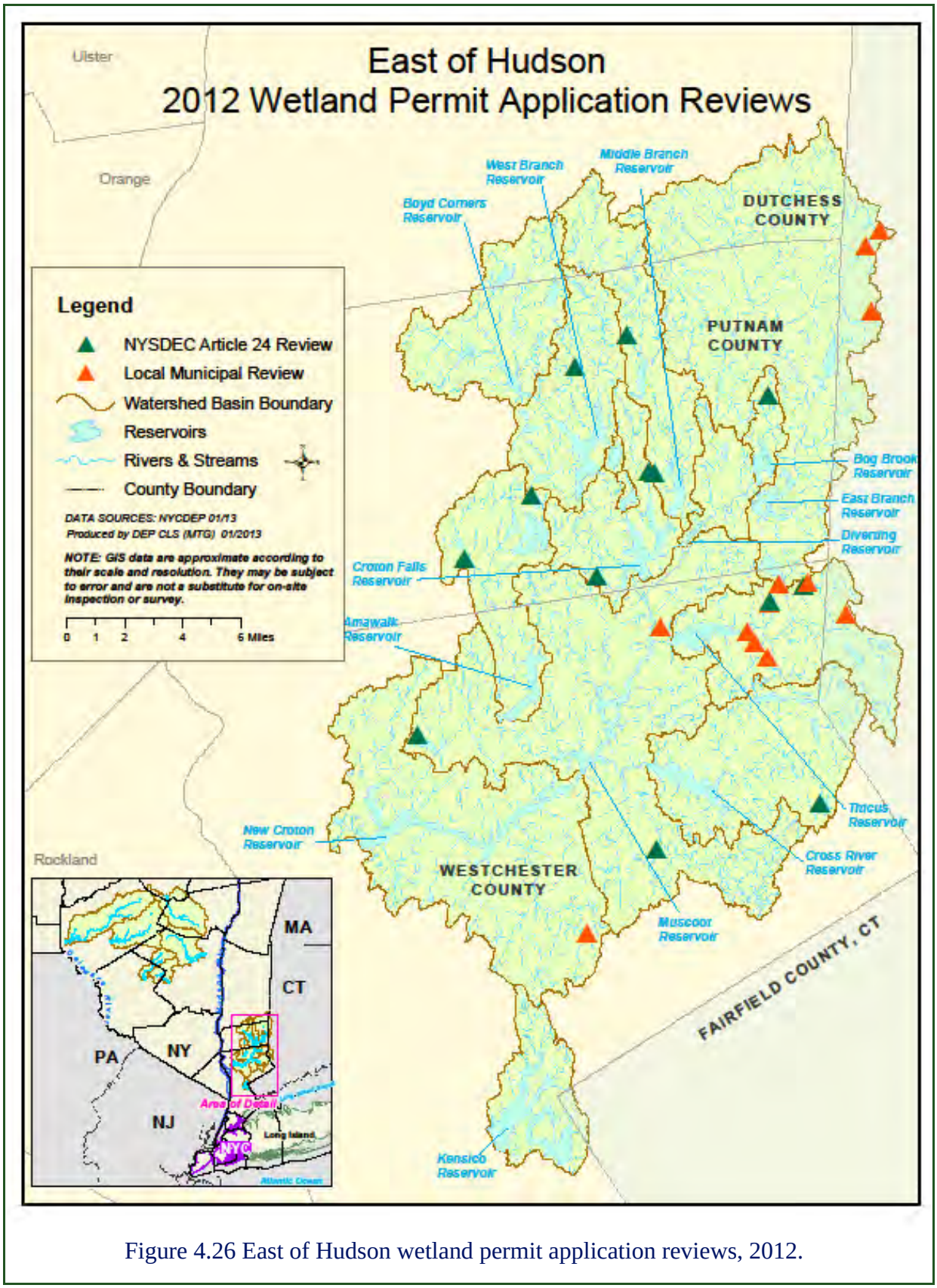


Figure 4.26 East of Hudson wetland permit application reviews, 2012.

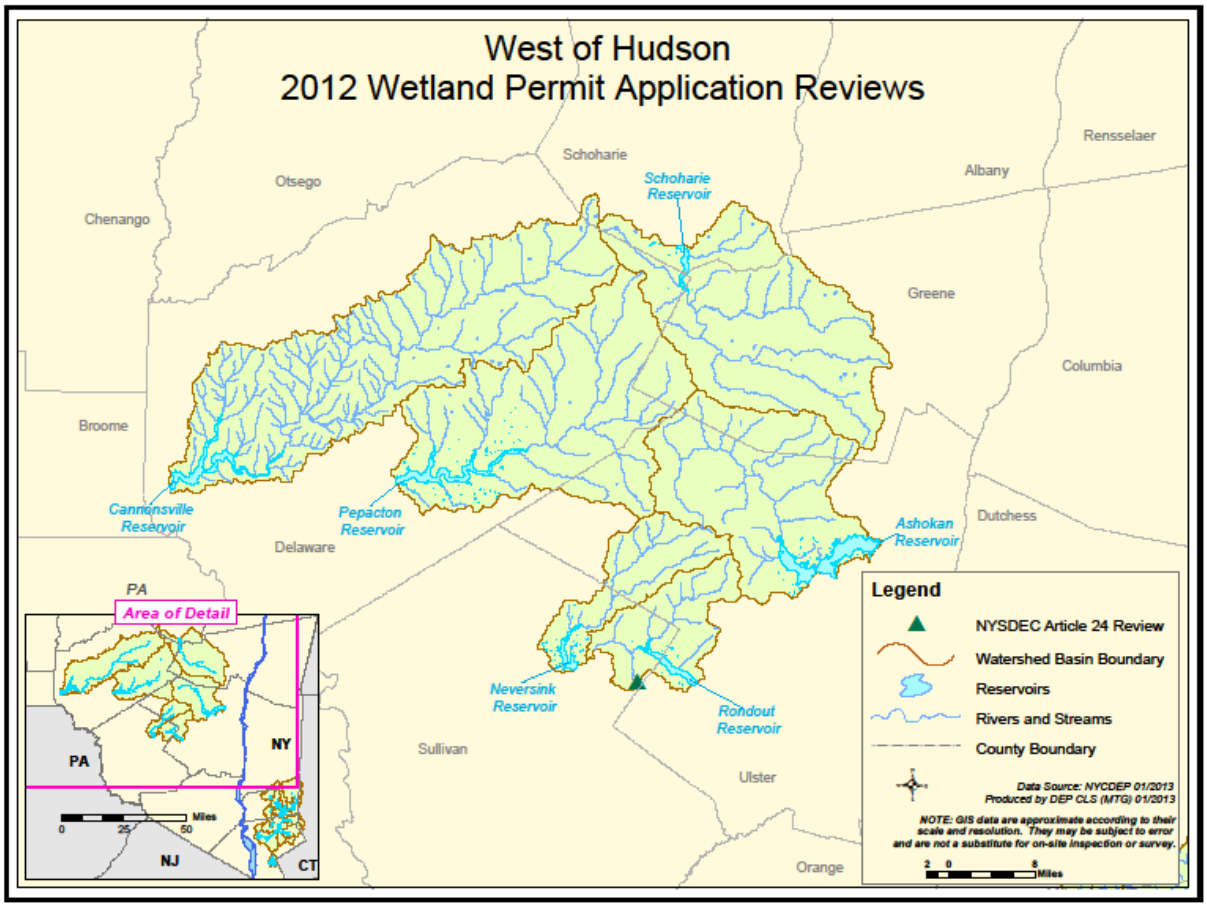


Figure 4.27 West of Hudson wetland permit application reviews, 2012.

Table 4.12. Wetland permit reviews completed in 2012.

| Project name | Permit type | Reservoir basin | Regulated activity |
|---|---|---|---|
| Lake Secor Outlet Dredge | NYSDEC | Amawalk | Adjacent area disturbance |
| Wixon Pond Estates | NYSDEC | Amawalk/ West Branch | Adjacent area disturbance |
| Bog Brook Unique Area Habitat Restoration | NYSDEC | Bog Brook | Wetland, adjacent area disturbance |
| Lake Kitchawan | NYSDEC | Cross River | Aquatic nuisance species management |
| Brewster-Meadowland | NYSDEC | Croton Falls | Adjacent area disturbance |
| MacDonald Marine Storage Building | NYSDEC | Croton Falls | Wetland, adjacent area disturbance |

Table 4.12. (Cont.) Wetland permit reviews completed in 2012.

| Project name | Permit type | Reservoir basin | Regulated activity |
|---|---|---|---|
| Lake Tonetta-Storm Water Basin | NYSDEC | Diverting | Wetland disturbance (reduced per DEP 2011 review) |
| Big Trail Bridge Repair | Local | East Branch | Wetland stream crossing, adjacent area disturbance |
| 4 Elwell Road | Local | East Branch | Wetland stream crossing |
| Fogle-Continental Lot 3 | Local | East Branch | Adjacent area restoration |
| 2 Durgy Lane | Local | East Branch | Adjacent area disturbance |
| VIP Wash and Lube | NYSDEC | Middle Branch | Adjacent area disturbance |
| Adams-Bottlegate Farm | NYSDEC | Middle Branch | Wetland, adjacent area disturbance |
| Bear Mountain Parkway | NYSDEC | Muscoot | Adjacent area disturbance |
| Zinman Dredge | NYSDEC | Muscoot | Pond dredging, adjacent area disturbance |
| Commons at Purdys | Local | Muscoot | Wetland, adjacent area disturbance |
| Sarles Realty LLC | Local | New Croton | Wetland, adjacent area disturbance, stream relocation |
| KRC Associates LLC | NYSDEC | Rondout | Wetland crossing, adjacent area disturbance |
| Finch Farm, 25 Finch Road | NYSDEC | Titicus | Adjacent area disturbance |
| Foxy Meadow Farm-Baxter Road | NYSDEC | Titicus | Adjacent area disturbance |
| Redbud Partners, LLC | Local | Titicus | Wetland, adjacent area disturbance |
| deVaulx Residence, 1 Lost Pond Lane | Local | Titicus | Wetland (stream corridor), adjacent area disturbance |
| Colley Violation | Local | Titicus | Adjacent area restoration of existing violation |
| Foxy Meadow Baxter Road LLC | Local | Titicus | Adjacent area disturbance |
| Esposito | Local | Titicus | Wetland, adjacent area disturbance |
| Fink, 55 Finch Road | Local | Titicus | Pond dredging, wetland fill |
| Gipsy Trail Club | NYSDEC | West Branch | Aquatic nuisance species management |

DEP reviewed NYSDEC's proposed draft GP-0-12-003 Freshwater Wetland Adjacent Area General Permit, published in the DEC Environmental Notice Bulletin on August 22, 2012. The proposed Draft Wetland GP seeks to authorize up to 0.25 acres of disturbance within previously disturbed portions of the adjacent area, greater than 50 feet from the wetland boundary. While limited in scope, this general permit could authorize the replacement of lawn and landscaped areas with impervious surfaces. A comment letter was issued on September 17, 2012, requesting that this permit not apply within the New York City watershed, to avoid incremental negative impacts to wetlands and their water quality functions.

### 4.8.2 Land Acquisition

According to the National Wetlands Inventory (NWI) and NYSDEC Freshwater Wetland maps, there are 15,200 acres of wetlands in the Catskill/Delaware watershed. Since 1997, DEP has protected 2,614 acres, or 17.2%, of these wetlands through its Land Acquisition Program. (See Section 4.2 for details of the Land Acquisition Program.) Table 4.13 summarizes, for both the Catskill/Delaware and Croton watersheds, the number of acres of each type of wetland and the number of acres of each type that has been protected.

Table 4.13. Wetlands acquired or protected by the NYC Land Acquisition Program (LAP) in the Catskill/Delaware and Croton Systems as of December 31, 2012.*

| Description | Acres | Percent of total watershed acreage | Percent of total land acquired | Percent of total wetland type in system |
|---|---|---|---|---|
| **Catskill/Delaware (Ashokan, Schoharie, Rondout, Neversink, Pepacton, Cannonsville, West Branch, Boyd Corners, Kensico watersheds)** | | | | |
| *Entire Watershed* | 1,049,465 | | | |
| Wetlands (both NWI and DEC-regulated) (excluding Inundated Aquatic Habitats**) | 15,200 | 1.45 | | |
| Inundated Aquatic Habitats | 28,339 | 2.70 | | |
| Total Wetlands and Inundated Aquatic Habitats | 43,539 | 4.15 | | |
| *Lands Under Contract or Closed by DEP as of 12/31/12†** | 125,292 | 11.94 | | |
| Wetlands (both NWI and DEC-regulated, excluding Inundated Aquatic Habitats**) | 2,614 | | 2.09 | 17.20 |
| Inundated Aquatic Habitats** | 185 | | 0.15 | 0.65 |
| Total Wetlands and Inundated Aquatic Habitats** | 2,799 | | 2.23 | 6.43 |
| **Croton** | | | | |
| *Entire Watershed* | 212,577 | | | |
| Wetlands (both NWI and DEC-regulated) (excluding Inundated Aquatic Habitats**) | 20,038 | 9.43 | | |
| Inundated Aquatic Habitats | 10,809 | 5.08 | | |
| Total Wetlands and Inundated Aquatic Habitats | 30,846 | 14.51 | | |

Table 4.13. (Cont.) Wetlands acquired or protected by the NYC Land Acquisition Program (LAP) in the Catskill/Delaware and Croton Systems as of December 31, 2012.*

| Description | Acres | Percent of total watershed acreage | Percent of total land acquired | Percent of total wetland type in system |
|---|---|---|---|---|
| *Lands Under Contract or Closed by DEP as of 12/31/12†** | 1,990 | 0.94 | | |
| Wetlands (both NWI and DEC-regulated, excluding Inundated Aquatic Habitats**) | 98 | | 4.91 | 0.49 |
| Inundated Aquatic Habitats** | 2 | | 0.08 | 0.02 |
| Wetlands and Inundated Aquatic Habitats** | 99 | | 4.99 | 0.32 |

* Acres are calculated directly from areas of GIS polygons and therefore may not match exactly other acreage totals submitted by DEP.

** Categories considered "Inundated Aquatic Habitats" include reservoirs or large lakes (L1), unconsolidated bottom (L2UB), riverbeds (RUB and RRB), or streambeds (RSB), but exclude uplands (U), and unconsolidated shore (L2US). Categories considered "Wetlands" exclude the Inundated Aquatic Habitats classes as well as all upland (U) and unconsolidated shore (L2US).

† Includes fee, conservation easements, and farm easements. Excludes non-LAP and pre-MOA land.

### 4.8.3 Mapping and Monitoring

In 2012, DEP developed a contract for a pilot project to determine whether the 2009 Light Detection and Ranging (LiDAR) and aerial photography collection will improve wetland mapping and connectivity assessment in the watershed.The 2009 collection improved the resolution, accuracy, and completeness of watershed hydrography, topography, and land use coverages, which may provide a richer source of wetland indicators than standard photointerpretation methods alone. Moreover, there are indications that LiDAR intensity data could improve the detection of inundated wetland area.

The project will be conducted in three phases over two years to (1) assess variation in the quality of these data sources throughout the watershed, (2) develop protocols for applying these data to wetland mapping and connectivity assessment in pilot areas, and (3) assess the feasibility of applying the protocol to the entire watershed. Any gains in wetland mapping accuracy realized from these data sources would benefit the implementation of numerous watershed protection programs. Further, the enhanced resolution of wetland connectivity would benefit the assessment of wetland function and federal regulatory status.

DEP also gains information on the characteristics and functions of watershed wetlands through its reference wetlands monitoring program. In 2012, DEP continued to collect data from automated monitoring wells installed in 22 reference wetlands throughout the Catskill/Delaware

watershed. The wells measure water table level at 6-hour intervals and provide a long-term hydrologic record for various wetland types. Vegetation, soils, and water quality data were previously collected at these wetlands and are used in conjunction with the water level data to assess wetland condition. Reference wetland monitoring informs wetland mapping, protection, and management programs and is used to assess long-term trends in wetland condition and function.

### 4.8.4 DEP Forest Management Program

DEP conducts an interdisciplinary review of its proposed forest management projects on City lands to ensure long-term stewardship of the forest and all of the natural and cultural resources contained within it. As part of this review, DEP wetland scientists delineate on-site wetlands, which are treated as exclusion zones in which no disturbance is permitted under normal circumstances. Moreover, the 100-foot wide area surrounding wetlands is considered a special management zone, within which limits are placed on tree removal and equipment operation. In 2012, DEP conducted delineations on five proposed forest management projects on City lands and mapped approximately 62 acres of wetlands within them.

### 4.8.5 Education and Outreach

DEP continued to distribute the educational pamphlet *Wetlands in the Watersheds of the New York City Water Supply System* at public forums and upon request. DEP also presented findings from its wetlands mapping and monitoring programs at the annual conference of the New York State Wetlands Forum, the Watershed Science and Technical Conference, and the Catskill Environmental Research and Monitoring Conference. In addition, DEP delineated wetlands within the 264-acre Clearpool Model Forest project. This work will support the model forest management objectives and provide educational outreach opportunities. (See Section 4.5.4 for details of DEP's Model Forest Program.) DEP will present its findings as part of the Clearpool Model Forest Adult Workshop Series.

## 4.9 East of Hudson Non-Point Source Pollution Control Program

The East of Hudson (EOH) Nonpoint Source Pollution Control Program seeks to address nonpoint pollutant sources in the four EOH Catskill/Delaware watersheds (West Branch, Croton Falls, Cross River, and Boyd Corners). The program supplements DEP's existing regulatory efforts and nonpoint source management initiatives.

### 4.9.1 Wastewater-Related Nonpoint Source Pollution Management Programs

#### *Wastewater Infrastructure Mapping and Inspection Program*

To locate and characterize the sanitary infrastructure in the four basins, DEP funded a program to video inspect and digitally map the sanitary infrastructure. DEP completed the program in 2011, and no additional work was necessary in 2012. The video files, digital mapping

data, and summary report have been distributed to the Engineering Departments of the Towns of Carmel and Lewisboro for import and analysis.

***Septic Program East of Hudson***

DEP provides ongoing support to Westchester County and Putnam Counties in their efforts to reduce the potential impacts of improperly functioning or maintained subsurface sewage treatment systems (SSTSs). In 2012, DEP continued to help the Westchester County Health Department refine its comprehensive Septic System Management Program (SSMP) database and web-based SSMP database access tool. The database includes information on new septic applications, septic repairs/remediation, and pump out data, as well as contractor licensing information.

