

New York City Department of Environmental Protection

Filtration Avoidance Annual Report

for the period January 1 through December 31, 2016



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**Cover photo by Kristen Artz, NYCDEP
(View of the gorge below the Ashokan Reservoir spillway)**

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List of Acronyms

AIS	aquatic invasive species
APHIS	Animal and Plant Health Inspection Service
ATU	advanced treatment unit
AUV	autonomous underwater vehicle
AWSMP	Ashokan Watershed Stream Management Program
BMP	best management practice
BODR	Basis of Design Report
C&D	construction and demolition
CAD	Computer Aided Design
CAT/DEL	Catskill/Delaware
CATUEC	Catskill Upper Effluent Chamber
CC	compliance conference
CCD	Croton Consent Decree
CCE	Cornell Cooperative Extension
CCEUC	Cornell Cooperative Extension of Ulster County
CDUV	Catskill/Delaware Ultraviolet Disinfection Facility
CE	conservation easement
CMC	Catskill Mountain Club
CP	Forest Management Plan Conservation Practices
CREP	Conservation Reserve Enhancement Program
CRISP	Catskill Regional Invasive Species Partnership
CRP	Conservation Reserve Program
CSBI	Catskill Streams Buffer Initiative
CT	contact time
CUNY	City University of New York
CWC	Catskill Watershed Corporation
CWMP	Community Wastewater Management Program
DCPD	Delaware County Planning Department
DCSWCD	Delaware County Soil and Water Conservation District
DEIS	Draft Environmental Impact Statement
DEM	Digital Elevation Model
DEP	New York City Department of Environmental Protection
DFIRM	digital flood insurance rate map
DMAP	Deer Management Assistance Permit
DOE	New York City Department of Education
DOHMH	New York City Department of Health and Mental Hygiene
DPR	New York City Department of Parks and Recreation
DSEIS	Draft Supplemental Environmental Impact Statement
EAB	emerald ash borer
EAF	Environmental Assessment Form

ECLRS	Electronic Clinical Laboratory Reporting System
ED/RR	Early Detection and Rapid Response Plan
EFC	New York State Environmental Facilities Corporation
EIS	environmental impact statement
ELAP	Environmental Laboratory Approval Program
ELTP	Enhanced Land Trust Program
EOH	East of Hudson
EOHWC	East of Hudson Watershed Corporation
EWP	Emergency Watershed Protection
FAD	Filtration Avoidance Determination
FDNY	New York City Fire Department
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHMP	Flood Hazard Mitigation Program
FITT	Forestry Interdisciplinary Technical Team
FMP	New York City Forest Management Plan
GCSWCD	Greene County Soil and Water Conservation District
GI	gastrointestinal illness
GIS	Geographic Information System
GPS	Global Positioning System
HAA5	haloacetic acid five
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HEFS	Hydrologic Ensemble Forecast Service
HEV	human enteric virus
HMGP	Hazard Mitigation Grant Program
IAR	inactivation ratio
IRSP	individual residential stormwater plan
ISAC	Invasive Species Advisory Committee
ISC	New York State Invasive Species Council
ISWG	Invasive Species Working Group
JV	Joint Venture
LAP	Land Acquisition Program
LFA	Local Flood Analysis
LFHMIP	Local Flood Hazard Mitigation Implementation Program
LiDAR	Light Detection and Ranging
LIMS	Laboratory Information Management System
MAP	Management Assistance Program
MFO	Master Forest Owner
MCL	Maximum Contaminant Level
MGD	million gallons per day
MMI	Milone & MacBroom, Inc.
MOA	New York City Memorandum of Agreement