Putnam County assessed potential revisions to its septic repair program in light of the requirements stipulated in the NYSDEC MS4 General Permit (GP-0-10-002) that became effective in May 2011. The permit requires all municipalities to "Develop, implement and enforce a program that ensures that on-site sanitary systems…are inspected at a minimum frequency of once every five years and, where necessary, maintained or rehabilitated." As required by this provision of the MS4 permit, the repair of failing septic systems will continue in Putnam County. The county also continues to implement the program's maintenance component for septic systems repaired under the program. In addition, the county continues to follow up on the home owner maintenance agreements that were previously signed by program participants.

### 4.9.2 Stormwater-Related Nonpoint Source Pollution Management Programs

***Stormwater Retrofit and Remediation***

In an effort to further reduce pollutant loading from stormwater runoff, DEP is working on multiple nonpoint source reduction projects within the EOH Catskill/Delaware watersheds. These projects include large retrofit projects as well as remediation of smaller erosion sites (Figure 4.28).

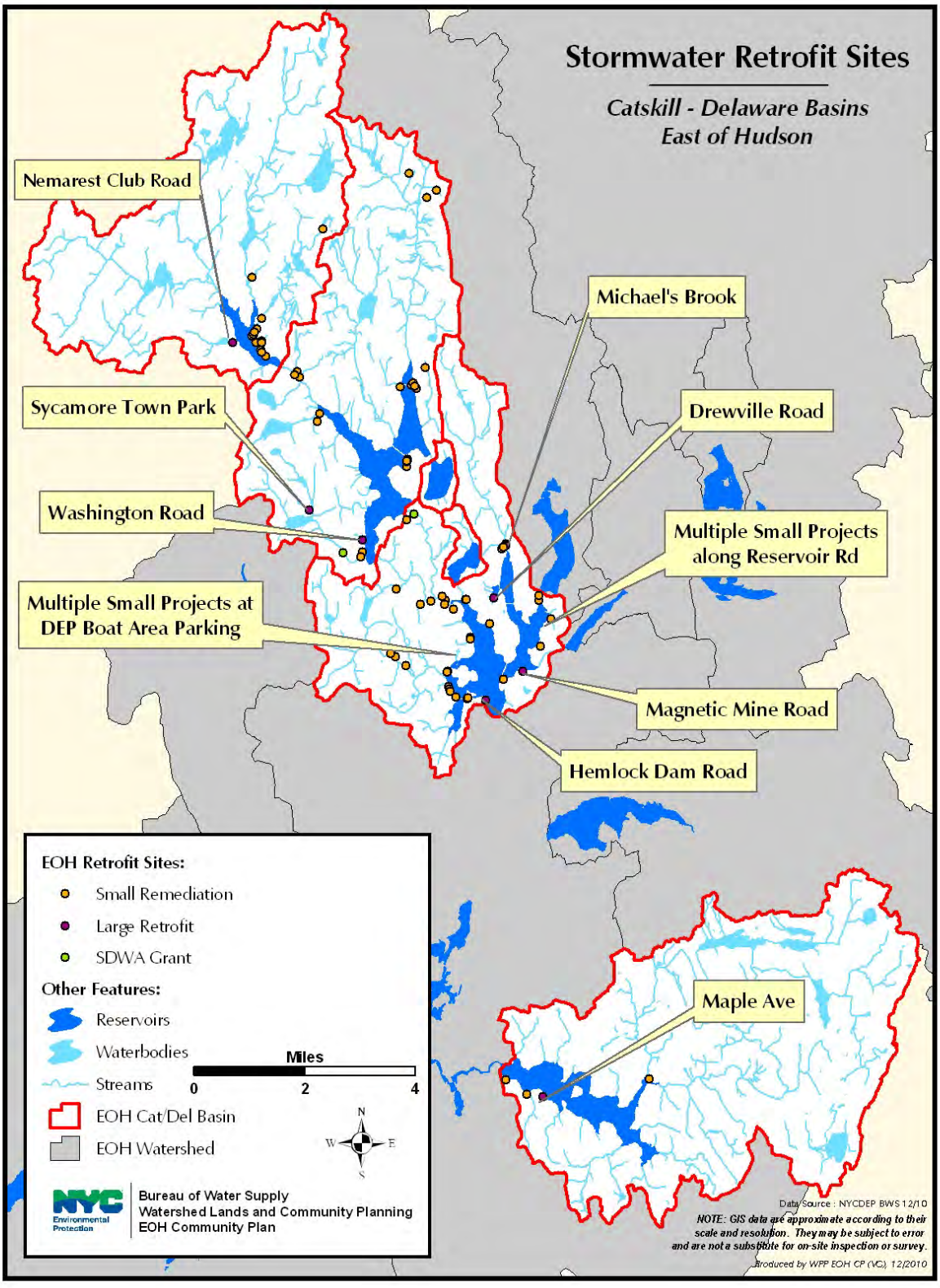


Figure 4.28 Stormwater retrofit sites, EOH Catskill/Delaware basins.

*Stormwater Retrofit Projects*

Hemlock Dam Road and Magnetic Mine Road are unpaved roads in the Town of Carmel that drain toward Croton Falls Reservoir. DEP completed all project work for the reconstruction of both Hemlock Dam Road and Magnetic Mine Road in 2010.

*Stormwater Remediation Projects on City-Owned Property*

Maple Avenue, Town of Bedford, Westchester County: The designs are 100% complete. Due to changes in design at the request of the Town, the stormwater pollution prevention plan (SWPPP) was not approved until the first half of 2012. This project will be bid with the Drewville Road project.

Michael Brook, Town of Carmel, Putnam County: The contract to construct this stormwater project was registered in April 2012. Construction Notice to Proceed was issued in September 2012. Approximately half of the work has been completed, including the swale on the south side of Hughson Road. Habitat restrictions for trout required that work be suspended, preventing completion of the project. Work will resume in May 2013.

Drewville Road, Town of Carmel, Putnam County: Due to changes in design at the request of the Town, the SWPPP was not approved as anticipated in 2012. The Town is requesting design modifications for aesthetic reasons. DEP anticipates receipt of the SWPPP approval in the first half of 2013. This will be bid with the Maple Avenue project.

*Stormwater Remediation Projects on Privately-Owned Property*

Sycamore Park, Long Pond Road/Crane Road, Town of Carmel, Putnam County: The contract to construct this stormwater project was registered in April 2012. Construction began in September 2012. The project culvert has been constructed and work on the bioretention system and parking lot is underway.

Nemarest Club, Town of Kent, Putnam County: The contract to construct this stormwater project was registered in April 2012. Construction began in September 2012. To date, the work on site includes construction of the temporary road, diversion and piping of streamflow, tree removal, and utility protection.

*Stormwater Remediation Small Projects*

The Small Stormwater Remediation Projects Program involved the identification and remediation of smaller erosion sites in the four EOH Catskill/Delaware watersheds. The program was completed in 2009. The sites are now maintained under the Facility Inspection and Maintenance Program.

***Stormwater Facility Inspection and Maintenance***

The Facility Inspection and Maintenance Program was developed to ensure that previously constructed stormwater remediation facilities continue to function as designed. New

facilities continue to be brought on line and are added to the routine inspection program. Maintenance during the first year of a facility's life is completed under the warranty in the facility's construction contract and under DEP's maintenance contract thereafter. Inspection and maintenance follow procedures identified in the Operation and Maintenance Guidelines contained in the maintenance contract.

***Stormwater Infrastructure Mapping and Inspection Program***

DEP completed the mapping and video inspection program in 2009.

***Stormwater Infrastructure Capacity Evaluation***

DEP completed the Stormwater Infrastructure Capacity Evaluation in 2010.

***Stormwater Prioritization Assessment—DEP Properties***

DEP completed the prioritization report in March 2009.

***Funding Program—Croton Falls/Cross River***

In November 2011, the majority of watershed communities in Putnam, Westchester, and Dutchess Counties established the EOH Watershed Corporation (EOHWC). The mission of the EOHWC is to implement a regional retrofit program in the EOH watershed. The EOHWC subsequently elected officers and adopted bylaws.

In early 2012, DEP held numerous discussions with the EOHWC to finalize the funding agreement that will allow the transfer to the EOHWC of both the $4.5 million provided under the Croton Falls/Cross River Stormwater Retrofit Program and the additional funding required by the December 2010 Water Supply Permit (WSP). Final agreement was reached on the contract, which is consistent with the 2007 FAD and 2010 WSP, later in the year. In the second half of 2012 DEP worked with the EOHWC to ensure that various administrative submittals were completed to allow for contract registration. It is anticipated that the contract will be registered in the first half of 2013.

## 4.10 Kensico Water Quality Control Program

Kensico Reservoir, located in Westchester County, is the terminal reservoir for the City's Catskill/Delaware water supply system. Because the reservoir provides the last impoundment of Catskill/Delaware water prior to entering the City's distribution system, DEP has prioritized watershed protection in the Kensico basin. A comprehensive review of Kensico Reservoir water quality can be found in the 2011 Kensico Water Quality Annual Report (DEP 2012).

### 4.10.1 Stormwater Management and Erosion Abatement Facilities

***BMP Construction, Operation, and Maintenance***

DEP has constructed 45 stormwater management and erosion abatement facilities throughout the watershed to reduce pollutant loads conveyed to the reservoir by stormwater. The

facilities, shown in Figure 4.29, were routinely inspected and maintained as needed throughout 2012 in accordance with the Operation and Maintenance Guidelines. Maintenance included grass mowing, vegetation removal, tree removal, and sediment and debris removal. All BMPs are performing as designed.

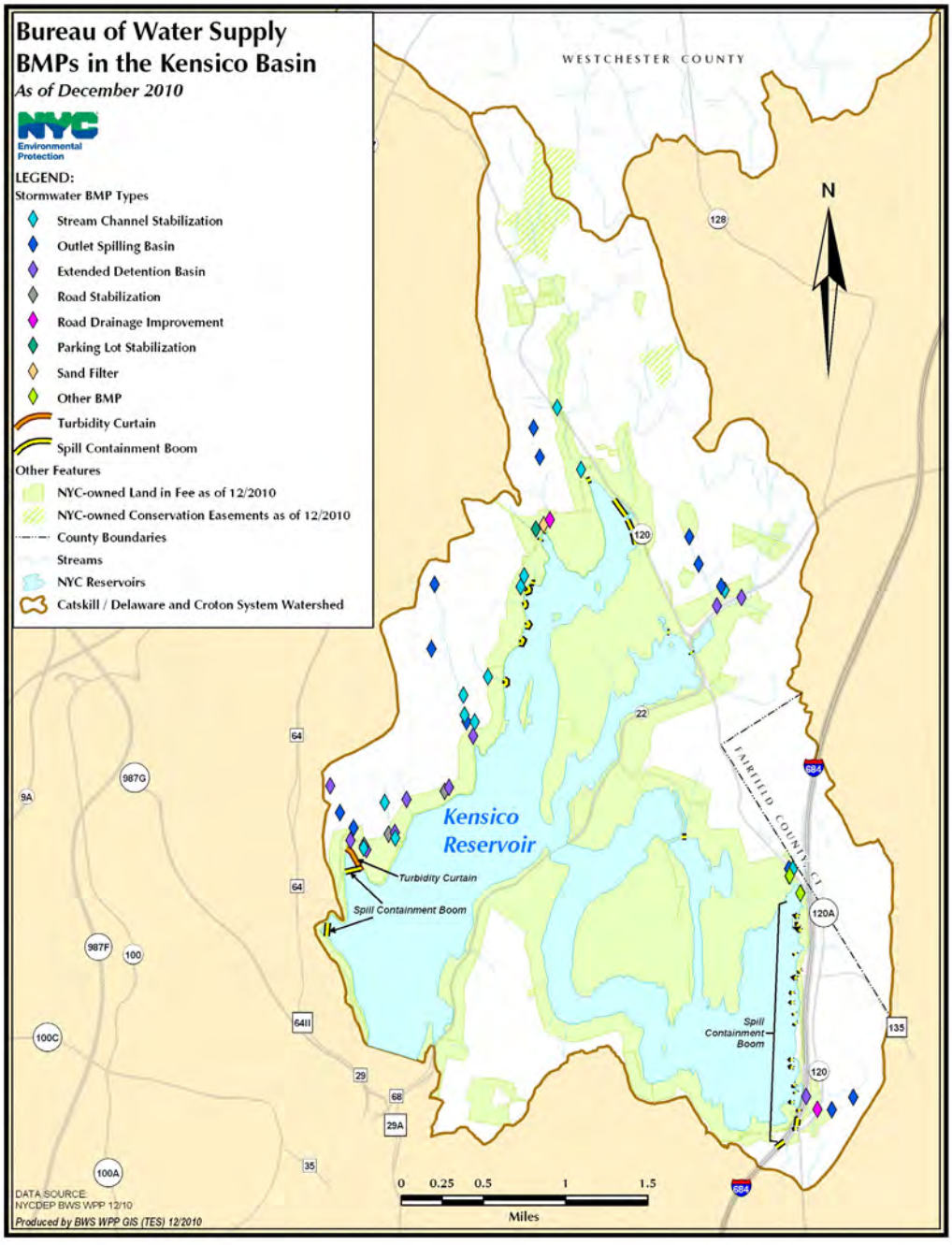


Figure 4.29 Location of BMPs in the Kensico watershed.

Following Tropical Storms Irene and Lee in 2011, DEP hired a consulting firm to assess the water quality conditions and operational response in Kensico Reservoir. The report, "Kensico Reservoir Watershed Assessment, Fecal Coliform Occurrence, and Operational Response During and after Tropical Storms Irene and Lee" (DEP 2012), made several recommendations to DEP. In response to the recommendation that stormwater management and abatement facilities be inspected and cleaned out before hurricane season, DEP performed inspections and sediment/ debris removal, as necessary, of extended detention basins, catch basins, and swales before, during, and after hurricane season. Particular attention has been given to facilities in sub-basins within the southwest portion of the Kensico basin.

#### *Spill Containment Facilities*

DEP installed, and now maintains, spill containment facilities in and around Kensico Reservoir (Figure 4.29). The facilities improve spill response and recovery, thereby minimizing water quality impacts in the event of a spill. In 2012, routine maintenance was completed at the spill boom sites. No spills were reported during the reporting period.

#### *Turbidity Curtain*

DEP continues to monitor the extended primary curtain and back-up turbidity curtain that are designed to direct flows from Malcolm and Young Brooks further out to the body of the reservoir and provide enhanced protection for water entering the Catskill Upper Effluent Chamber. DEP's diving contractor performed inspections of both turbidity curtains in October 2012. Based on these inspections, no repair work was required and the turbidity curtains appear to be functioning as intended.

### 4.10.2 Kensico Action Plan

During 2012, DEP continued to implement the four stormwater treatment facilities plans proposed in the Kensico Action Plan. A summary of progress and current site status follows.

#### *N1 - West Lake Drive Drainage Improvements*

Work at the N1 site was completed in 2012. Activities included installation of two new catch basins, replacement of a pipe culvert with 30" reinforced concrete pipe, rip-rap channel reconstruction, temporary dewatering, bypass, sediment control measures, and re-seeding.

#### *N7 - Sub-Basin Pipeline System*

Work at the N7 site included clearing, construction of a stormwater bypass, field sampling, and geotechnical evaluation. It is anticipated that the proposed pipeline system will be installed in the first half of 2013.

#### *N12 – Extended Detention Basin*

Work at the N12 site consisted of site clearing and a geotechnical investigation. The investigation revealed the need for design changes to the proposed basin, which necessitated a

change order to the construction contract. It is anticipated that the change order will be registered in the first half of 2013, with construction to follow shortly thereafter.

***Whippoorwill Stream Rehabilitation***

Construction at the Whippoorwill site was completed in 2012. Activities included construction of a temporary access road, installation of streambed rock structures, temporary dewatering, bypass and sediment control measures, and site restoration (see Figure 4.30). It is anticipated that planting and seeding will be completed in the first half of 2013.


Figure 4.30 Seeding and mulching at Whippoorwill.

### 4.10.3 Westlake Sewer Trunk Line

The Westlake Sewer Trunk Line, owned and maintained by the Westchester County Department of Environmental Facilities (WCDEF), conveys untreated wastewater to treatment facilities located elsewhere in the county. Defects or abnormal conditions within the sewer line and its components could lead to exfiltration or overflows of wastewater, which, given the proximity of the collection system to Kensico Reservoir, could impact the reservoir's water quality. The intent of this program is to work with the county to mitigate risks posed by the line while maintaining the collection system's location and gravity flow.

***Sanitary Sewer Remote Monitoring System***

DEP proposed a sanitary sewer remote monitoring system for the trunk line in order to provide real-time detection of problem events such as leaks, system breaks, overflows, and blockages. DEP issued the Order to Commence Work to WCDEF in January 2012. The Smart Cover technology for remote monitoring of manholes in the Westlake system was completed in July 2012. Staff have completed several inspections of the various remote monitoring units since July. A site visit to one of the completed manholes was conducted with staff from USEPA and NYSDOH in September 2012. WCDEF has responded call outs from the remote monitoring units to verify operations of the sewer collection line. There have been no issues or overflows to report. The remote monitoring units appear to be working well.

***Sewer Line Visual Inspection***

DEP conducts an annual visual inspection of the trunk line to assess the condition of exposed infrastructure, including manholes, for irregularities. The annual full inspection was performed in May 2012. Partial inspections were conducted throughout the year in association

with ongoing routine maintenance of Kensico stormwater BMPs in the vicinity of the line. No defects or abnormalities were noted.

### 4.10.4 Video Inspection of Sanitary Sewers

DEP completed the project to inspect portions of the sanitary sewer system located within the Kensico watershed in 2011. None of the inspected pipe sections demonstrated any significant defects or deterioration; therefore, failure is unlikely in the foreseeable future. No additional work was necessary in 2012.

### 4.10.5 Septic Repair Program

DEP initiated the Kensico Septic System Rehabilitation Reimbursement Program to reduce potential water quality impacts that can occur through failing septic systems. During 2012, construction was completed at nine sites. At six of the sites, the SSTS was repaired; at another, the SSTS was remediated; and at the remaining two, the properties were connected to municipal sewer lines.

In October 2012, the NYS Environmental Facilities Corporation (EFC) mailed an annual reminder letter to eligible residents notifying them of the continuing availability of funding under the program. Based on responses to that mailing, EFC continues to update the database and sign interested participants into the program as appropriate. Figure 4.31 shows the sewage service status of each parcel based on resident responses and other available records.

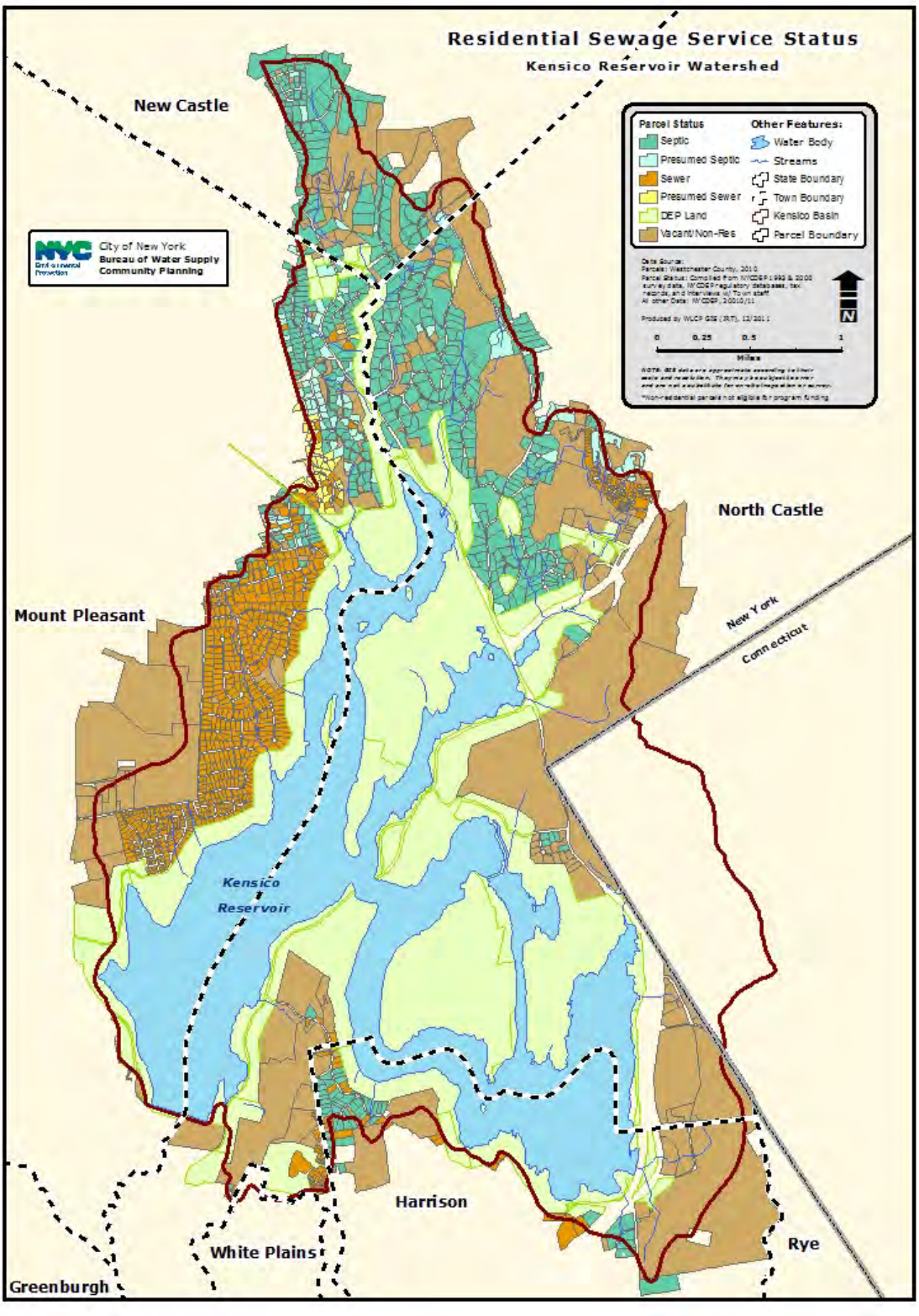


Figure 4.31 Residential sewage service status, Kensico Reservoir watershed.

### 4.10.6 Turbidity Reduction

The Catskill Upper Effluent Chamber (CATUEC) is situated along the shore of a cove in the southwest section of Kensico Reservoir. DEP will be constructing a shoreline stabilization project located south of CATUEC in order to mitigate the erosion and possible resuspension of near-shore materials near CATUEC during wind events. During the reporting period, DEP worked to secure the permits required to mitigate the project's potential impact on wetlands. DEP secured the USACOE Individual Permit in June 2012.

### 4.10.7 Route 120

The New York State Department of Transportation completed a project to resurface I-684 and construct stormwater treatment basins in the I-684 median from just south of the new Lake Street overpass in New York northward to the bridge over Tamarack Swamp in Connecticut. All of the project items listed above are complete.

### 4.10.8 Westchester County Airport

The Westchester County Airport is located east of Kensico Reservoir in close proximity to Rye Lake. Because of the airport's closeness to the reservoir, DEP continues to review any activities that are being proposed there. There was no activity to report in 2012.

## 4.11 Catskill Turbidity Control

Due to the nature of its underlying geology, the Catskill watershed is prone to elevated levels of turbidity in streams and reservoirs. High turbidity levels are associated with high flow events, which can destabilize stream banks, mobilize streambeds, and suspend the glacial clays that underlie the streambed armor. The design of the Catskill System accounts for the local geology, and provides for settling within Schoharie, Ashokan West Basin, Ashokan East Basin, and the upper reaches of Kensico Reservoir. Under normal circumstances, the extended detention time in these reservoirs is sufficient to allow the turbidity-causing clay solids to settle out, and the system easily meets turbidity standards at the Kensico effluent. Periodically, however, the City has had to use chemical treatment to control high turbidity levels.

DEP undertook the Catskill Turbidity Control Study to provide a comprehensive analysis of potential engineering and structural alternatives to reduce turbidity levels in the Catskill System. DEP engaged the Gannett Fleming/Hazen and Sawyer Joint Venture (JV) to support this effort, along with JV subconsultants Upstate Freshwater Institute (UFI) and HydroLogics, Inc. The study was conducted in three phases. The Phase I study, completed in December 2004, provided a preliminary screening-level assessment of turbidity control alternatives at Schoharie and Ashokan Reservoirs, and identified potentially feasible, effective, and cost-effective measures for subsequent detailed evaluation. Phase I results also showed that turbidity sources

during high flows within the Ashokan watershed are the driver for elevated turbidity levels leaving the reservoir.

The Phase II study, completed in September 2006, consisted of detailed conceptual design, cost estimation, and performance evaluation of three alternatives for improving turbidity and temperature in diversions from Schoharie Reservoir: Multi-Level Intake, In-Reservoir Baffle, and Modification of Reservoir Operations. The performance evaluation relied on development and application of an integrated modeling framework that linked the OASIS water supply model of the entire NYC reservoir system and Delaware watershed with the W2 water quality model of Schoharie Reservoir. DEP selected Modification of Reservoir Operations (MRO) as the most feasible, effective, and cost-effective alternative for improving turbidity and temperature control at Schoharie Reservoir, and proposed in the December 2006 Phase II Implementation Plan to develop a system-wide Operations Support Tool (OST) to support implementation of this alternative. The MRO/OST plan was conditionally approved by regulatory agencies in August 2008, pending completion of additional analyses. DEP is currently proceeding with development of the OST.

The Phase III study, completed in December 2007, focused on alternatives at Ashokan Reservoir that could reduce turbidity levels entering Kensico Reservoir, including a West Basin Outlet Structure, Dividing Weir Crest Gates, East Basin Diversion Wall, Upper Gate Chamber Modifications, a new East Basin Intake, and Catskill Aqueduct Improvements and Modified Operations. The performance evaluation relied on an updated version of the OASIS-W2 model, which included water quality models of the West and East Basins of Ashokan Reservoir and Kensico Reservoir. The Phase III evaluation indicated that, when turbidity levels rise, taking the Catskill System offline (or operating the Catskill Aqueduct at the minimum flow rate needed to satisfy demand) is the most effective way to reduce the turbidity load transferred from Ashokan to Kensico and reduce the frequency of alum treatment. Releasing water from the West Basin prior to and during a storm event was also found to provide significant reductions in turbidity loading to the East Basin, and hence to Kensico.

DEP selected Catskill Aqueduct Improvements and Modified Operations as the most feasible, effective, and cost-effective alternative for reducing turbidity levels entering Kensico Reservoir, and proposed implementation of this alternative in the July 2008 Phase III Implementation Plan. The Phase III Implementation Plan also presented the results of extensive model sensitivity and uncertainty testing undertaken by DEP. These analyses demonstrated that while inherent uncertainty in some model parameters (e.g., Esopus Creek flow-turbidity relationship) influences the absolute performance of alternatives, it does not generally affect their relative performance.

### 4.11.1 Implementation of Catskill Turbidity Control Alternatives

***Catskill Aqueduct Improvements***

One operational strategy for controlling turbidity is to minimize delivery of turbid water via the Catskill Aqueduct from Ashokan Reservoir to Kensico Reservoir. However, certain outside communities take their water supplies from this section of the Aqueduct, which limits DEP's ability to decrease flows. Currently, to avoid service interruptions at outside community connections when reducing aqueduct flow below 275 MGD, DEP installs stop shutters at five locations along the Aqueduct. The installation and removal of these stop shutters is labor intensive and time consuming. Further, because these old wooden shutters leak, DEP needs to run the Catskill Aqueduct at a minimum of 50 MGD to sustain pools of water behind each shutter at sufficient elevation to keep the outside community taps wetted. By upgrading the stop shutters, DEP will be able to reduce flow more quickly and to a lower level, thereby minimizing the delivery of turbid water to Kensico while meeting outside community demands.

Improvements to the stop shutter installation process consist of fabricating new lightweight aluminum stop shutters and building hoist system improvements that will allow DEP Operations staff to install and remove stop shutters more quickly, and provide shutters that will seal more effectively. The improved stop shutter facilities will continue to require service personnel to operate on-site equipment and coordinate the timing of shutter installation and removal. The improved stop shutters will enable DEP to decrease the minimum flow in the Catskill Aqueduct to approximately 25 MGD.

A construction contract is being developed to provide the new stop shutters and to make the improvements to the six stop shutter locations along the Catskill Aqueduct. This project is currently in design. Since DEP was unable to shut down the Catskill Aqueduct due to Tropical Storm Irene in late 2011, a diving inspection at the Harlem Railroad Siphon Chamber was performed in March 2012. This inspection required a brief shutdown of the Catskill Aqueduct, a safe work plan including lock-out/tag-out procedures and responsibilities, and the hiring of emergency rescue services. The results of the diving inspection were incorporated into the project's 60% design, which was finalized in May 2012.

While the 90% design was being developed, a Risk Register was developed and permitting requirements were identified. The 90% design was submitted in November 2012 and is expected to be finalized / completed in early 2013.

During the 60% and 90% design reviews, scheduling details were developed for the functional testing of the new stop shutters before final acceptance during construction. It was determined that since DEP cannot install stop shutters or lower the aqueduct during certain seasons, the overall construction contract duration should be increased to account for these anticipated delays. Accordingly, the FAD deadline of "Functionally Complete by 12/31/2014"

may need to be revised, since DEP cannot accept the new stop shutters until the testing is complete.

### 4.11.2 Shaft 4 Project

The Shaft 4 interconnection contract was bid on August 24, 2012 and awarded to Halmar International on January 3, 2013 for the sum of $21,228,000. The contract was sent to the Comptroller for registration in March 2013, and, pending registration, an Order to Commence Work is anticipated for April 2013. The project is expected to be completed by January 2016. The contract will allow Delaware Aqueduct water to be discharged into the Catskill Aqueduct at the Shaft 4 site in Gardiner, NY, where the systems will interconnect.

## 4.12 Sand and Salt Storage

The Institutional Sand and Salt Storage Facilities Program is administered and managed by the CWC in consultation with DEP. During the reporting period, no funds were spent on design or construction of new storage facilities.

# 5. Watershed Monitoring, Modeling, and GIS

## 5.1 Watershed Monitoring Program

### 5.1.1 Routine Water Quality Monitoring

To ensure the delivery of high quality drinking water, DEP conducts extensive water quality monitoring that encompasses all areas of the watershed, including sites at aqueducts and water supply intakes (keypoints), streams, reservoirs, and wastewater treatment plant facilities. DEP's monitoring objectives for 2012 are documented in the 2009 Watershed Water Quality Monitoring Plan (WWQMP) (DEP 2009), which is designed to meet the broad range of DEP's many regulatory and informational requirements. The plan prescribes monitoring to achieve compliance with all federal, state, and local regulations; meet the terms of the 2007 FAD; enhance the capability to make current and future predictions of watershed conditions and reservoir water quality; and ensure delivery of the best water quality to consumers through ongoing surveillance.

The overall goal of the plan is to establish an objective-based water quality monitoring network, which provides scientifically defensible information regarding the protection and management of the New York City water supply. The objectives of the plan have been defined by the requirements of those who ultimately require the information, including DEP program administrators, regulators, and other external agencies. As such, the monitoring regime prescribed in the plan is driven by legally binding mandates, stakeholder agreements, operations, and watershed management information needs. The plan covers four major areas that require ongoing attention: compliance, FAD program evaluation, modeling support, and surveillance monitoring, with many specific objectives within these major areas.

*Compliance*. The compliance objectives of the sampling plan are focused on meeting the regulatory compliance monitoring requirements for the New York City watershed. This includes the requirements of the Surface Water Treatment Rule (SWTR) (EPA 1989) and its subsequent extensions, as well as the New York City Watershed Rules and Regulations (WR&R) (1997), the Croton Consent Decree (CCD), administrative orders, and State Pollution Discharge Elimination System (SPDES) permits. The sampling sites, analytes, and frequencies are defined in each objective according to each specific permit, rule, or regulation.

*FAD program evaluation*. USEPA has specified many requirements in the 2007 FAD that must be met to protect public health. These requirements form the basis for the City's ongoing assessment of watershed conditions, changes in water quality, and ultimately any modifications to the strategies, management, and policies of the Long-Term Watershed Protection Program. The City also conducts a periodic assessment of the effectiveness of the program using, among other information, DEP's water quality monitoring data. Program effects on water quality are reported in the Watershed Protection Summary and Assessment reports (e.g., DEP 2011a), which are produced approximately once every five years.

*Modeling support.* Modeling data are used to meet the long-term goals for water supply policy and protection and provide guidance for short-term operational strategies when unusual water quality events occur. These objectives are achieved through implementation of watershed and reservoir model improvements based on ongoing data analyses and research results; ongoing testing of DEP's watershed and reservoir models; updating of data necessary for the development of models; and development of data analysis tools to support modeling projects.

Stream, reservoir, aqueduct, and meteorological data are all needed to develop, calibrate, and validate models. Data acquired through stream monitoring include both flow and water quality data. Reservoir monitoring provides flow and reservoir operations data to support reservoir water balance calculations. The water balance and reservoir water quality data are required to test, apply, and further develop DEP's one- and two- dimensional modeling tools. The meteorological data collection effort provides critical input necessary to meet both watershed and reservoir modeling goals. For a summary of the modeling program's activities in 2012, see Section 5.3.

*Surveillance monitoring.* The surveillance monitoring plan contains several objectives that provide information to guide the operation of the water supply system, other objectives to help track the status and trends of constituents and biota in the system, and specific objectives that include aqueduct monitoring for management and operational decisions. Another surveillance objective relates to developing a baseline understanding of potential contaminants such as trace metals, volatile organic compounds, and pesticides, while another summarizes how DEP monitors for the presence of zebra mussels in the system. Zebra mussel monitoring is meant to trigger actions to protect the infrastructure from becoming clogged by these organisms. The remaining objectives pertain to recent water quality status and long-term trends for reservoirs, streams, and benthic macroinvertebrates in the Croton System. It is important to track the water quality of the reservoirs to be aware of developing problems and to pursue appropriate actions.

### 5.1.2 Additional Water Quality Monitoring

Weather-related events that occurred in 2011, i.e., Tropical Storms Irene and Lee, continued to impact water quality in 2012, and led to the continuation of enhanced monitoring beyond that prescribed in the WWQMP. Alum treatment of the Catskill System was continued along with enhanced monitoring from August 29, 2011 until May 15, 2012. See the DEP after-action report for details (DEP 2012c).

In addition, Hurricane Sandy had a significant impact on turbidity levels in Kensico Reservoir at the end of October. For a summary, see Section 2.1.2. This event resulted in a Tier 2 treatment technique violation of the Surface Water Treatment Rule (SWTR) (USEPA 1989) as outlined in the New York State Sanitary Code 10 NYCRR Section 5-1.30(c). To minimize any potential public health risks associated with the elevated turbidity, DEP increased the chlorine treatment dose at Kensico and Hillview Reservoirs. This ensured compliance with the SWTR and provided additional disinfection above and beyond what is normally provided during routine

treatment operations. DEP also took other operational actions and collected additional samples for *Giardia* and *Cryptosporidium* analysis at the Hillview Reservoir downtakes at the time the elevated turbidity was moving through the reservoir. Results were normal, indicating that the event likely posed no public health risk to drinking water consumers from these protozoan pathogens. See the DEP after-action report for details (DEP 2012d).

Additional weather-related monitoring, dependent upon storm intensity and precipitation, was conducted in 2012 at Kensico Reservoir, as per the Kensico Storm Event Monitoring Plan, and was documented in Special Investigation (SI) Reports. SIs are performed to document man made or natural events occurring in the watershed that have the potential to negatively affect water quality. SIs may include DEP's response to a sewage overflow, oil spills, or storm events. Three SIs related to storm events occurred in 2012.

### 5.1.3 Water Quality Reports

Pursuant to the City's Long-Term Watershed Protection Plan (DEP 2011b) and as a FAD requirement (Section 5.1 Watershed Monitoring Program), DEP produces a Watershed Water Quality Annual Report, which is submitted to USEPA in July of each year (e.g., DEP 2012e). This document contains chapters covering water quantity (e.g., the effects of droughts or excessive precipitation during the reporting period), water quality of streams and reservoirs, watershed management, and water quality models (terrestrial and reservoir). For the 2012 report (due July 2013), the limnology and hydrology components of the document will draw largely from information obtained from approximately 214 routinely-sampled reservoir and stream sites, resulting in almost 5,500 samples and over 57,000 analyses. For the pathogen component, 581 routine samples were analyzed for *Giardia*, *Cryptosporidium*, turbidity, pH, and temperature (2,354 analyses) at 53 sampling sites (including keypoints), while 239 samples were collected for human enteric virus (HEV) examination.