MRO	Modification of Reservoir Operations
MST	Microbial Source Tracking
NAS	National Academies of Science
NHD	National Hydrography Dataset
NMP	nutrient management plan
NOV	Notice of Violation
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
NWI	National Wetlands Inventory
NYC	New York City
NYNJTC	New York-New Jersey Trail Conference
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
OIT	Office of Information Technology
OST	Operations Support Tool
PAA	Public Access Area
PCR	polymerase chain reaction
PRISM	Partnership for Regional Invasive Species Management
RBAP	Riparian Buffer Acquisition Program
RCMP	Riparian Corridor Management Plan
REP	Regulatory and Engineering Programs
RFP	Request for Proposals
RNSP	Rondout/Neversink Stream Program
ROV	remote operated vehicle
RTCR	Revised Total Coliform Rule
RWBT	Rondout-West Branch Tunnel
SAFARI	Shandaken Area Flood Assessment and Remediation Initiative
SBR	sequential batch reactor
SCSWCD	Sullivan County Soil and Water Conservation District
SDE	Spatial Database Engine
SDEIS	Supplemental Draft Environmental Impact Statement
SEIS	Supplemental Environmental Impact Statement
SEQRA	State Environmental Quality Review Act
SMIP	Stream Management Implementation Program
SMP	Stream Management Program
SPDES	State Pollutant Discharge Elimination System
SSMP	Septic System Management Program
SSTS	subsurface sewage treatment system
SUNY	State University of New York
SWAC	Schoharie Watershed Advisory Committee

SWCD	Soil and Water Conservation District
SWPPP	stormwater pollution prevention plan
SWTR	Surface Water Treatment Rule
TCR	Total Coliform Rule
TFS	Team Foundation Server
THM	trihalomethane
TKN	total kjeldahl nitrogen
TSI	timber stand improvement
TTHM	Total trihalomethane
UCSWCD	Ulster County Soil and Water Conservation District
UFI	Upstate Freshwater Institute
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
WAC	Watershed Agricultural Council
WaLIS	Watershed Lands Information System
WAP	Watershed Agricultural Program
WCDEF	Westchester County Department of Environmental Facilities
WDRAP	Waterborne Disease Risk Assessment Program
WECC	Watershed Enforcement Coordination Committee
WFP	whole farm plan
WOH	West of Hudson
WR&R	New York City Watershed Rules and Regulations
WSP	Water Supply Permit
WSPS	Water and Sewer Permitting System
WWQMP	Watershed Water Quality Monitoring Plan
WWTP	wastewater treatment plant
WWTPCI	Wastewater Treatment Plant Compliance and Inspection

1. Introduction

In 2016, New York City continued to implement a broad array of initiatives as part of the City's source water protection program. Nearly a quarter century ago, the City initiated an ambitious plan to continue to provide affordable, high quality water by protecting it at its source. Since then, the New York City Department of Environmental Protection (DEP) has committed more than \$1.7 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.

DEP's programs have become a national and international model. Each year, water and public health professionals come from around the world 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.

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 address current potential pollution sources and prevents the creation of new 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.

In 2016, DEP completed its most recent Watershed Protection Program Summary and Assessment (the Assessment) ([DEP 2016a](#)), and submitted the 2016 Long-Term Watershed Protection Plan (the Plan) ([DEP 2016b](#)) to the New York State Department of Health (NYSDOH). The Assessment summarized source water protection program activities over the previous five years 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. Annual watershed water quality reports compiled by DEP continue to confirm this. The Plan laid out DEP's proposed source water protection activities for 2017 through 2027, which build on existing programs and accomplishments to date.

DEP 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 2016, DEP sought ways to improve efficiency while continuing steady implementation of critical watershed protection projects. While New York City dedicates 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, 2016, through December 31, 2016, and is compiled to satisfy the requirements of the Revised 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 (Figure 1.1 and Figure 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.