It is very important that DEP monitor pathogen concentrations in the water supply on an ongoing basis to be able to confirm that pathogens do not threaten the safety of the water supply. To maintain a constant flow of information to DEP managers and regulators, pathogen data are reported frequently and in several different reports. The following reports were issued in 2012:

- Weekly results of *Cryptosporidium* and G*iardia* sampling at the three source waters, which are routinely posted on DEP's website and sent directly to regulators by email
- Monthly filtration avoidance reports
- Monthly Croton Consent Decree reports
- Annual mid-term report on DEP pathogen studies of G*iardia* spp., *Cryptosporidium* spp., and HEVs (e.g., DEP 2012f)
- Annual Kensico Reservoir Report (e.g., DEP 2012a)
- Watershed Water Quality Annual Report (e.g., DEP 2012e)
- Drinking Water Supply and Quality Annual Report (DEP 2012g)
- Bureau of Water Supply Annual Report (e.g., DEP 2012h, or, every fifth year, the Watershed Protection Program Summary and Assessment, e.g., DEP 2011a)

Additional reports are submitted to describe the activities of the Kensico Water Quality Control Program. DEP submits a Kensico Programs Annual Report to USEPA in January, and a companion report in March, which analyzes monitoring data from the Kensico watershed and provides an update on the status and application of the Kensico Reservoir model. Additionally, the document reports observations from the assessment of Kensico BMPs, sampling for toxic substances, and applications of the Kensico water quality model to guide operations. A Kensico Programs Semi-Annual Report is submitted in July that provides a brief report discussing material events in Kensico program implementation.

## 5.2 Wastewater Treatment Plant Protozoan Monitoring

The purpose of the wastewater treatment plant (WWTP) protozoan monitoring in the Filtration Avoidance watershed is to demonstrate that microfiltration, and technologies deemed equivalent, continue to perform well with respect to protozoan removal from the effluents of the plants. From July 2002 through December 2008, DEP monitored the same 10 WWTPs quarterly, as stated in the previous monitoring plan (DEP 2003). In 2009, the new WWQMP (DEP 2009) took effect and it outlined monitoring for five new WWTPs west of the Hudson River (Andes, Fleischmanns, Hunter, Prattsville, and Windham), while maintaining monitoring at three of the previous locations (Grahamsville, Hunter Highlands, and Stamford) (Figure 5.1). Late in 2011, the Ashland WWTP reached functional completion and this plant was added for sampling in 2012. All nine plants were monitored quarterly for *Giardia* and *Cryptosporidium* in 2012.

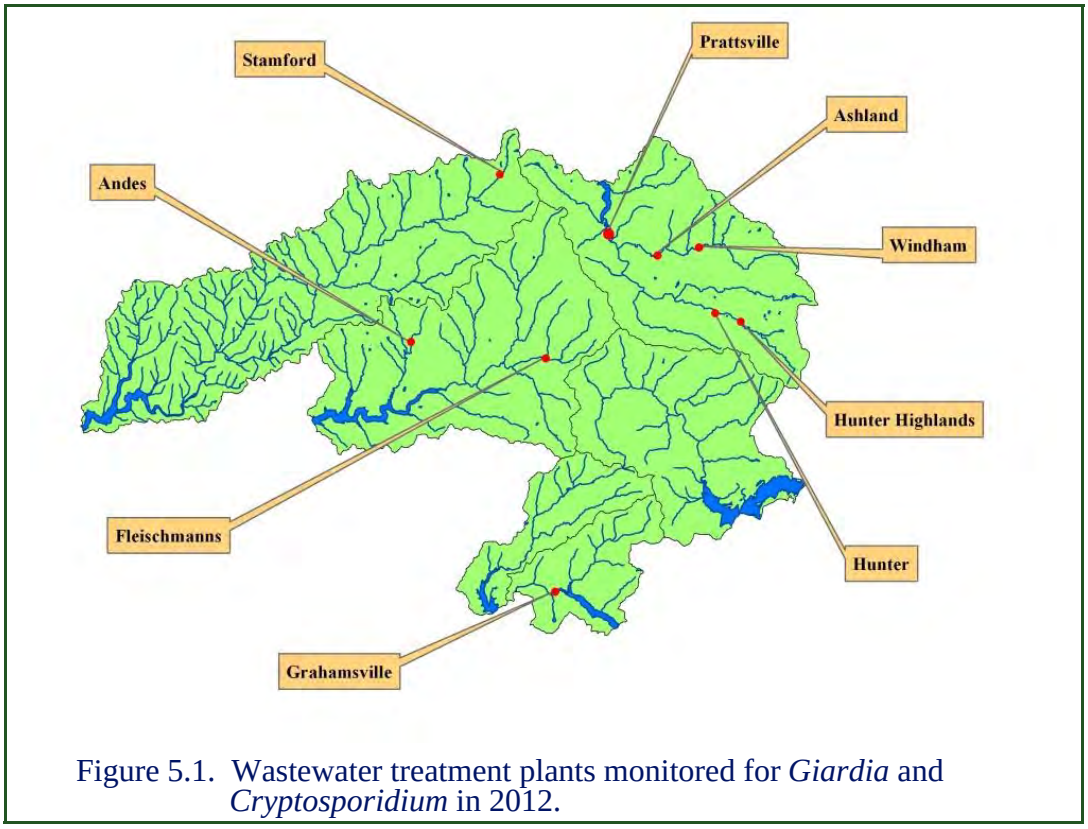


Figure 5.1. Wastewater treatment plants monitored for *Giardia* and *Cryptosporidium* in 2012.

Monitoring for *Cryptosporidium* and *Giardia* involved the field filtration of 50 liters of water for each sample. Samples were analyzed by DEP according to EPA Method 1623 (EPA 2005). All 36 protozoan samples were collected as scheduled in 2012, and all were negative for both *Cryptosporidium* oocysts and *Giardia* cysts.

## 5.3 Multi-Tiered Water Quality Modeling Program

DEP's Multi-Tiered Water Quality Modeling Program applies watershed and reservoir models and analyzes data to support reservoir operations, watershed management, and long-term water supply planning. A detailed account of the activities of the Modeling Program from October 2011 to September 2012 is given in the October 2012 FAD Modeling Program Status Report (DEP 2012i). The following is a summary of the activities which occurred during calendar year 2012.

### *Modeling in Support of Reservoir Operations*

During 2012, 14 sets of simulations were run to support reservoir operational decision making. The majority of these helped identify operational strategies that would help mitigate the lingering effects of hurricane Irene and tropical storm Lee. These two extreme events occurred during September and October 2011, and as a consequence, alum treatment of Catskill System water was required through late May of 2012. In the period up until the end of alum treatment, seven sets of simulations were used to evaluate the turbidity levels in Ashokan and Kensico Reservoirs. Simulations, focusing on the conditions in Ashokan Reservoir, evaluated potential future increases in turbidity that might be expected, especially those that might occur during spring snowmelt supplemented streamflow. Some of these simulations also evaluated the impacts of using the Ashokan Release Channel on the transfer of turbidity from the West to East Basin of Ashokan Reservoir and the turbidity of the water withdrawn from the East basin. Kensico Reservoir simulations were used to help better define the optimal Catskill Aqueduct flow rates, while maintaining Kensico effluent turbidity levels at safe and acceptable levels. These simulations, therefore, helped better define the timing of stop shutter use, flow rates that could minimize the volume of water treated with alum, and the length of time over which alum treatment was required. The simulations were run in response to declining Ashokan turbidity, and to the increased turbidity loads to Kensico Reservoir once conditions allowed the removal of stop shutters after the cessation of alum treatment.

During 2012, a second period of elevated turbidity occurred during September, when a large and intense rain event led to a large turbidity input to Ashokan Reservoir and an unusually large increase in turbidity in Neversink Reservoir. This storm prevented the water from Neversink Reservoir from being used, while in Ashokan Reservoir the turbidity inputs were initially confined to the West Basin, and had only a small impact on the turbidity levels in the water transferred to Kensico Reservoir. Simulations done in response to this storm focused on forecasting the effects of the loss of Neversink water on water storage in the remainder of the system, and on the

timing of future transfers of turbidity to the East Basin of Ashokan as the West Basin eventually filled. The potential effects of Ashokan Release Channel use on the transfer of turbidity between the West and East Basins of the reservoir were also evaluated. As a progression of storm events eventually led to the transfer of turbidity to the East Basin of Ashokan Reservoir, simulations focused on Kensico Reservoir and were used to help define acceptable Catskill Aqueduct flow rates in response to first increasing and later decreasing levels of turbidity input to the Catskill Aqueduct. Unlike the extreme levels of turbidity associated with the tropical storms in 2011, the fall event in 2012 could be managed by changes in reservoir operations; alum treatment was not needed.

### *Evaluation of Climate Change*

A number of modeling analyses to evaluate the effects of future climate change on the quantity and quality of water in the NYC water supply were conducted as part of the Climate Change Integrated Modeling Project (CCIMP). One of the most consistent and certain predictions made by the CCIMP, and many other climate change studies, is more frequent winter rain and snowmelt, leading to increased winter streamflow and decreased flows at the time of contemporary peak spring streamflow. During 2012, a number of CCIMP analyses examined the consequences of this expected change in the seasonality of stream discharge on the timing of nutrient and turbidity transport to the water supply reservoirs, and on the turbidity and trophic levels in the reservoirs. As would be expected, the projected future increases in streamflow led to increased winter loading of nutrients and turbidity. In the case of turbidity, this resulted in shifts in the long-term seasonal pattern in Ashokan Reservoir turbidity, with greater values being predicted throughout the winter, and somewhat lower values being predicted during the summer. Simulated increases in nutrient loading to Cannonsville Reservoir during the winter also occurred, as did reservoir nutrient concentrations. The effects of shifting larger portions of the annual nutrient loads to the winter had a relatively small effect on annual or stratified period chlorophyll concentration. An earlier onset of thermal stratification simulated in the future scenarios led to an earlier phytoplankton bloom.

### *Model Development and Testing*

Model development, testing and improvement continued during 2012. Significant efforts were expended towards assessing the value and utility of the Snow Data Assimilation System (SNODAS) spatially distributed snow data set that is available from the National Snow and Ice Data Center. SNODAS data were used to evaluate the frequency and importance of rain on snow events in the NYC watershed area and other regions of New York State. A systematic comparison was also made between the watershed-wide SNODAS predicted snow water equivalent (SWE) and the SWE values simulated by the GWLF model presently used by the water quality modeling group, and a spatially distributed version of the GWLF snow model.

Analysis of turbidity transport dynamics in the Esopus Creek watershed continued, with the development and testing of an improved turbidity prediction method that accounted for turbidity levels at the time of prediction using an autocorrelation time series prediction. This method has the potential to improve future turbidity predictions when automated monitoring data are available to specify current turbidity levels.

A screening tool was developed and tested which predicts areas of potential stream channel erosion based on variations in stream power, which is in turn predicted from estimations of bankfull discharge, stream channel morphometry, and stream channel slope. The calibration of a one-dimensional reservoir eutrophication model for Pepacton Reservoir was updated using an automated hybrid genetic calibration method and making comparisons against the full time series of DEP water quality monitoring data from Pepacton Reservoir. Following this calibration, simulated water quality parameters better matched the long-term measurements.

### *Data Acquisition and Development*

Model data acquisition and organization included GIS and time series data. GIS data development included: updating of water quality monitoring site and DEP meteorological station site location information and providing sampling site locations to the Laboratory Information Management System (LIMS); use of the Natural Resources Conservation Service's Soil Survey Geographic Database (SSURGO) soils data to derive soil property layers for West of Hudson (WOH) watersheds; development of a spatial model of stream power in Esopus Creek tributaries. Time series data development included updating of meteorology, WWTP nutrient loads, streamflow, stream water quality and temperature, limnology, keypoint, and reservoir operations data used for driving and testing watershed and reservoir models. During 2012, 4-km gridded meteorological data were obtained from the Northeast Regional Climate Center covering the entire WOH watershed. These data were evaluated for use as an alternative source of input to the GWLF models developed for the WOH watershed region.

### *Modeling Program Collaboration*

Modeling Program collaboration and participation in external research projects in 2012 included: Water Resource Foundation (WRF) Project 4262—Vulnerability assessment and risk management tools for climate change: assessing potential impacts and identifying adaptation options; WRF Project 4306—Analysis of reservoir operations under climate change; and the Water Utility Climate Alliance's Pilot for Utility Modeling Applications (PUMA).

The Modeling Program continued managing two ongoing contracts which provide data and scientific support. A contract with the U.S. Geological Service (USGS) provides turbidity and suspended sediment monitoring in the upper Esopus Creek watershed. A Scientific Modeling Support contract with the Research Foundation of the City University of New York continues to provide post-doctoral research associates who are stationed in DEP's Kingston, NY office and work directly with modeling group staff.

During 2012 two contracts with the Upstate Freshwater Institute (UFI) were successfully completed. The "Integrated Program of Measurement, Process Studies and Modeling for the Turbidity Problem at Schoharie Creek and Esopus Creek" contract has been a long-term effort to develop water quality modeling tools that can be used to simulate turbidity levels and transport in Schoharie, Ashokan, and Kensico Reservoirs. The models developed under this contract are routinely used to evaluate turbidity conditions, and to provide forecasts that can support reservoir operations. The water quality models have also been incorporated into the DEP Operations Support Tool (OST), and UFI continues to work on the OST development contract. The contract with UFI to develop "Robotic Monitoring of Selected New York City Reservoirs and Major Tributaries" came to a conclusion, with the operation of the monitoring system and associated monitoring database being successfully transferred to DEP.

During 2012, the Modeling Program supported a NASA grant application prepared by the City College of New York Center for Remote Sensing of the Earth Science and Technology (CUNY CREST), titled "Application of Evapotranspiration and Soil Moisture Remote Sensing Products to Enhance Hydrological Modeling for Decision Support in the NYC Water Supply". This grant has been funded. In addition, the Modeling Program collaborated with CUNY CREST on a comparison of watershed simulations of evapotranspiration and soil moisture with remote sensing-based estimates of these parameters. It also helped prepare, with potential external collaborators, two additional National Science Foundation funding proposals which, if funded, would improve the program's modeling capability and data access. The proposals were "Taking Upland, Channel and Future Climate Into Account For Effectively Managing Erosion And Sediment: The Stony Clove Watershed", with collaborators from Cornell University and the USDA ARS National Sediment Laboratory; and "Macrosystem Controls on Nitrogen Cycling and Export Through Terrestrial and Aquatic Ecosystems in the Eastern Forest Biome", with Lawrence E. Band, University of North Carolina-Chapel Hill as the lead investigator.

### *Publications*

The Modeling Program authored five scientific papers that were accepted for publication in peer-reviewed journals (Huang and Pierson 2012, Klug et al. 2012, Matonse et al. 2012, Mukundan et al. 2012, Samal et al. 2012) and made 18 conference presentations.

## 5.4 Geographic Information System

In fulfillment of the FAD requirement for an annual GIS status report, this section presents an overview of continued development and utilization of DEP's Geographic Information System (GIS) from January 1, 2012 to December 31, 2012. GIS activities support numerous FAD and New York City Memorandum of Agreement (MOA) (1997) watershed management applications. This report describes progress in providing GIS technical support for protection programs, moni-

toring programs, and modeling applications; the completion or acquisition of new GIS data layers and aerial products in the GIS spatial data libraries; GIS infrastructure improvement; and GIS data dissemination summaries.

DEP's GIS is used to manage the City's interests in the lands and facilities of the upstate water supply system, and to display and evaluate the potential efficacy of watershed protection programs through maps, queries, and spatial analyses. The GIS is also used to support watershed and reservoir modeling of water quantity and quality, as well as modeling of water supply system operations. GIS resources are utilized by DEP at offices throughout the watershed, either directly through a centralized geodatabase (the GIS library) or indirectly via the Watershed Lands Information System (WaLIS).

### 5.4.1 GIS Technical Support

During the reporting period, the GIS Program provided technical support and data development, including extensive GPS fieldwork, for a variety of protection programs and modeling applications in the following areas:

***Watershed Protection Programs and Facilities:***

- Land Acquisition Program (LAP) parcel ranking system refinement, based on updated natural features criteria
- Rondout-West Branch Tunnel (RWBT) Bypass Project surveys and spatial alignments
- Marcellus Shale map and statistic updates to include hydrofracking exclusion areas
- emergency response mapping after Hurricane Sandy
- Catskill Watershed Corporation Septic Repair Program prioritization
- 2010 census data analysis comparing population change by basin
- Delaware Aqueduct Project parcel delineations in Wawarsing
- MS4 East of Hudson (EOH) facility inventory
- Ongoing efforts:
    - land acquisition parcel tracking
    - water supply infrastructure mapping
    - municipal sewer infrastructure mapping
    - stream assessment and flood hazard classification
    - wetland trend assessment
    - invasive species mapping and assessment
    - GPS upload, download, differential correction, and GIS conversion of points collected by various programs

***Watershed Water Quality Science and Research Programs:***

- Graphics for reports, posters, presentations, and peer-reviewed publications
- Animation of spatially-distributed, near real-time meteorological data
- Derivation of stream power values from Digital Elevation Models (DEMs) of differing resolutions
- Regional analysis of rainfall totals for Hurricane Irene and Tropical Storm Lee events
- Variable source area modeling in the watershed

- Pathogen source analysis
- Lower Delaware Basin loading
- Climate change impact assessment

### 5.4.2 Completion or Acquisition of New GIS Data Layers and Aerial Products

Many new feature classes and tables were created and placed in the GIS library in 2012, while several existing feature classes were updated or overhauled as part of ongoing data maintenance. Staff updated or developed mission-critical data sets for various DEP programs, including annual digital tax parcel updates for all watershed counties, NYC-owned land or interests, New York State-owned land, DEP water supply facilities, stream reaches and restoration projects, septic repairs, and engineering project locations. Updates were also made to SSURGO2 detailed soil data and attribute tables for eight watershed counties and Connecticut, and DEP sample site locations for LIMS. CAD conversion into GIS format of alignments for the RWBT Bypass project were made available to GIS users via the central geodatabase and WaLIS. Census population data for 1990, 2000, and 2010 were also added.

By the end of the year, the majority of final products was delivered from a contract to derive high-resolution hydrography data using the 2009 Light Detection and Ranging (LiDAR) and orthoimagery collections, an example of which is shown in Figure 5.2. A comparison of this high resolution data with older 1:24,000 scale USGS data is shown in Figure 5.3.