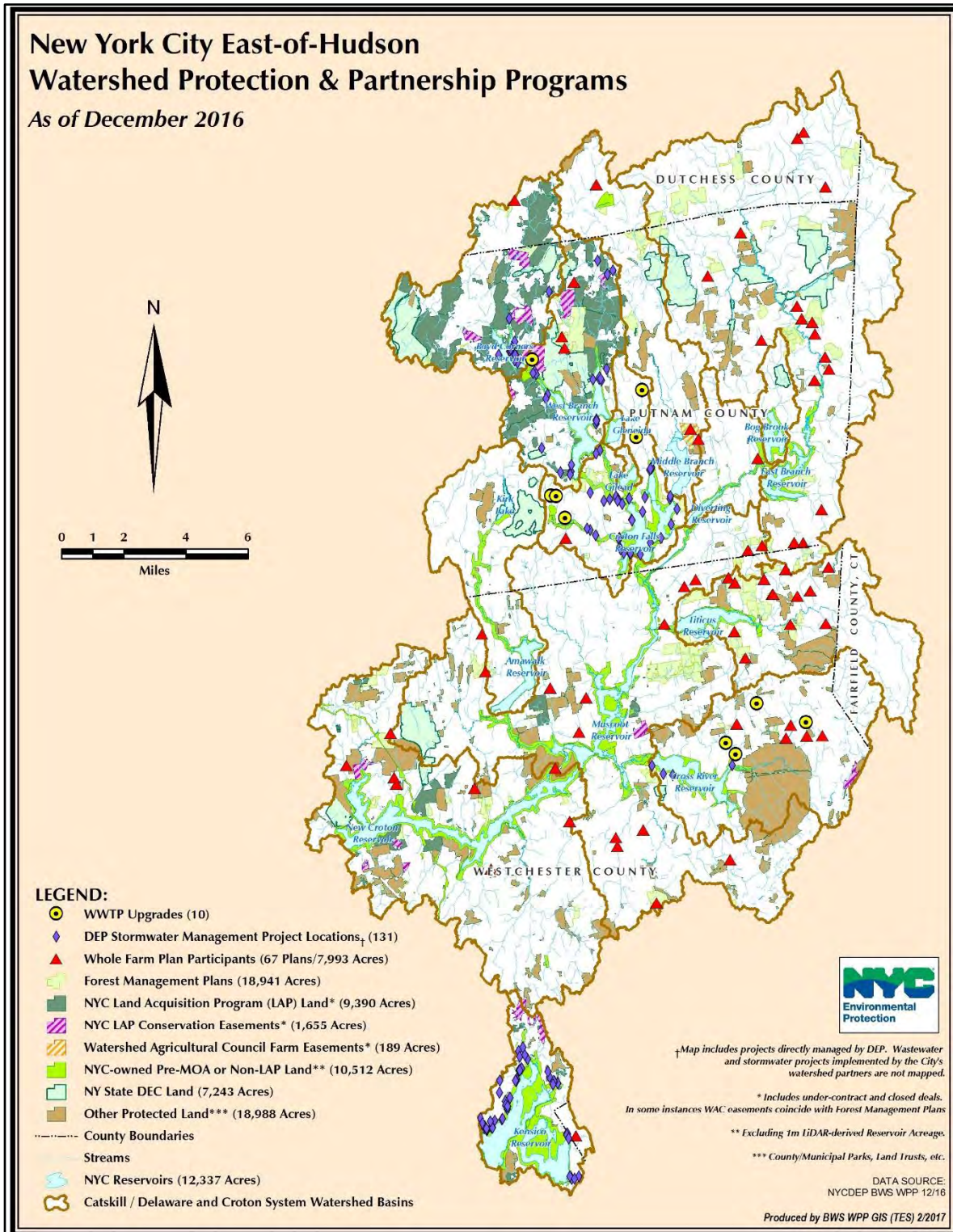


Figure 1.1 New York City East-of-Hudson watershed protection and partnership programs as of December 2016.