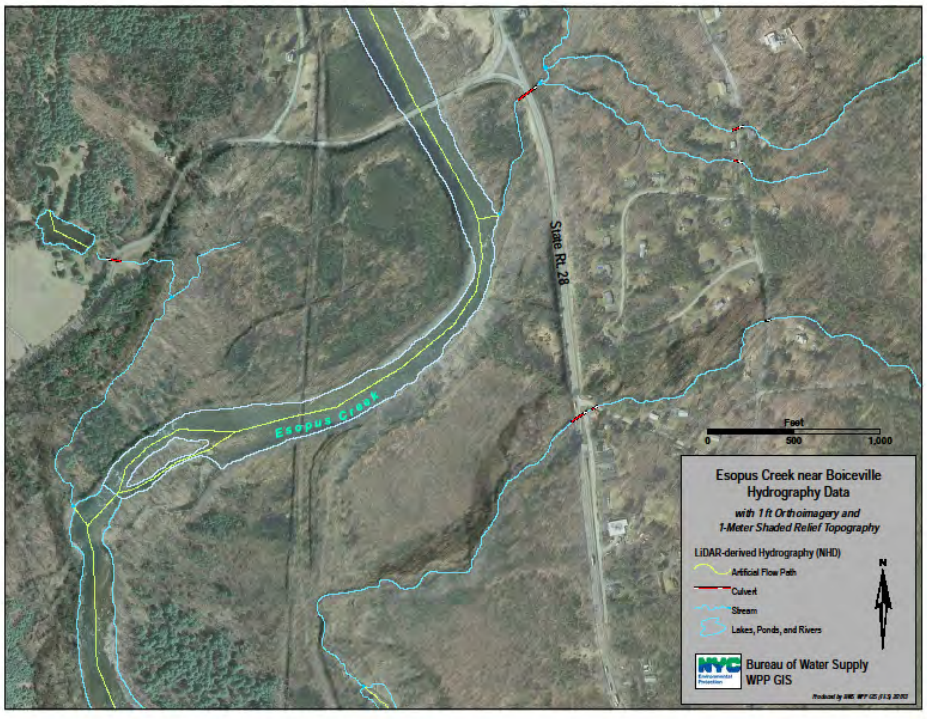


Figure 5.2. A portion of the LiDAR-generated hydrography GIS data in NHD format for Esopus Creek at Boiceville, NY, in the Ashokan basin. This hydrography data, which includes hydraulic structures, stream centerlines, water body polygons with their artificial flow paths, and a 1-ft. hydro-conditioned DEM, were developed wall-to-wall for all NYC reservoir basins.

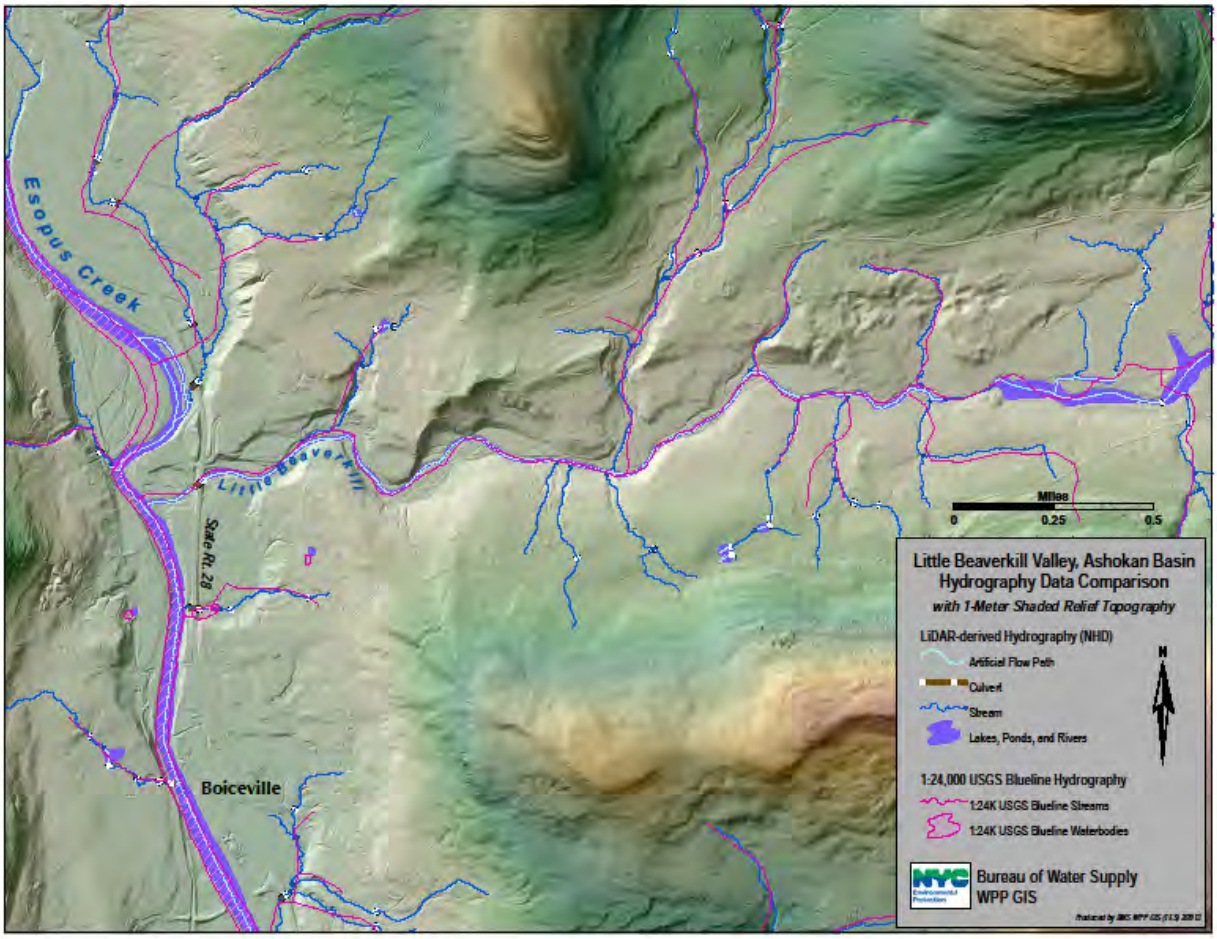


Figure 5.3. A comparison of the LiDAR-generated hydrography GIS data in NHD format to 1:24,000 scale USGS "Blueline" data, which was the best available hydrography GIS data until recently.

All WOH and EOH hydrography was completed and submitted to the USGS National Hydrography Dataset (NHD). In order to implement the new data in the GIS library, all hydrography-related data dependencies were identified and are being addressed. This includes archiving and replacing many existing data sets with the new data, such as streams, water bodies, basins, contours, and DEMs. Any derived data sets must also be regenerated, such as hydrologic and regulatory buffers, slopes, LAP criteria models, and Septic Repair Program prioritization. Finally, attribute information and business tables in WaLIS related to hydrography, topography, or basin delineation must be updated.

A contract to map impervious surfaces and land use/land cover at high resolution from 2009 orthoimagery has produced final deliverables of WOH and EOH impervious surface polygons. The data have a minimum mapping unit of 20 feet (i.e., 400 sq. ft.) and an overall accuracy

of 92%, exceeding specifications. Impervious classes are broken down by type into roads, buildings, or other impervious. A "Level One" land cover classification product has also been completed. The final phase of this work, a land use classification, will be ongoing throughout 2013.

### 5.4.3 GIS Infrastructure Improvement

***Hardware and Software***

Significant progress and near completion of a large, complex enterprise-wide GIS server migration effort were achieved in 2012. In the autumn, the DEP Office of Information Technology (OIT) completed the installation and configuration of new Hewlett-Packard Blade servers procured by the Watershed Lands and Community Planning Division (WLCP). This allowed staff to begin migrating over the GIS and WaLIS databases, which had outgrown existing server disk space, to the new server hardware. This also involved updating GIS application and database software versions, as well as related WaLIS scripts to work with those new versions, all extremely complex tasks. Staff built a test GIS library on the new development server and integrated new LiDAR-derived hydrography. After much effort spent on troubleshooting network speed, load-balancing, and performance-testing, all issues have been resolved as of the end of the year, and a production database is near completion.

WLCP purchased 32 GB of RAM for OIT to upgrade a new terminal server which allows numerous WaLIS users from remote sites to access the WaLIS database in Kingston. WLCP also purchased four new GPS units, trading in older units for credit toward the purchase.

All ESRI GIS software licensing continues to be coordinated and managed at the agency level by DEP OIT through an ESRI Enterprise Licensing Agreement (ELA), which was renewed in 2012. In addition to the ESRI ArcGIS User and Server applications, the ELA provides DeP with licenses of ESRI ArcEngine Runtime and ArcEngine Developer's Toolkit for use in continued development and deployment of the WaLIS application.

***System and Database Administration***

During the past year, the GIS database administrator managed the GIS library by creating and updating data sets, maintaining file geodatabase copies of the library, supporting spatial data development for WaLIS, updating schemas, and backing up all databases. At the same time, a significant effort was spent performing the following GIS server migration tasks:

- Upgrading 68 upstate user workstations running ArcGIS
- Building and successfully testing a new version of WaLIS that uses ArcEngine 10
- Working with OIT on load-balancing and roaming profiles on the new terminal servers, for remote access to both native GIS software and the WaLIS application
- Upgrading automation and backup scripts to ArcGIS 10
- Restoring the Bureau of Water Supply central geodatabase onto new development and test servers, installing ArcSDE 10.0, then upgrading the geodatabase to SDE 10.0

- Running numerous performance tests on the new server
- Testing WaLIS and ArcMap on the new virtual terminal servers

The GIS Program develops, upgrades, and maintains WaLIS, which currently operates on the workstations of 251 distinct DEP users. Of these, 169 used WaLIS at least 10 or more times during 2012. The integration of the Regulatory Compliance (RCI) database and application into WaLIS was completed and a new version released. In order to facilitate field data entry into WaLIS by Regulatory and Engineering Program (REP) staff, a tablet application was developed and field-tested to work with several customized data forms for RCI, Stormwater, and Wastewater programs. A process to track new flood buyouts in WaLIS was developed. Solicitation process data were updated and refined in support of LAP solicitation analysis workflow. The schema and data related to LAP soft-cost payments were updated and migrated into WaLIS. BWS facilities data attachments were migrated into WaLIS for the Capital Planning Directorate. DEP Police at the Eastview precinct were set up with access to WaLIS. The GIS Program also continued to develop and maintain hundreds of built-in customized WaLIS server reports using Crystal Reports software.

### 5.4.4 Data Dissemination to Stakeholders

Using data sharing policies developed in cooperation with DEP Legal, the GIS Program reviewed all outside requests for GIS data, and either emailed or wrote approved GIS data to CDs or portable drives as required for data sharing. Over 45 stakeholders and communities are currently on a schedule to receive semiannual data updates of newly-acquired and existing NYC water supply lands, and were sent these data via email in January and July. NYSDEC was sent updated GIS data of DEP recreational lands for the new edition of its Catskill Park Map. ConEdison was sent GIS data of NYC-owned lands for Hurricane Sandy-related response work in Westchester County. DEP provided data assistance and interpretation to a consultant developing a sustainability plan for Ulster County. A GIS data distribution agreement was established with the New York Natural Heritage Program, allowing DEP to contribute invasive species data to a statewide secure database. Several GIS data sets were sent to the East of Hudson Watershed Corporation. Numerous other individual GIS data layers were sent to contractors and consultants working on various DEP-related projects, including the RWBT Bypass Project and a FEMA floodplain mapping contract.

# 6. Regulatory Programs

A primary component of DEP's overall watershed protection strategy is the enforcement of applicable environmental statutes and regulations, which include the New York City Watershed Rules and Regulations (WR&R) (2010), the federal Clean Water Act (33 U.S.C. §1251 et seq.), the National Pollutant Discharge Elimination System, and the State Environmental Quality Review Act (SEQRA), as well as local ordinances. Of these, the primary mechanism for protection of the water supply is the WR&R.

DEP's regulatory efforts are focused on three major areas: review and approval of projects within the watershed, environmental law and WR&R enforcement, and regulatory compliance and inspection of wastewater treatment plants (WWTPs).

## 6.1 Project Review

Each project proposed in the watershed, including those designed or sponsored by DEP, is reviewed to ensure compliance with the WR&R, as well as federal, state, and local laws. Projects that require DEP review and approval include all wastewater treatment systems, including WWTPs, sewer collection systems and the installation of subsurface sewage treatment systems (SSTSs), the preparation of stormwater pollution prevention plans (SWPPPs), and the construction of certain impervious surfaces. In addition, DEP reviews and issues permits for individual residential stormwater plans (IRSPs) and for impervious surfaces associated with stream diversions or pipings. DEP also ensures that during and after construction, projects that require SWPPPs or IRSPs have the necessary best management practices (BMPs) installed, and that erosion controls are properly sited and maintained. In addition, DEP reviews applications that have been sent to NYSDEC for special permits involving mining operations, timber harvesting, stream crossings, and wetland issues. These applications are forwarded to DEP for review and comment as provided for in the DEP/DEC Memorandum of Understanding.

Table 6.1 lists the number of new projects received in 2012 in the East of Hudson FAD basins. These projects are all stormwater and variance applications, with the exception of a single NYSDOT project (the "Other" category). The new, delegated, and remediated individual SSTSs for these basins are listed in Table 6.2.

Table 6.1. East of Hudson FAD basin new projects for 2012. Project summaries and maps showing project locations can be found in the biannual Filtration Avoidance 6.1 Project Activities reports. OT = other; SP = stormwater and crossing, piping, diversion; VA = variance.

| Basin | Town | OT | SP | VA | Total |
|---|---|---|---|---|---|
| Cross River | Lewisboro | | 2 | | 2 |
| Croton Falls | Carmel | | 2 | 1 | 3 |
| Kensico | North Castle | | 1 | | 1 |
| West Branch | Carmel | 1 | | | 1 |
| Total | | 1 | 5 | 1 | 7 |

Table 6.2. East of Hudson FAD basin individual SSTSs for 2012.

| Reservoir | Delegated septics | New septics | Septic repairs | Approvals | Under construction |
|---|---|---|---|---|---|
| Boyd Corners | 2 | 1 | 2 | 4 | 0 |
| Cross River | 3 | 0 | 6 | 10 | 6 |
| Croton Falls | 4 | 0 | 15 | 7 | 1 |
| Kensico | 1 | 0 | 2 | 5 | 1 |
| West Branch | 4 | 0 | 13 | 5 | 0 |
| Total | 14 | 1 | 38 | 31 | 8 |

All new and repaired individual SSTS applications in the Kensico, West Branch, Boyd Corners, Croton Falls, and Cross River basins located in Putnam and Westchester Counties are subject to delegated review by the county health departments. (For more on delegation agreements, see Section 6.1.2.) The new and repaired individual SSTSs located in Dutchess County are reviewed and approved by DEP.

Table 6.3 lists new projects received in 2012 in the West of Hudson (WOH) basins. These projects include new or repaired commercial, institutional, and multi-family septics, and individual residential projects with advanced treatment units (ATUs). The “Other” projects consist of NYSDOT projects, wetland and stream disturbances, mining applications from NYSDEC, timber harvesting, and stormwater retrofit projects. New, delegated, and remediated individual SSTSs are listed in Tables 6.4 (Catskill watersheds) and 6.5 (Delaware watersheds).

Table 6.3. West of Hudson new projects for 2012. Project summaries and maps showing project locations can be found in the biannual Filtration Avoidance 6.1 Project Activities reports. CR = intermediate repair; IS = intermediate SSTS; OT = other; SC = sewer collection; CN = sewer connection; SP = stormwater and crossing, piping, diversion; SD = stream disturbance.

| Reservoir | Town | CR | IS | OT | SC | CN | SP | SD | Total |
|---|---|---|---|---|---|---|---|---|---|
| Ashokan | Hunter | | | 1 | | | | | 1 |
| Ashokan | Olive | | 1 | | | | | | 1 |
| Ashokan | Shandaken | 1 | | 2 | | | 2 | | 5 |
| Ashokan | Woodstock | 1 | | 1 | | | | | 2 |
| Cannonsville | Delhi | 1 | | | | | 1 | 2 | 4 |
| Cannonsville | Deposit | | | 1 | | | | | 1 |
| Cannonsville | Hamden | | | | | 2 | | 1 | 3 |
| Cannonsville | Kortright | | | | | | 2 | | 2 |
| Cannonsville | Tompkins | | | 1 | | | 2 | 2 | 5 |
| Cannonsville | Walton | | | 2 | | | 1 | 1 | 4 |
| Pepacton | Andes | | | | | | 1 | 1 | 2 |
| Pepacton | Middletown | 1 | 1 | 1 | | | | 1 | 4 |
| Pepacton | Roxbury | 1 | | | | | 2 | | 3 |
| Rondout | Neversink | | | 1 | | 1 | | | 2 |
| Schoharie | Ashland | | | | | | 1 | | 1 |
| Schoharie | Gilboa | 1 | | 1 | | | | | 2 |
| Schoharie | Hunter | | | 1 | | 1 | 2 | | 4 |
| Schoharie | Jewett | 1 | | | | | 1 | | 2 |
| Schoharie | Lexington | | | 3 | | | 1 | | 4 |
| Schoharie | Prattsville | 1 | | 2 | | | 2 | | 5 |
| Schoharie | Windham | | | 1 | | | 11 | 1 | 13 |
| Schoharie | (V) Tannersville | | | | | 1 | | | 1 |
| Total | | 8 | 2 | 18 | 0 | 5 | 29 | 9 | 71 |

Table 6.4. Ashokan and Schoharie Reservoirs individual SSTSs for 2012.

| Reservoir | Delegated septics | New septics | Septic repairs | Approvals | Under constructions |
|---|---|---|---|---|---|
| Ashokan | 16 | 1 | 65 | 83 | 83 |
| Schoharie | N/A* | 21 | 41 | 62 | 71 |
| Totals | 16 | 22 | 106 | 145 | 154 |

* DEP does not have a Delegation Agreement with Greene or Schoharie County, so the number of delegated septics is not applicable to this reservoir.