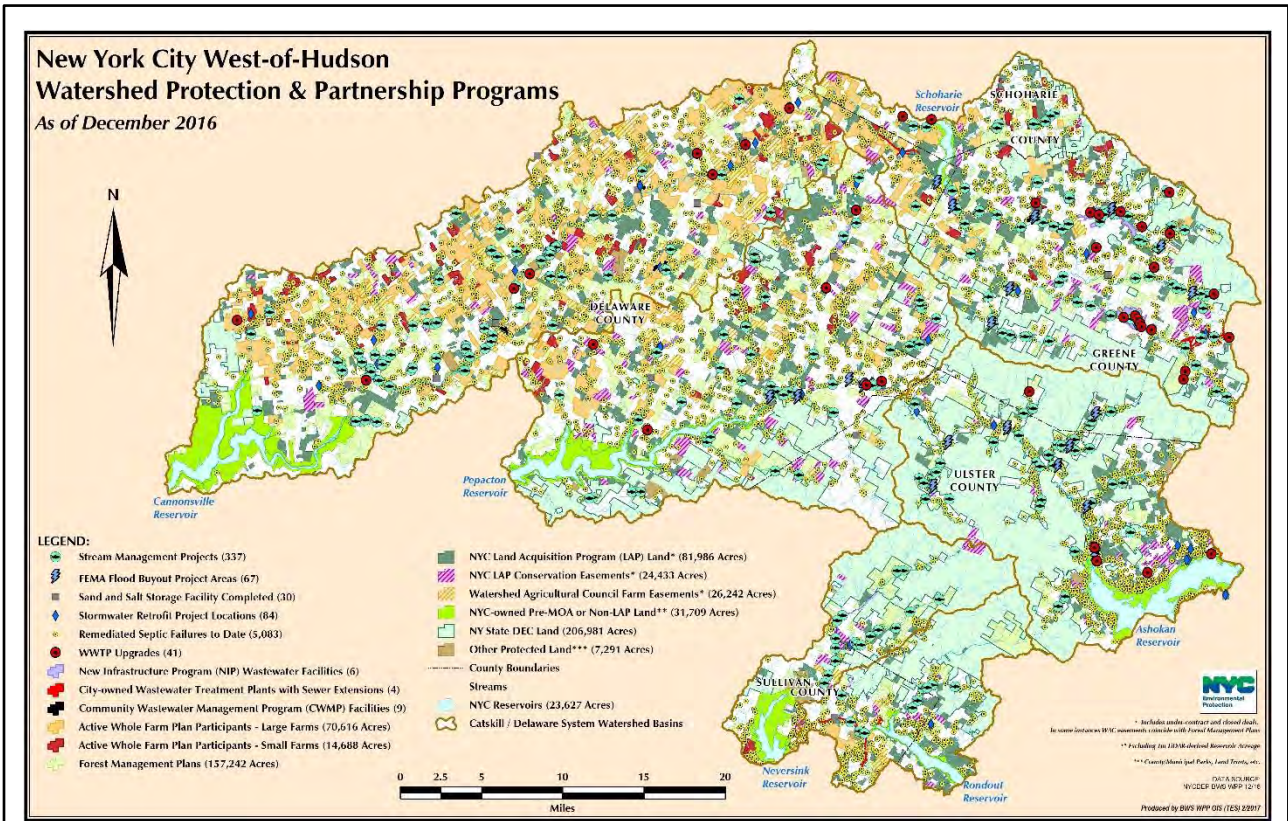


Figure 1.2 New York City West-of-Hudson watershed protection and partnership programs as of December 2016.

2. Federal and State Objective Water Quality Compliance

During 2016, DEP continued its comprehensive water quality monitoring efforts. New York City's sampling program is far more extensive than 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 2016, DEP collected 51,477 samples and conducted 639,318 analyses. Of these, 36,304 samples were collected and 407,547 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), only 0.3% of the 9,756 in-City compliance samples analyzed pursuant to the Revised Total Coliform Rule (RTCR) were total coliform positive, and all samples were negative for *E. coli*. Since 1995, DEP has collected more than 229,450 of coliform compliance samples and only 14 of them have tested positive for *E. coli*.

On the 10th of every month, DEP provides both the United States Environmental Protection Agency (USEPA) and NYSDOH with the results of its enhanced monitoring program, which was developed to comply with the requirements of the SWTR 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.