Table 6.5. Cannonsville, Neversink, Pepacton, and Rondout Reservoirs individual SSTSs for 2012.

| Reservoir | Delegated septics | New septics | Septic repairs | Approvals | Under construction |
|---|---|---|---|---|---|
| Cannonsville | N/A* | 20 | 59 | 77 | 100 |
| Neversink | 1 | 1 | 9 | 9 | 7 |
| Pepacton | N/A* | 9 | 41 | 52 | 62 |
| Rondout | 1 | 4 | 18 | 22 | 27 |
| Totals | 2 | 34 | 127 | 160 | 196 |

* DEP does not have a Delegation Agreement with Greene or Schoharie County, so the number of delegated septics is not applicable to this reservoir.

### 6.1.1 SEQRA Coordination

DEP conducts reviews of all State Environmental Quality Review Act (SEQRA) projects in the watershed. To manage these often large and complex projects, and the accompanying SEQRA environmental reviews, DEP tracks all SEQRA projects in the watershed, maintains a database of new projects and development trends in the watershed, and interacts with local, state, and federal officials and other parties.

Projects undergoing a SEQR review may require the preparation of some or all of these documents: Notices of Intent to Act as Lead Agency, Determinations of Action Types, Environmental Assessment Forms (EAFs), Scoping Documents, Draft Environmental Impact Statements (DEISs), Final Environmental Impact Statements (FEISs), Final Generic Environmental Impact Statements (FGEISs), Supplemental Environmental Impact Statements (SEISs), and Findings to Approve or Deny. Table 6.6 presents a summary of SEQRA reviews in 2012.

Table 6.6. SEQRA reviews in 2012.

| Received | Reviewed | Comment letters issued | Ongoing reviews | SEQRA process closed* |
|---|---|---|---|---|
| 91 | 91 | 50 | 70 | 93 |

* Includes certain actions that DEP received prior to the beginning of the reporting period.

Table 6.7 provides a brief overview of the nature and status of significant, privately-sponsored, SEQRA Type I Actions that are currently undergoing, or have undergone, SEQRA environmental reviews during the reporting period.

Table 6.7. 2012 SEQRA review and status for significant Type I Actions.

| Project Name | Town/County | Basin | Description | Status |
|---|---|---|---|---|
| The Green At Somers | Somers/ Westchester | Amawalk | Four 3-story mixed used buildings to include 82 residential units and 238 parking spaces on 11.07-acre parcel and wastewater collection system | DEP received project notification and issued comment letter. Awaiting a determination from the Lead Agency. |
| The Mews Phase 2 | Somers/ Westchester | Amawalk | Phase 2 construction of 75 affordable housing units on newly created 7.7-acre parcel | DEP issued comment letter and received Lead Agency Negative Declaration. |
| South Kortright CWMP | Cannonsville | Kortright/ Delaware | Proposed new community wastewater collection and treatment system and stormwater retrofit | DEP issued comment letter and received Lead Agency Negative Declaration. |
| Pawling Comprehensive Plan | Pawling/ Dutchess | East and West Branch | Proposed comprehensive plan update and zoning amendments | DEP reviewed and issued comments on the FGEIS. DEP received Lead Agency Findings to Approve. |
| Kent Wireless Infrastructure Plan | Kent/Putnam | East and West Branch | Proposed locations for cell towers in formalized agreement | DEP reviewed and issued comment letter on FGEIS. |

Table 6.7. (Continued) 2012 SEQRA review and status for significant Type I Actions.

| Project Name | Town/County | Basin | Description | Status |
|---|---|---|---|---|
| Watchtower | Patterson/ Putnam | East Branch | Proposed 407,794-sq. ft. expansion of facility, 137 parking space increase and 661 population increase | DEP reviewed and issued comment letter on the FEIS. DEP received Lead Agency Findings to Approve. |
| North Castle Industrial Zones | North Castle/ Westchester | Kensico | Expanded uses within Industrial Zoning to permit educational facilities | DEP issued comment letter and received Lead Agency Negative Declaration. |
| Bridleside | Bedford/ Westchester | Muscoot | Proposed 65 affordable housing units and community wastewater treatment facility on 40-acre parcel | DEP issued comment letter and received amended Findings to Approve. |
| Delaware County Emergency Radio Communication System | Delaware Countywide | Multiple | Rehabilitation and replacement of cell tower sites | DEP issued comment letter and received Lead Agency Negative Declaration. |
| Chappaqua Crossing | New Castle/ Westchester | New Croton | Redevelopment of the 120-acre Reader's Digest campus to include 348 new residential units and continuation of office space | DEP received and commented on the SEIS. |
| State Land Corporation | Yorktown/ Westchester | New Croton | Proposed 200,000-sq. ft. retail/office building and 920 space parking lot to be served by municipal water and sewer involving a change in zoning | DEP received project notification and issued comment letter. Awaiting a determination from the Lead Agency. |
| Costco | Yorktown/ Westchester | New Croton | Proposed retail store, gas filling station, 610 parking spaces, and wastewater collection system | DEP reviewed and commented on the DEIS. |
| Lexington CWMP | Lexington/ Greene | Schoharie | Proposed new community wastewater collection and treatment system, and stormwater retrofit | DEP issued comment letter and received Lead Agency Negative Declaration. |

Table 6.7. (Continued) 2012 SEQRA review and status for significant Type I Actions.

| Project Name | Town/County | Basin | Description | Status |
|---|---|---|---|---|
| Windham Mountain Sporting Club | Windham/ Greene | Schoharie | Construction of 345 multiphase residential units, two lodges, wellness center with swimming pool, roads, and two ski lifts on 465-acre parcel | DEP reviewed and commented on the DEIS. |
| North Salem Zoning Change Titicus Commons | North Salem/ Westchester | Titicus | Zoning petition for accessory apartments | DEP received project notification and issued comment letter. Awaiting a determination from the Lead Agency. |

### 6.1.2 Delegation Agreements

Westchester and Putnam Counties perform reviews of new, modified, and repaired SSTSs in accordance with their Delegation Agreements. Ulster County performs reviews of new SSTSs in accordance with its Delegation Agreement.

DEP received documentation concerning the review of 276 delegated systems during calendar year 2012. Seventy-three of these reviews were for projects located in the WOH watershed. The remaining 203 delegated SSTSs are located in the EOH watershed.

## 6.2 Enforcement Activities

DEP investigates and confirms septic failures, issues Notices of Violation (NOVs), pursues enforcement actions on failed SSTSs, and refers certain criminal activity to the DEP Police. These activities are coordinated with DEP Legal and Corporation Counsel, county health departments, local building inspectors, and the Catskill Watershed Corporation if the activity is in a New York City Watershed Memorandum of Agreement (MOA) (1997) program area.

The DEP Police patrol the watershed on a daily basis. The police receive over 300 hours of training in environmental law and services, as well as 170 hours of practical field training in environmental and infrastructure protection. They have the authority to issue summonses or Notices of Warning for violations of the New York State Environmental Conservation Law and the WR&R, as well as other state and local laws. The DEP Police coordinate with other DEP divisions to ensure they are aware of ongoing construction sites in the watershed, and that areas of special concern are being monitored. Currently, members of the DEP Police attend the DEP monthly enforcement meetings for both the EOH and WOH watersheds.

In 2012, DEP Police:

- Completed 23,500.7 hours of training.
- Conducted 5,977 preliminary investigations.
- Conducted 513 long-term investigations related to pollution or terrorism.
- Patrolled 1,760,364.2 miles.
- Conducted 276,348 physical security inspections.

Also in 2012, the DEP Police made 68 arrests, issued 925 summonses, and served 936 Notices of Warning for violations of the New York State Penal Law, the New York State Environmental Conservation Law, the New York State Vehicle and Traffic Law, the WR&R, and various other state and local statutes.

## 6.3 Wastewater Treatment Plant Compliance and Inspection Program

DEP's Wastewater Treatment Plant Compliance and Inspection (WWTPCI) Program conducts a quarterly compliance inspection at each surface-discharging WWTP that operates on a year-round basis. A minimum of two compliance inspections are conducted during the operating season per year at seasonal surface-discharging facilities. Similarly, at least two compliance inspections per year are conducted at non-contact cooling water discharges to surface waters, groundwater remediation systems, landfills, and oil/water separators. Treated industrial waste discharges to groundwater, via ground surface application, are inspected four times per year.

In addition to compliance inspections, DEP also conducts reconnaissance inspections at facilities, at which DEP staff meet with owners and/or operators to address special problems and provide operations assistance when necessary. Reconnaissance inspections may be prompted by violations or sampling results from biweekly DEP sampling and analyses. When needed, DEP laboratories are asked to collect samples and conduct special analyses to identify violations and assist in resolving operational issues.

When violations are identified at WWTPs, DEP coordinates enforcement activities with NYSDEC through the quarterly Watershed Enforcement Coordination Committee (WECC) meetings. At these meetings, the compliance status of watershed WWTPs is discussed and steps are taken to ensure that adequate enforcement activities are pursued to achieve compliance. In attendance at these proceedings are representatives from the USEPA, NYSDOH, and the New York State Attorney General's Office.

WWTPs in the City's watershed were impacted by Hurricane Sandy in October. The majority of facilities experienced sustained periods operating on auxiliary power; nevertheless, the plants were still able to provide adequate treatment of their waste streams. None of the plants encountered problems treating wastewater or endured sewage overflows because of the storm.

### *Facility Compliance in the Catskill/Delaware Watershed*

Thirty-five WOH WWTPs, including the New Infrastructure Program (NIP) facilities and Community Wastewater Management Program (CWMP) facilities and their respective connections, were inspected by DEP on a regular schedule in 2012. Of these, 28 are permitted for year-round discharge and 7 for seasonal discharge. Three of the 35 are wastewater treatment facilities permitted to discharge to groundwater. These are the Hamlet of Chichester, Mountainside Farms, and Hanah Country Club. Three other facilities are classified as industrial non-contact cooling water discharges. These are Ultra Dairy, Friesland Campina- DOMO, and Kraft Dairy. Altogether, DEP conducted 197 scheduled compliance, emergency response, and WWTP upgrade construction inspections in 2012.

Compliance with State Pollution Discharge Elimination System (SPDES) permits continued to improve among WWTPs in the Catskill/Delaware watersheds in 2012, due in large part to the DEP WWTP Compliance and Inspection Program.

DEP participates in Compliance Conferences (CC) with those facilities that continue to violate their SPDES permit limits and/or monitoring requirements. CCs are usually conducted after repeated attempts by DEP to remediate the problem with the facility owner and/or operator have failed. DEP, in conjunction with DEC and local regulatory authorities, sends out an NOV letter prior to calling for a CC. DEP did not need to conduct any CCs in 2012 because many problematic and outdated facilities which used to exceed their permits on a regular basis have since been connected to another upgraded facility, upgraded as a standalone facility, converted to subsurface discharge, or totally abandoned; as a result, the number of failed WWTPs has decreased greatly.

DEP reviewed, approved, funded, and oversaw the modification of the Town of Andes's WWTP. The plant is operating under an NYSDEC Order on Consent, the result of hydraulic overloads and numerous treatment bypasses caused by inadequately designed treatment units. The Order stipulated the Town remediate the collection system to mitigate infiltration and inflow (I&I) to the plant and to complete a major unit process evaluation to determine performance of each wastewater treatment component. The partnering process between the Town and DEP led to a full plant modification, in which the sequential batch reactor, continuously backwashing upflow sand filters, and pressurized microfiltration units were decommissioned, and the existing plant superstructure was retrofitted with a membrane bioreactor. Construction began in the summer of 2012, with functional completion scheduled for February 2013.

### *Facility Compliance in the East of Hudson Watershed*

The West Branch, Boyd Corners, Croton Falls, Cross River, and Kensico Reservoir basins are of special interest because they contribute to waters of the Delaware System. The following is a summary of the WWTPs and collection systems inspected within the West Branch, Croton Falls, and Cross River basins. There are no WWTPs in the Kensico and Boyd Corners basins, but

DEP does perform inspections of the collection system/pump stations maintained by Westchester County and the Towns of North Castle and Harrison within the Kensico basin. In 2012, DEP conducted 38 scheduled compliance, emergency response, and WWTP upgrade construction inspections for the WWTPs in the EOH FAD basins.

There are eight WWTPs in the West Branch, Croton Falls, and Cross River basins. Most of the WWTPs were in substantial compliance with their SPDES permit discharge limitations in 2012. Carmel Sewer District #2 WWTP did experience a sewage overflow from its collection system on March 23, 2012 that was not entirely contained; water quality, however, was not impacted. The Town responded to a small leak surfacing from a crack in the county road because the nearby manhole was blacktopped over. Once the manhole cover was discovered, uncovered, and removed, the blockage in the sewer main was cleared.

The Michelle Estates WWTP experienced chronic DEP laboratory exceedances for total phosphorus, fecal coliforms, total suspended solids, and settleable solids, even though plant self-monitoring data indicated full compliance with all SPDES permit parameters. A compliance assistance conference was held at the plant on November 20, 2012 between representatives from DEP, NYSDEC, and the contract operator to discuss operational practices and process control adjustments necessary to bring the facility back into compliance. There did not appear to be any mechanical flaw in the plant that could have led to the exceedances. The facility changed to a new coagulant to improve settling and is continuing to fine tune the chemical feed process to achieve the desired phosphorus results. The caustic soda and citric acid used during the clean-in-place process for the microfiltration units was not properly neutralized before the backwash was returned to the head of the plant; this affected the secondary treatment process and reduced removal efficiency for all wet chemistry parameters. During the compliance assistance conference it was agreed that the facility will perform additional pH testing of the backwash to ensure proper neutralization prior to recycling the waste stream through the treatment process. The facility will also install a cover over the step-aeration basin to prevent sunlight and debris from making contact with the treated effluent. DEP will closely monitor future laboratory results and work with the contract operator to correct any abnormal conditions. NYSDEC will consider modifying the SPDES permit to increase sampling frequency from once per quarter to once per month for all wet chemistry and bacteriological parameters.

The Westlake Sewer Trunk Line was monitored by both DEP and the Westchester Department of Environmental Facilities (WCDEF) in 2012. DEP performed visual inspections of the line monthly throughout the year in conjunction with regularly scheduled stormwater BMP inspections in the Kensico basin. These inspections revealed no abnormal conditions. WCDEF installed an early warning monitoring system to minimize the impact of sewage overflows from the trunk line. The remote monitoring system consists of strategically located manhole level sensors that transmit information to a web-based software application and provides immediate notification to WCDEF and DEP personnel of any abnormal conditions within the line. The

WCDEF faithfully submitted the results of its annual inspection and flushing of all associated pipelines, in accordance with the NYSDEC and WCDEF Order on Consent (DEC Case No. 3-R3-20030228-17), to all relevant regulatory agencies. No problems within the line were reported.

DEP performed compliance inspections of the Town of North Castle (Old Route 22, Cooney Hill Road, Route 120/Loudens Cove, New King Street, Old Orchard Street) and Harrison (Park Lane) pump stations and collection system throughout the 2012 monitoring period. The inspections revealed no abnormal conditions.

### 6.3.1 Sampling of Wastewater Treatment Plant Effluents

Sampling of surface-discharging WWTP effluents is conducted by DEP's ELAP-approved laboratories. At non-City-owned WWTPs, grab samples are taken twice monthly. In addition, a composite sample is collected once a year from those plants that have composite sample monitoring requirements in their SPDES permits; these plants are listed in DEP's Watershed Water Quality Monitoring Plan (DEP 2009). Special cases are the non-contact cooling water discharges at Kraft, Morningstar Foods/Dairyvest, and Friesland Campina-DOMO, which are routinely sampled quarterly, by composite sample. City-owned WWTPs are also sampled in accordance with SPDES permit monitoring requirements, and these samples, including grab samples, are analyzed by DEP laboratories, with the results reported in Discharge Monitoring Reports.

In the Catskill System, 14 WWTP effluents were sampled in 2012; composite samples were collected from 8 of the plants. In the Delaware System, 12 WWTP effluents and the 3 non-contact cooling water discharges (Kraft, Morningstar, and Friesland Campina-DOMO) were sampled. Composite samples were collected at 9 of the WWTPs as well as the non-contact cooling water discharges. In the EOH System, 8 WWTPs were sampled; composite samples were collected at the Mahopac STP.

Overall in 2012, 2,381 analyses were performed on 430 effluent samples from WWTPs in the Catskill System. For the Delaware System, there were 2,604 analyses performed on 328 effluent samples from WWTPs and non-contact cooling water discharges (e.g., Friesland Campina-DOMO). In the EOH System, 1,081 analyses were performed on 249 WWTP effluent samples.

Sampling data are shared regularly with DEP's Wastewater Treatment Plant Compliance and Inspection Program for the purpose of tracking compliance with SPDES-permitted effluent limits.

## 6.4 Winter Road Deicer Policy and Protection Development

In the past, DEP has reported on developments pertaining to local and regional initiatives to mitigate the impacts associated with the application of roadway deicing materials. In 2012,

NYSDOT requested that DEP review a proposal by two state vendors to modify the chemical specifications of their deicers. DEP reviewed the proposed changes to assess potential water quality impacts and provided comments to NYSDOT. Further determinations by NYSDOT and NYSDEC are required before the deicer specifications can be amended. There was no other significant activity in 2012. DEP will report on initiatives in the future if there is renewed activity related to roadway deicing.

# 7. Catskill/Delaware Filtration/UV Disinfection Facilities

DEP's UV Disinfection Facility has been constructed along the eastern side of the City-owned Eastview Parcel (Towns of Mount Pleasant and Greenburgh, Westchester County). Provisions have been made for future connections from the Catskill Aqueduct, as well as from the proposed Kensico-City Tunnel and to/from the Catskill/Delaware water filtration facility, if built. The current design also includes design elements that facilitate connections for local consumers and the delivery of finished water to the Kensico-City Tunnel should it someday be constructed at this site.

To maintain its dual track approach for meeting the goals of the Surface Water Treatment Rule (USEPA 1989), DEP continues to perform biennial updates of the preliminary design of a Catskill/Delaware Ozone/Direct Filtration facility that can be advanced to final design and construction in the event that filtration of the Catskill/Delaware water supplies is deemed necessary. The most recent update was completed in September 2011.

## 7.1 Ultraviolet Disinfection Facilities

### 7.1.1 Facility Construction Contracts

Progress has been steady, allowing completion of Administrative Consent Order milestones on schedule. As of December 1, 2012, DEP has achieved the milestone “Commence full operation of the UV Facility utilizing a UV dose of 40 mJ/cm$^2$ based on MS2 coliphage as the test surrogate or alternate dose as approved by NYSDOH.”

Work on other buildings related to the facility continued. These buildings include the North Forebay, South Forebay, and the Energy Dissipating Valve Chamber. At the end of 2012, each of these buildings was enclosed and wiring of the equipment to control panels had been completed. The contractor also installed other major site utilities and electrical duct banks to allow for communications and power between each major structure. As of the end of 2012, the contractor was completing the testing of systems and control programs.

All equipment was delivered and installed at the site as of December 2012. The major work items remaining are completion of the security portal at the main entrance and completion of paving and landscaping.

### 7.1.2 Project Schedule

The project schedule is prescribed in both the 2007 FAD and an Administrative Order on Consent between DEP and USEPA. Monthly reports are submitted in accordance with the Administrative Order on Consent and describe progress on the project and provide a mechanism for describing any known or anticipated non-compliant milestones.

During testing it was observed that the existing milestones did not provide a way to account for performing iterations of testing required for acceptance of the facility. In August 2012, DEP, USEPA, and NYSDOH renegotiated the terms of the consent order. The revised milestones required that by December 1, 2012, DEP was to provide a 40mj/cm$^2$ dose to all the water being supplied to the City through the facility. It also provided for an additional round of validation testing (see Section 7.1.5).

### 7.1.3 Design of Ancillary Projects

#### *Wetland Mitigation*

The contract to perform wetland work, CAT210WL, was issued to Halmar International, LLC, in an order to commence in July 2009. The contract calls for the creation, restoration, stabilization, and maintenance of wetland areas in accordance with U.S. Army Corps of Engineers Protection of Waters permit requirements. This work achieved substantial completion in the summer of 2012. The contractor will monitor the site, verifying plant viability, through 2014.

#### *Mount Pleasant UV*

As part of the site plan permit approval agreement, DEP is required to provide the Town of Mount Pleasant with UV-treated water. The project involves the installation of a new UV disinfection system within the Commerce Street pump station. In 2011, the contract was awarded to the FCM Group, Inc. The contract is currently underway. Site-specific validation of the UV units was completed in the fall of 2012. The contract is scheduled to be completed in the spring of 2013.

### 7.1.4 Permitting

#### *Greenburgh Work Permits*

In 2012, the contractor completed construction of a small superstructure in the Town of Greenburgh related to the building permit. The structure will provide access to the proposed treated water connection to the Catskill Aqueduct.

#### *State Pollution Discharge Elimination System (SPDES) Permits for Operations*

The SPDES application for operation was sent out to NYSDEC on August 27, 2010 and approved in 2011. It calls for monitoring the discharge at three outfalls and has an effective date of January 2012. Monitoring has continued in accordance with the permit requirements.

### 7.1.5 Validation Testing

Due to complications concerning start-up, as well as the requirement to conduct additional validation testing, a revised consent order was entered into by USEPA, NYSDOH, and DEP. The revised order calls for a two-phased validation to address the items of concern raised by NYS-

DOH earlier in 2012. Phase I testing has been completed and the results were submitted to NYSDOH on November 5, 2012. The Phase II testing was also completed and the results will be submitted to NYSDOH in January 2013.

#### *Additional Validation Testing*

NYSDOH questioned the differences in the inlet piping configuration at the UV Facility versus the configuration used at the validation facility in Johnstown. DEP agreed to perform additional validation testing to provide data with a more stringent hydraulic condition. This work was performed as part of the 2012 Phase I validation testing. The results from this test showed that the facility is providing a 40mj/cm$^2$ dose and that this dose is above the required 2-log inactivation. When compared to previous data, there were minor discrepancies. In an effort to obtain approval of the operating envelope proposed by previous testing, Phase II testing was commenced.

Phase II testing used three surrogate organisms under a variety of operating conditions. The purpose of this testing is to propose a lower operating dose and additional flexibility in operating the UV plant. The testing has been completed and the final report is being prepared for submission by January 2013.

## 7.2 Filtration Planning Design Update

### 7.2.1 Facility Design Update

In accordance with the terms for relief from completing final designs for a filtration facility, a preliminary design update was completed in September 2009 for a 2,110 MGD ozone/direct filtration facility for the Catskill/Delaware water supply. The design update was presented as a supplement to the 2003 Preliminary Design Update and incorporated all modifications previously presented in the 2005 design update. The changes included converting the previous design into a three-dimensional drawing platform. This change will facilitate additional coordination among the different design disciplines while resolving many conflicts before work begins on-site.

The 2011 biennial review of the Filtration Plant Design found that the previously submitted report is still valid as a complete preliminary design. As there have been no significant site modifications since the 2009 update, modifications to the report were not performed.

# 8. In-City Programs

## 8.1 Waterborne Disease Risk Assessment Program

New York City's Waterborne Disease Risk Assessment Program (WDRAP) is a joint agency program involving the Department of Health and Mental Hygiene (DOHMH) and DEP. The two major ongoing functions of WDRAP are:

- Obtain data on the rates of giardiasis and cryptosporidiosis, along with demographic and risk factor information on case-patients.
- Provide a system to track diarrheal illness to ensure rapid detection of any outbreaks.

Active laboratory surveillance, involving regular visits to or telephone contact with parasitology laboratories by DOHMH staff members, began in July 1993 for giardiasis and in November 1994 for cryptosporidiosis, and continued through 2010. In January 2011, active laboratory surveillance for giardiasis and cryptosporidiosis was discontinued, as it had been replaced by an electronic reporting system. By January 2011, almost all NYC clinical laboratories were fully enrolled in the Electronic Clinical Laboratory Reporting System (ECLRS), which was developed in order to ensure more rapid and complete reporting of reportable conditions, including giardiasis and cryptosporidiosis. Electronic reporting provides timelier data than active surveillance, and is more complete than typical paper-based systems. This change in surveillance is not expected to have a significant impact on the completeness or quality of giardiasis and cryptosporidiosis surveillance data.

For all cryptosporidiosis cases, and as needed for giardiasis cases, public health epidemiologists contact patients to verify the data provided on the case report, to collect additional demographic and clinical information, and to identify possible sources of exposure. During 2012, surveillance for giardiasis and cryptosporidiosis was ongoing, and interviews were conducted as per the above parameters. At the time of this writing, the 2012 *preliminary* count of cases reported to DOHMH among NYC residents is 867 cases of giardiasis and 122 cases of cryptosporidiosis.

With regard to outbreak detection systems, New York City currently has four types of systems in operation, each one tracking a different indicator of gastrointestinal illness (GI) in the community. These systems are not specific to giardiasis or cryptosporidiosis nor are they specific for waterborne illness. All systems rely upon the voluntary participation of the organizations providing the data. A brief description of the different systems and a summary of system operations for 2012 (including program disruptions, largely related to Hurricane Sandy) follows below.

One of the outbreak detection systems involves the tracking of chief complaints from hospital emergency department (ED) logs; under another system, DOHMH monitors and assists in the investigation of GI outbreaks in eight sentinel nursing homes; and a third system tracks the number of stool specimens submitted to a clinical laboratory for microbiological testing. Due to

Hurricane Sandy, there were data transmission problems in the ED system in 2012. During and immediately following the storm, data were not available from approximately 21 of 49 EDs due to hospital shut downs and power outages. Data flow was subsequently restored and backfill of data was obtained from the EDs that were in operation throughout the storm period. Due to damage from the storm, five emergency departments were closed. Two of those hospitals are still closed. As hospitals come back online their data is reintegrated into the ED syndromic surveillance system.

With regard to the clinical laboratory monitoring system, due to Hurricane Sandy there was a disruption in normal operations from October 29 to October 31 in the participating clinical laboratory. Normal operations at the laboratory resumed on November 1. Regarding the sentinel nursing home system, due to damages incurred as a result of Hurricane Sandy, there was an evacuation in one of the nursing homes participating in the sentinel surveillance program on November 6; residents were returned to the facility on November 13. Also due to the hurricane, a second nursing home evacuated approximately 100 residents from the facility to another nursing home participating in sentinel surveillance. Those residents were subsequently admitted to the receiving nursing home. The other six participating nursing homes remained in operation throughout 2012.

The fourth type of outbreak detection system in operation in New York City includes monitoring of sales of over-the-counter or non-prescription anti-diarrheal medications. The City's anti-diarrheal medication monitoring activities have two components: the "ADM" system and the "OTC" system. The two systems monitor daily sales of non-prescription antidiarrheal medications at major store chains. The ADM is managed by DEP and the OTC system is managed by DOHMH.

Regarding the OTC system, as noted in the 2011 WDRAP Annual Report, there was a decrease in the number of stores reporting medication sales to the system beginning in mid-June 2011. The decrease resulted from a disruption in data transmission that occurred because the store chain that had been submitting data merged with another large chain and underwent a revision to its data system as stores were being gradually moved over to the new system. This change affected the ability of the OTC system to detect signals in anti-diarrheal medication sales from mid-June 2011 to October 2011. From October 21, 2011 to April 16, 2012, due to very limited and inconsistent data transmission, DOHMH did not run the OTC analysis. On April 17, 2012, when consistent data transmission was restored, OTC data analysis was resumed. In the interim period the number of stores providing data to the OTC system had been increased by the addition of more stores to the DOHMH OTC system and through the inclusion of stores from the DEP ADM system. The ADM system addition was made possible through an arrangement among DEP, DOHMH, and the data provider that had been submitting data to the DEP ADM system. Consequently, anti-diarrheal medication sales data from that data provider are currently analyzed by both DOHMH and DEP, resulting in some parallel data analysis between the DOHMH OTC system and the DEP ADM system. The plan is for DEP to eventually phase out its ADM monitor-

ing program. Enhancements now in effect in the OTC system include an increased number of stores providing data, new analytic methods, and separate analyses for citywide increases in sales of over-the-counter, non-bismuth-containing anti-diarrheal medications and bismuth medications.

From April 17 to December 31, 2012, a mean of 328 stores submitted daily data for OTC analysis. During this period, there were 20 days when there was a notable decrease in the number of stores reporting data. A backfill of data for these days has been requested. The changes in administration of the retail pharmacies participating in the OTC system as described above have resulted in fluctuations in store reporting. In the coming year, DOHMH is planning to conduct an evaluation of the system in order to determine ways to improve its utility.

The ADM system was in operation at DEP throughout 2012. The supply of data from the ADM data provider to DEP was highly reliable. Some data analysis and reporting delays were experienced sporadically throughout 2012 at DEP. The metrics tracking system, established for the ADM system under the EPA-funded Water Security Initiative, continued.

Educational outreach in 2012 included presentations by DOHMH WDRAP team members to clinicians in two Brooklyn hospitals and in a Manhattan hospital.

Additional WDRAP results (including demographic data and case interview results for giardiasis and cryptosporidiosis cases), summary results from syndromic surveillance programs, and WDRAP program implementation information can be found in the WDRAP semiannual and annual reports.

In addition to the above, during 2012 WDRAP staff and others from DOHMH and NYSDOH completed a Functional Exercise (FE) of the Hillview Reservoir (HVR) Cryptosporidium and Giardia Action Plan (CGAP). This exercise fulfilled a requirement under the HVR Administrative Order on Consent and built upon lessons learned as part of DEP's consequence management planning and incident management training. The findings and suggestions for improvement were reviewed and incorporated into revisions to the CGAP that became effective January 1, 2013.

## 8.2 Cross Connection Control Program

During 2012, DEP's Cross Connection Control Program continued to exceed the milestones established by the FAD (Table 8.1).

Table 8.1. Cross Connection FAD milestones.

| Annual and semiannual periods | Responding to incidents | Facility "hazardous" inspections | Enforcement initiated for "hazardous" premises | Backflow preventer plans approved | Backflow preventer plans reviewed with self-certification (approved) | Exemption requests processed[2] (approved) | Notices of Violation issued for failure to test annually[3] (install) |
|---|---|---|---|---|---|---|---|
| Jan. - Dec. 2007 | 4 | 4232 | 1122 | 2120 | 44 | 1290 | 532 |
| Jan. - Dec. 2008 | 0 | 3207 | 1124 | 2642 | 12 | 1160 | 586 |
| Jan. - Dec. 2009 | 0 | 2812 | 1064 | 3021 | 0 | 792 | 568 |
| Jan. - Dec. 2010 | 3 | 9262 | 2887 | 3280 | 1 | 472 | 474 |
| Jan. - Dec. 2011 | 2 | 5187 | 4060 | 7625 | 19(6) | 445 | 57 |
| Jan. - Dec 2012 | 2 | 4,318 | 4,348 | 6,115 | 7(4) | 374(266) | 413(1623) |
| FAD Requirement | 1-2/yr | 300-450/yr | 225/yr | 400/yr | TBD[1] | 400/yr | 200/yr |

[1]No established minimum level of response.

[2]Exemption submissions have waned due to new fee schedule, policy changes and rejections.

[3]These were orders to submit the test reports. Failure to install are in parentheses.

In the beginning of last year, DEP determined that the Cross Connection Control Program should be separated into three distinct sections. The inspection staff and its responsibilities were sent to Distribution Operations. This was done to allow for better response and coordination with any cross connection-related distribution system anomalies and/or emergencies. The Enforcement Group was sent to a newly formed section which was expanded to include all of the enforcement needs for the Bureau. The plan review and exemption unit remained within its current section, which was renamed Permitting and Compliance.

DEP's mission of directing the installation of backflow prevention devices as required by both USEPA and NYSDOH continues and has not changed dramatically. A temporary contract to schedule inspections was used in the first half of the year to assist in meeting annual inspection target numbers which were established as one of the points in the Commissioner's Strategic Plan. The number of inspections and reviews performed by staff and consultants are included in the summaries of the statistics in Table 8.1. At this time, in addition to performing inspections of potentially hazardous locations, DEP has been inspecting some facilities classified as aesthetically objectionable, when identified as such. All locations that are inspected are recorded in the Cross Connection Control database and tracked throughout the compliance process as needed.

Crucial policies were changed following the updating of the NYC Building Code, which facilitated a need to confirm that all existing fire sprinkler services have the proper backflow protection. The NYC Plumbing Code, in its present version, requires fire sprinkler services to have installed the minimum backflow protection of an approved Double Check Detector Assembly, or DCDA. A permit to obtain a new water service connection for a fire sprinkler system requires an approval from the Cross Connection Plan Review Unit and approval from the NYC Department of Buildings for the sizing of the service line. This requirement ensures that no water connections will be made without the necessary level of backflow protection. If the fire sprinkler system contains any chemical treatment for the prevention of freezing or corrosion control, or the building is located in close proximity to an unapproved source or water body, a Reduced Pressure Zone Detector Check Assembly would be required on that fire service line.

DEP has made some additional upgrades to its website providing easier navigation of the information regarding backflow prevention and the approval process. There is also available an email address for contacting the Cross Connection Control Program staff (backflow@dep.nyc.gov). This address is used to receive inquiries from small businesses and the public for any questions or concerns relating to compliance with the backflow prevention requirements.

In 2012, DeP responded to an incident that was possibly related to a backflow or cross connection condition. This occurred at the Brooklyn Navy Yard, where multiple inspections and surveys were conducted in and around the area, none of which resulted in the identification of any specific cross connection problem; however, enforcement action is in progress. Several locations within the Navy Yard were issued Commissioner's Orders to install a backflow device, and the metering program has heightened its efforts to achieve compliance in that area as well. At least four devices are planned for installation to help protect the city's water.

# 9. Education and Outreach

DEP advances its long-term watershed protection strategy through stakeholder collaboration, community outreach, and targeted educational programs for specific audiences. Towards this end, DEP partners with the Catskill Watershed Corporation (CWC), Cornell Cooperative Extension (CCE), Soil and Water Conservation Districts (SWCDs), the Watershed Agricultural Council (WAC), and others to inform constituents and raise public awareness about the water supply system, source water protection and conservation, and environmental stewardship.

The 2007 FAD requires DEP to report on the educational efforts of the Watershed Agricultural and Forestry Programs, Stream Management Program, and CWC Public Education Program, in addition to school-based education efforts, general community outreach, and partnerships with regulatory and local government officials. The FAD specifically requires DEP to collaborate with local municipal officials on education, outreach, and training programs that promote land use planning, stream corridor protection, and stormwater management.

During 2012, DEP estimates that over 765,000 people were exposed to information about the water supply and watershed protection through more than 446 unique events that were directly attended, coordinated, or supported by DEP and its many upstate/downstate partners. The majority of these events (89%) were targeted programs such as audience-specific workshops, professional development trainings, school visits, speaking engagements, conference presentations, and watershed tours that reached approximately 29,000 people. Approximately 11% of the activities tracked during 2012 were considered “general public outreach” events such as county fairs and large outdoor festivals; however, these events were estimated to attract more than 736,000 visitors (96% of the total estimated participants for 2012). While it is difficult to estimate the direct educational impact from large public events, they nevertheless provide an important outreach multiplier effect for disseminating key messages and publications to many thousands of visitors who attend these events on a collective basis.

This chapter summarizes watershed education and outreach accomplishments according to five primary audience categories; a complete listing of all 2012 activities is available upon request.

## 9.1 Water Consumers

DEP’s official website (nyc.gov/dep) continued to feature a wealth of information about the water supply, watershed protection, water conservation, drinking water quality, watershed recreation, and environmental education. DEP’s website serves as a repository for key publications such as the annual consumer confidence report, watershed program brochures, newsletters and

press releases, watershed regulations and recreational rules, regulatory guidance documents, environmental education materials, and FAD reports. DEP also maintains an active online presence on popular social media sites such as Twitter and Facebook.

DEP issued 106 press releases during 2012, more than half of which addressed the water supply system, watershed protection, or watershed recreation. Specific topics included the Gilboa Dam, Rondout-West Branch Tunnel, Ashokan turbidity, drinking water quality, water rates, and storm preparedness. DEP also expanded the availability of its "Water-on-the-Go" drinking water fountains throughout the five boroughs, with an estimated 580,000 people visiting these stations during 2012.

DEP and its partners also participated in numerous public events that attract New York City water consumers. Examples include the Greenpoint Film Festival, City of Water Day on Governors Island, New Green City Farmers Market, Brooklyn Food Conference, Green Getaways Local Food & Travel Expo, and various presentations to local community groups. In 2012, DEP continued to utilize the Visitor Center at Newtown Creek in Brooklyn to conduct more than 56 watershed-related educational programs for about 2,375 people.

## 9.2 Watershed Landowners and Home Owners

The Watershed Agricultural Program conducted 33 farmer education programs that were attended by 778 participants; these programs are described more fully in Section 4.4. The WAC also co-sponsored the annual Clean Sweep Chemical Disposal Day for Delaware County residents, exhibited at the Old Salem Horse Show in Westchester County, and sponsored a nine-week series of watershed film screenings. The WAC also continued to maintain websites for the organization (nycwatershed.org), the Pure Catskills campaign (purecatskills.com), the Catskill Woodnet campaign (catskillwoodnet.org), and the Catskill Farm Link project (catskillsfarmlink.org).