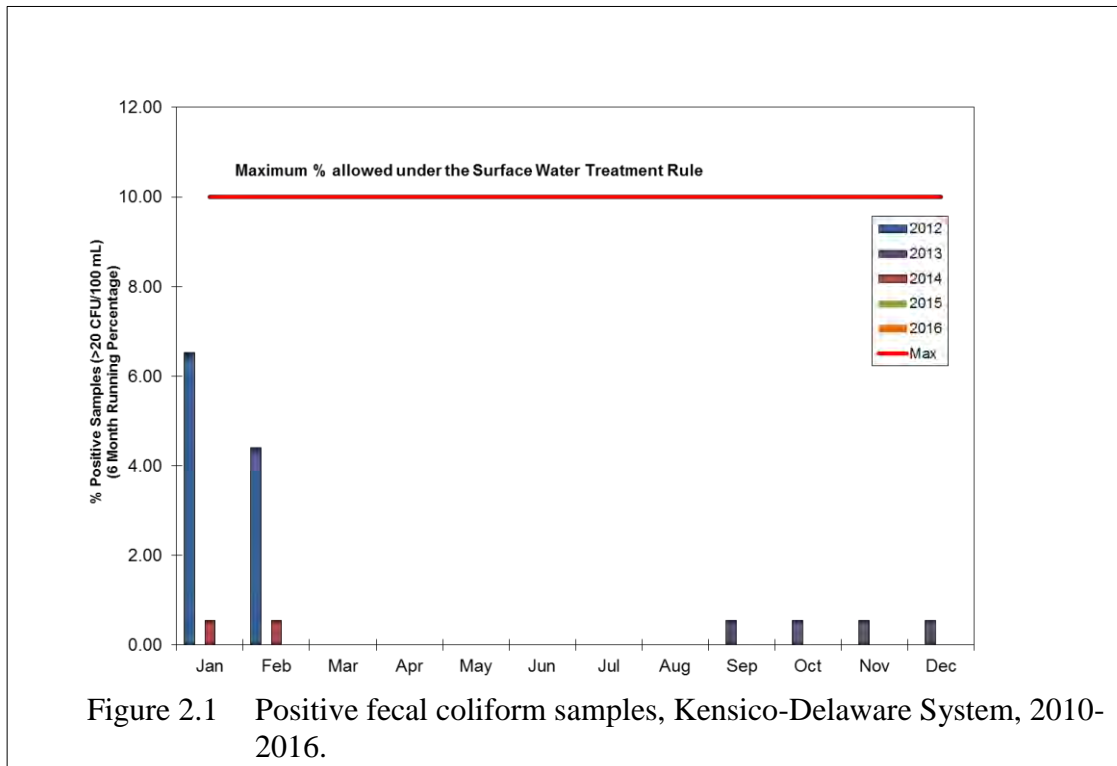
2.1 Surface Water Treatment Rule Monitoring and Reporting

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 2016, 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))

In 2016, the Catskill Aqueduct south of Kensico Reservoir was offline; therefore, no Catskill Aqueduct effluent fecal coliform samples were collected for the year. The Delaware Aqueduct effluent 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/Delaware System was 100%.

As shown in Figure 2.1, the six-month running percentage of positive raw water fecal coliform samples at the Delaware Aqueduct effluent from Kensico Reservoir was well below the maximum percentage of positive samples allowed under the SWTR.