The Watershed Forestry Program continued to implement a targeted Forest Land Owner Education Program that includes workshops, self-study courses, and collaboration with the NYS Master Forest Owner Program. A primary venue for conducting these programs is the watershed model forest network, which in 2012 hosted more than 60 events for over 1,750 participants.

The Stream Management Program continued to educate streamside landowners, primarily through basin-specific workshops, public presentations, volunteer riparian planting efforts, stream cleanup events, watershed advisory committees, project advisory meetings, newsletters and press releases, and the catskillstreams.org website. Watershed flooding, floodplain mapping, and emergency storm response were among the key topics addressed during 2012.

The CWC sponsored two home owner workshops covering septic system maintenance that were attended by 17 people. The CWC also kept watershed residents informed through 28 press releases, *The Advocate* e-newsletter, the CWC website (cwconline.org), and displays or

appearances at numerous public events where landowners and home owners comprise a majority of the local audience. For example, the CWC co-sponsored four watershed performances of "City That Drinks The Mountain Sky" that were attended by approximately 250 people.

## 9.3 School Groups and Youth Audiences

DEP continued to conduct educational programs for students, teachers, educators, and youth audiences through classroom visits, professional development workshops, and programs that promote upstate/downstate partnerships. DEP and its partners participated in Greene County Environmental Awareness Days, Woodstock Elementary School Go Green Day, Blue Mountain Middle School Career Day, Bennett Elementary School Earth Day, Bailey Middle School Career Fair, Rondout Valley Middle School Career Fair, Teaching the Hudson Valley Teacher Fair, BOCES Open House, Delaware Opportunities Children's Festival, and several other school visits and presentations/demonstrations. DEP also pilot tested a watershed summer reading program at three libraries during 2012, which reached about 25 local youth.

Within New York City, DEP participated in the Science Council of New York City annual conference and the 2012 Environmental Education Expo, which attract hundreds of teachers and educators. DEP also conducted more than 90 watershed education programs for in-City schools and colleges; approximately 25% of these classroom visits were part of the Trout in the Classroom Program, which involves thousands of students every year. Also in 2012, DEP conducted the 26$^{th}$ annual Water Conservation Art & Poetry Contest, which attracted more than 700 students from over 50 schools in both New York City and the watershed.

The Watershed Forestry Program continued to implement a comprehensive urban/rural school-based education program consisting of the Green Connections Program, the Watershed Forestry Bus Tour Program, and the Catskill Stream and Watershed Education Program (CSWEP); these programs are described more fully in Section 4.5. Another highlight for 2012 included working with the U.S. Forest Service to bring the Wyland Foundation Mobile Learning Center to the watershed for four days, where over 525 students from Bennett Elementary and Margaretville Schools learned about forestry through interactive exhibits and demonstrations.

The CWC Public Education Grants Program continued to fund watershed education projects for both New York City and West of Hudson (WOH) watershed audiences. During its Round 15 grant cycle that took place during 2012, CWC funded 22 education grants totaling $119,863. To date, the CWC has awarded 411 education grants totaling over $2.1 million and directly reaching an estimated audience of at least 115,320 people (primarily students) since 1998.

The Stream Management Program worked with schools and youth groups through a series of riparian planting efforts, volunteer stream clean-up activities, and use of a stream training demonstration table at various local schools and watershed festivals.

## 9.4 Local Officials and Professionals

During 2012, DEP and its partners conducted or attended more than 100 events that were attended by more than 7,500 local officials, legislators, municipal leaders, scientists, regulators, business groups, resource managers, and various watershed professionals. Key events where DEP had a direct presence included the NYC Watershed Science and Technical Conference, NYS Wetlands Forum Conference, NYS and New England Society of American Foresters Annual Meeting, NYS Floodplain and Stormwater Conference, Lake Champlain Flood Resilience Conference, and Northeast Geological Society of America Conference.

The CWC sponsored five separate training workshops for local officials and watershed professionals that were attended by 142 people. These workshops covered topics such as basic environmental compliance for municipalities, storm preparedness, land use planning tools, and advanced septic system design for professionals.

The Stream Management Program continued to work closely with local officials, technical professionals, and other municipal leaders to educate and train these audiences about stream corridor protection, roadside ditch maintenance, native riparian vegetation, floodplain mapping, emergency flood response, and related topics. More than 40 individual events were held throughout the WOH watershed for over 1,740 participants. Highlights included the Catskill Environmental Research and Monitoring Conference, Third Annual Ashokan Watershed Conference, Sixth Annual Schoharie Watershed Summit, a US Geological Survey Stakeholder Luncheon, and multiple presentations during meetings of town boards, highway departments, project advisory committees, and local floodplain commissions.

The Watershed Forestry Program continued to support education and training programs for loggers, foresters, wood using businesses, and various municipal officials. In addition to sponsoring 15 training workshops for loggers and foresters and conducting eight forestry presentations for local officials in the East of Hudson watershed, the WAC also participated in NYS Forestry Awareness Day, the Deposit Lumberjack Festival, the Catskill Forest Festival, and NYS Woodsmen's Field Days. Another highlight of 2012 was the completion of three international visits by nearly 100 professional foresters from India, who traveled to the Frost Valley Model Forest to learn about the Watershed Forestry Program and DEP's Forest Management Plan.

Both the Watershed Agricultural Program and the WAC's Farm-to-Market Program continued to work with local agribusinesses and related professionals, including sponsorship of the annual Catskill Regional Dairy, Livestock, and Grazing Conference and the annual Farm-to-Market Conference, which collectively attract nearly 300 participants. The WAC also attended the Delaware County Business Expo, the NOFA-NY Winter Conference, the American Farmland Trust "No Farms, No Food" Rally, the American Farmland Trust "Harvesting Opportunities" Conference, a NYS Agricultural Society Mixer, and other events.

## 9.5 Other Public Audiences

In addition to targeting specific audiences through individual programs, DEP and its partners attended dozens of community outreach events where educational information about the water supply system and watershed protection were made available to the broader public at large. Highlights for 2012 include the Delaware County Fair, Grahamsville Little World's Fair, Ulster County Fair, Taste of the Catskills Event, Cauliflower Festival, Woodstock Volunteer Day, Woodstock Library Fair, Hunter Family Fun Day, Phoenicia Rotary Duck Race, Mt. Tremper Family Fish and Fun Day, Central Catskills Great Outdoors Experience Festival, and others.

# 10. Miscellaneous Reporting Provisions

## 10.1 Water Conservation

Pursuant to 6 NYCRR Part 621 and the 2010 Water Supply Permit (WSP), the Conservation and Demand Management Program will submit a separate annual report on July 31, 2013. The Annual Conservation Update report can be found on the DEP website by following this link: http://www.nyc.gov/html/dep/pdf/conservation/water_conservation_report2012.pdf.

## 10.2 Updates to Drought Management Plan

In 2012, it was not necessary to invoke any of the components of the City's Drought Management Plan, since precipitation, runoff, and storage levels all remained high.

The Drought Management Plan has three phases—Drought Watch, Drought Warning, and Drought Emergency—that are invoked sequentially as conditions dictate. The Drought Emergency phase is further subdivided into four stages with increasingly severe mandated use restrictions. Guidelines have been established to identify when a Drought Watch, Warning, or Emergency should be declared and when the appropriate responses should be implemented. These guidelines are based on prevalent hydrological and meteorological conditions, certain operational considerations, and other factors. In some cases, other circumstances may influence the timing of drought declarations.

- Drought Watch. Drought Watch is declared when there is less than a 50% probability that reservoirs in either of the two largest systems, the Delaware (Cannonsville, Neversink, Pepacton, and Rondout Reservoirs) or the Catskill (Ashokan and Schoharie Reservoirs), will fill by June 1, the start of the water year.
- Drought Warning. A Drought Warning is declared when there is less than a 33% probability that reservoirs in either the Catskill or Delaware Systems will fill by June 1.
- Drought Emergency. A Drought Emergency is declared when there is a reasonable probability that, without the implementation of stringent measures to reduce consumption, a protracted dry period would cause the City's reservoirs to be drained. This probability is estimated during dry periods in consultation with the New York State Drought Management Task Force and the New York State Disaster Preparedness Commission. The estimation is based on analyses of the historical record, the pattern of the dry period months, water quality, subsystem storage balances, delivery system status, system construction, maintenance operations, snow cover, precipitation patterns, use forecasts, and other factors. Because no two droughts have identical characteristics, no single probability profile can be identified in advance that would generally apply to the declaration of a drought emergency.

DEP continues to encourage consumers to conserve water and to observe the City's year-round water use restrictions, which remain in effect. These restrictions include prohibition on watering sidewalks and lawns between November 1 and March 31 and illegally opening fire hydrants.

## 10.3 Delaware Aqueduct Leak

Efforts to evaluate the condition of, and to develop dewatering and repair plans for, the Rondout-West Branch Tunnel (RWBT) continued in 2012 and involved the following components:

- Hydraulic investigations of the RWBT
- Autonomous Underwater Vehicle (AUV) inspection of the RWBT
- Remote Operated Vehicle (ROV) inspection of the RWBT
- Tunnel and Shaft Rehabilitation Program
- Planning for a Roseton Bypass

### *Hydraulic Investigations of the RWBT*

Investigations of the Rondout-West Branch Tunnel helped DEP assess the nature and degree of leakage stemming from the aqueduct. Various efforts in 2012 to study the nature of the leak are described below.

- The Tunnel Monitoring Program continued. The object of this program is to determine if tunnel conditions are changing. On a routine basis DEP monitors tunnel flow rates, operational trends, and surface expressions to determine the quantity of the leak.
- Surface investigations continued in areas of Roseton and Wawarsing, where water is suspected to be leaking from the tunnel.

### *Autonomous Underwater Vehicle (AUV) Inspection of the RWBT*

The AUV program allows for an independent robotic vehicle to completely photograph the interior surface of the RWBT in one inspection lasting 12 hours. The 2009 inspection (the first since 2003) indicated there were no significant changes in crack patterns between 2003 and 2009. The 2012 AUV run has been postponed until 2013 as a result of water supply needs.

### *Remote Operated Vehicle (ROV) Inspection of the RWBT*

DEP is moving forward with the ROV program and expects to perform a detailed inspection of the Wawarsing and Roseton areas in 2013. Unlike the AUV, the ROV will make it possible to capture real-time tunnel data, and will give DEP the ability to perform detailed, close-up investigations beyond the reach of the AUV. The ROV is, however, limited to suspect areas in the tunnel.

### *Tunnel and Shaft Rehabilitation Program*

The work at Shaft 6 to prepare for eventual dewatering of the tunnel (contract DEL-185) is now expected to be complete in February 2014. Because of water supply needs, shutdowns necessary to complete the contract have been postponed.

### *Planning for a Roseton Bypass*

The Roseton bypass project is being implemented through two contracts. The first, BT-1, was bid in 2012 and registered by the Comptroller on December 28, 2012. The contractor, Schiavone Construction, LLC, has started site preparation work. Work on the sinking of the shafts is expected to commence in November 2013. The contract completion date is November 13, 2016. The bypass tunnel contract, BT-2, is scheduled to start in April 2015. This contract will connect the shafts, and upon completion of this effort, the tie-in to the existing RWBT will commence. During the execution of the tie-in, the leaks in the Wawarsing area of the tunnel will be grouted from within the dewatered tunnel. The bypass project is expected to be completed in 2022.

# References

DEP. 2003. Integrated Monitoring Report. Division of Drinking Water Quality Control. Valhalla, NY. 170 p.

DEP. 2009. 2009 Watershed Water Quality Monitoring Plan. Directorate of Water Quality (issued October 2008, revised May 2009). Valhalla, NY. 226 p. http://bwsintranet/Documents/Reports/Misc_Reports/2000s/2009_Watershed_Water_Quality_Monitoring_Plan.pdf (accessed 3/26/13).

DEP. 2010. DEP Fee-Land Monitoring Policy. Bureau of Water Supply. Division of Watershed Lands and Community Planning. Kingston, NY. 11 p.

DEP. 2011a. 2011 Watershed Protection Program Summary and Assessment. Bureau of Water Supply. Valhalla, NY. 416 p. http://www.nyc.gov/html/dep/pdf/reports/fad51_wmp_2011_fad_assessment_report_03-11.pdf (accessed 3/26/13).

DEP. 2011b. 2011 Long-Term Watershed Protection Program Plan. Bureau of Water Supply. Valhalla, NY. 104 p. http://www.nyc.gov/html/dep/html/watershed_protection/fad.shtml (accessed 3/26/13).

DEP. 2011c. DEP Strategy 2011-2014. Flushing, NY. 78 p. http://www.nyc.gov/html/dep/pdf/strategic_plan/dep_strategy_2011.pdf (accessed 3/26/13).

DEP. 2011d. New York City Watershed Forest Management Plan. 283 p. http://www.nyc.gov/html/dep/pdf/watershed_protection/dep_forest_management_plan_2011.pdf (accessed 3/26/13).

DEP. 2012a. 2011. Kensico Water Quality Annual Report. Directorate of Water Quality. Valhalla, NY. 79 p. http://bwsintranet/Documents/Reports/Annual_Reports/2010s/2011_KensicoWaterQualityAnnualReport.pdf (accessed 3/26/13).

DEP. 2012b. Kensico Reservoir Watershed Assessment, Fecal Coliform Occurrence, and Operational Response During and After Tropical Storms Irene and Lee. Final summary report. Prepared by HDR/GannettFleming. White Plains, NY. 124 p.

DEP. 2012c. Alum Treatment After Action Report: August 29, 2011–May 15, 2012. Valhalla, NY. 134 p.

DEP. 2012d. After Action Report: Kensico Raw Water Turbidity Violation October 29, 2012. Valhalla, NY. 23 p.

DEP. 2012e. 2011 Watershed Water Quality Annual Report. Directorate of Water Quality (issued July 2012, revised January 2013). Valhalla, NY. 128 p. http://www.nyc.gov/html/dep/pdf/reportsfad_5.1_watershed_monitoring_program_watershed_water_quality_annual_report_07-12.pdf (accessed 3/26/13).

DEP. 2012f. DEP Pathogen Mid-Term Surveillance Report on *Giardia* spp., *Cryptosporidium* spp., and Human Enteric Viruses. Valhalla, NY. 18 p.

DEP. 2012g. New York City 2011 Drinking Water Supply and Quality Report. Directorate of Water Quality. Flushing, NY. 16 p. http://bwsintranet/Documents/Reports/Annual_Reports/2010s/2011_NYC_Drinking_Water_Supply_&_Quality_Report.pdf (accessed 3/26/13).

DEP. 2012h. Filtration Avoidance Annual Report for the period January 1 through December 31, 2011. Bureau of Water Supply. Valhalla, NY. 154 p. http://bwsintranet/Documents/Reports/Annual_Reports/2010s/2011_FiltrationAvoidanceAR.pdf (accessed 3/26/13).

DEP. 2012i. Multi-Tiered Water Quality Modeling Program Annual Status Report. October 2012.

Directorate of Water Quality. Kingston, New York. 204 p. http://www.nyc.gov/html/dep/pdf/reports/5.2_multi_tiered_water_quality_modeling_program_annual_report_10-12.pdf (accessed 3/26/13).

Huang Y. and D. C. Pierson. 2012. Identifying sensitive parameters in a reservoir hydrothermal and water quality model through sensitivity analysis. Water Qual. Res. J. Can. 47: 451-462. doi: 10.2166/wqrjc.2012.020.

Klug J., D. Richardson, H. Ewing, B. Hargreaves, N. Samal, D. Vachon, D. C. Pierson, M. Lindsey, D. O'Donnell, S. W. Effler, and K. Weathers. 2012. Ecosystem effects of a tropical cyclone on a network of lakes in northeastern North America. Environ. Sci. Technol. 46: 11693-11701. doi: 10.1021/es302063v.

Matonse, A. H, D. C. Pierson, A. Frei, M. S. Zion, A. Anandhi, B. Wright, and E. Schneiderman. 2012. Investigating the impact of climate change on New York City's primary water supply. Climatic Change. doi: 10.1007/s10584-012-0515-4.

Mukundan, R. S. Pradhanang, E. Schneiderman, D. C. Pierson, A. Anandhi, M. Zion, A. Matonse, D. Lounsbury, and T. Steenhuis. 2012. Suspended sediment source areas and future climate impact on soil erosion and sediment yield in a New York City water supply watershed, USA. Geomorphology. 183:110-119. doi: 10.1016/j.geomorph.2012.06.021.

New York City Watershed Memorandum of Agreement. 1997. Environmental Facilities Corporation. http://www.nysefc.org/Default.aspx?TabID=76&fid=389 (accessed 3/26/13).

New York City Watershed Rules and Regulations. 1997, amended April 4,2010. Rules and Regulations for the Protection from Contamination, Degradation and Pollution of the New York City Water Supply and its Sources. RCNY Title 15, chapter 18. http://www.nyc.gov/html/dep/pdf/recrules/regulations.pdf (accessed 3/26/13).

Samal, N. R, D. C. Pierson, E. Schneiderman, Y. Huang, J. S. Read, A. Anandhi, and E. M. Owens. 2012. Impact of climate change on Cannonsville Reservoir thermal structure in the New York City water supply. Water Qual. Res. J. Can. 47: 389-405. doi: 10.2166/wqrjc.2012.020.

USEPA [U.S. Environmental Protection Agency]. 1989. Drinking Water: National Primary Drinking Water Regulations; Filtration, Disinfection, Turbidity, Giardia lamblia, Viruses, Legionella, and Heterotrophic Bacteria; Final Rule. 54 Fed. Reg. 27486. June 29, 1989. WHFRL-3607-7.Washington, D.C.

USEPA [U.S. Environmental Protection Agency]. 2005. US EPA Method 1623: *Cryptosporidium* and *Giardia* in Water by filtration/IMS/FA. EPA/821-R-01-025.

USEPA [U.S. Environmental Protection Agency]. 2007. New York City Filtration Avoidance Determination. 96 p. http://bwsintranet/Documents/Reports/EPA_Deliverables/2007_FADFinal.pdf (accessed 3/26/13).

VanBrakle, J. D. 2010. The effectiveness of forest management plans in promoting best management practices and sustained yield management on non-industrial private forest land. M.S. thesis, SUNY College of Environmental Sciences and Forestry. Syracuse, NY. 104p.