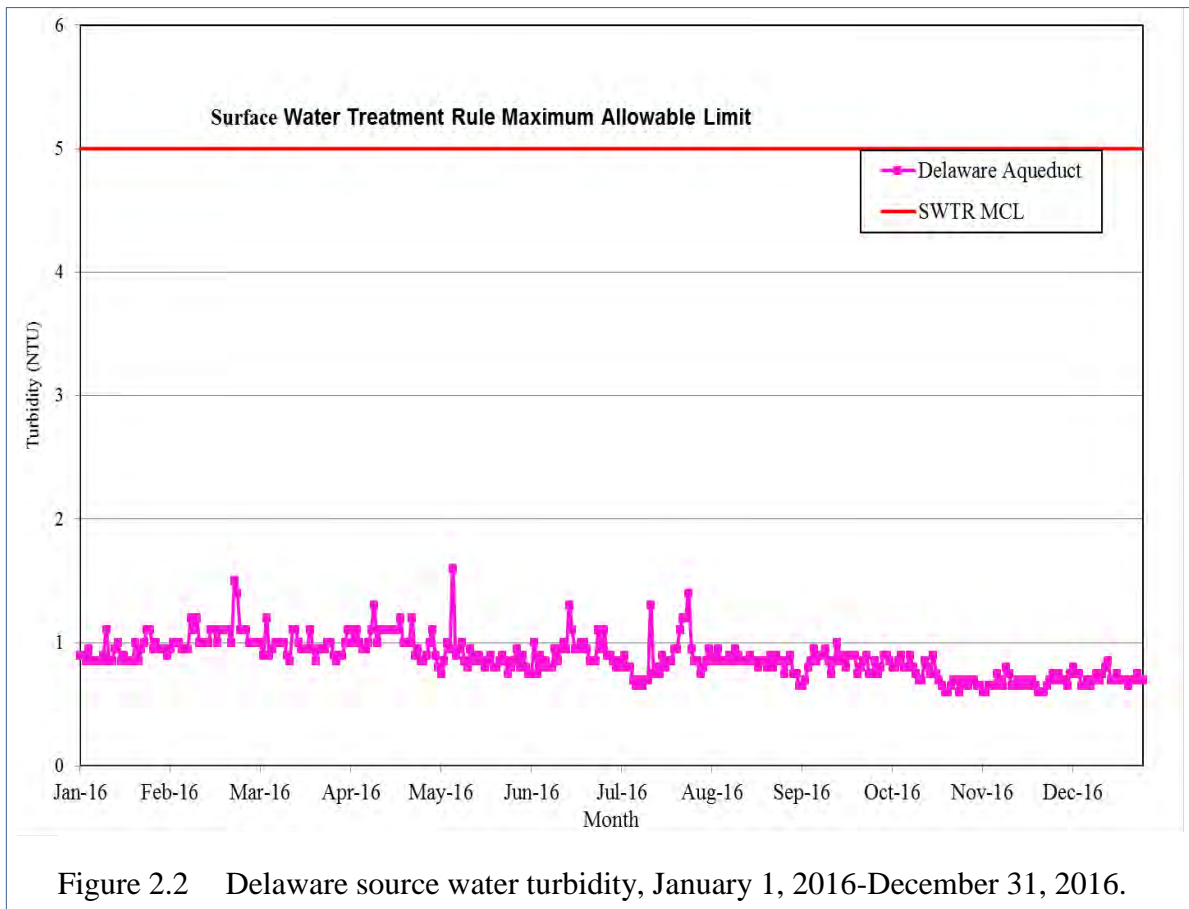


2.1.2 Raw Water Turbidity (40 CFR Section 141.71(a)(2))

No Catskill Aqueduct effluent turbidity samples were collected in 2016 because the Catskill Aqueduct south of Kensico Reservoir was offline. The Delaware Aqueduct effluent from Kensico Reservoir exhibited turbidity levels less than or equal to 5 NTU in water prior to disinfection for the entire 2016 calendar year (Figure 2.2).

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

As required, continuous monitoring for free chlorine residual was maintained at the distribution entry points throughout the year. 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 0.27 mg L⁻¹.



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

All chlorine residuals for the 15,816 samples measured within the distribution system during the year were detectable.

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

The analysis for trihalomethanes (THM), performed on a quarterly basis, resulted in a maximum total trihalomethane (TTHM) value of $76 \mu\text{g L}^{-1}$. The analysis for haloacetic acids, also performed on a quarterly basis, resulted in a maximum haloacetic acid five (HAA5) value of $57 \mu\text{g L}^{-1}$.

The highest TTHM quarterly running annual average during the year, recorded during the third quarter, was $56 \mu\text{g L}^{-1}$, a level below the regulated level of $80 \mu\text{g L}^{-1}$. The highest HAA5 quarterly running annual average, recorded during the second quarter, was $47 \mu\text{g L}^{-1}$, a level below the regulated level of $60 \mu\text{g L}^{-1}$.

2.2 Total Coliform Monitoring

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

On April 1, 2016, requirements under the RTCR took effect, eliminating the previous Maximum Contaminant Level (MCL) for total coliforms, and establishing the MCL for *E. coli*. Coliform data are presented for the entire year, even though the MCL was only applicable through March 31, 2016. Within the distribution system, coliform monitoring indicated monthly levels of total coliforms below the 5% maximum for the entire year (Figure 2.3). The number of compliance samples analyzed for total coliforms was 9,756, of which 27 were total coliform positive. 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 1.6%.

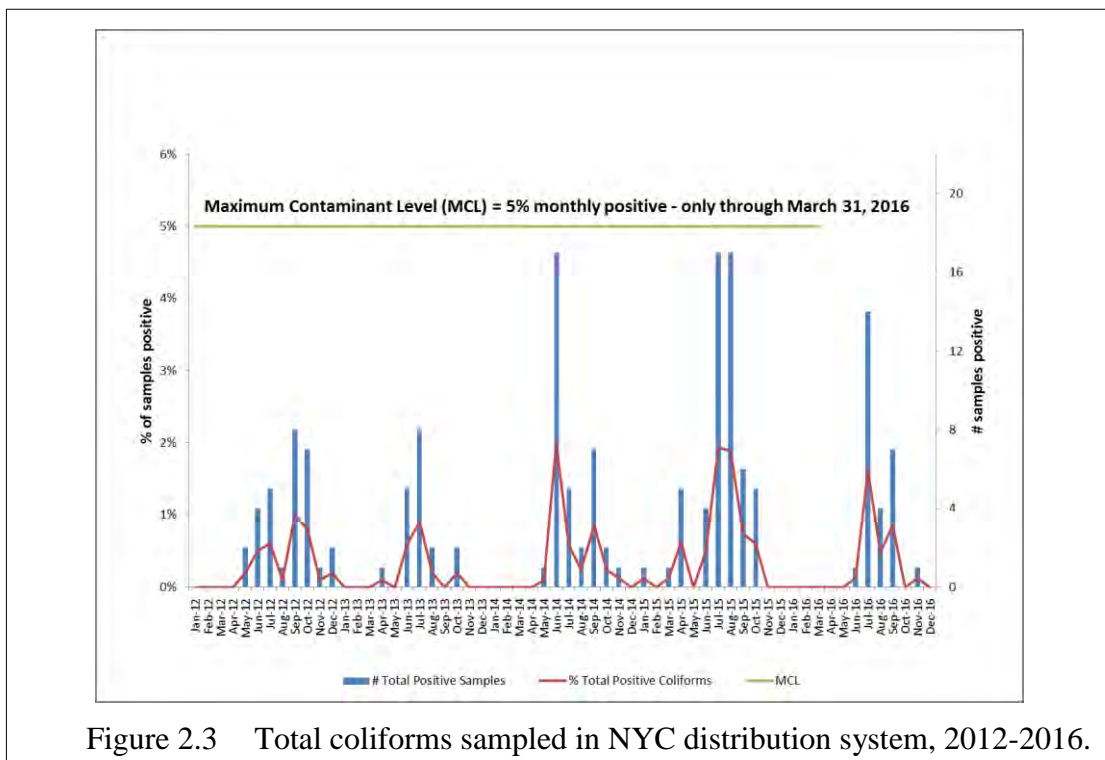


Figure 2.3 Total coliforms sampled in NYC distribution system, 2012-2016.

2.2.2 Chlorine Residual Maintenance in the Distribution System

During the year, DEP has continued a number of programs to ensure adequate levels of chlorine throughout the distribution system. These have included maintaining chlorination levels at the distribution system’s entry points, conducting spot flushing when necessary, and providing local chlorination booster stations at remote locations. Two 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; and for Staten Island. As a result, detectable chlorine residuals were maintained throughout the distribution system in 2016.

3. Environmental Infrastructure

3.1 Septic Programs

3.1.1 Septic Rehabilitation and Replacement Program

Since 1997, DEP has committed over \$90 million to rehabilitate, replace, and upgrade septic systems serving single- or two-family homes in the West of Hudson (WOH) watershed. The Septic System Rehabilitation and Replacement Program is managed by the Catskill Watershed Corporation (CWC) and includes 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 initiated in the 60-day travel time area and has expanded to include septic systems located within 700 feet of a watercourse. In 2016, the program funded the repair or replacement of 241 failing or likely-to-fail septic systems.

The Hardship Program funds septic repairs located in areas not covered by the Priority Area Program for applicants who meet certain income eligibility criteria. In 2016, there were no repairs or replacements within the Hardship Program.

The Reimbursement Program reimburses homeowners who repair or replace failing septic systems in areas not covered by the Priority Area Program, depending on funding availability. Presently, homeowners who fixed failing septic systems outside the priority areas between July 2, 1999, and December 31, 2016, are eligible for reimbursement. In 2016, the Reimbursement Program funded the repair or replacement of three failing septic systems.

In 2016, the Septic System Rehabilitation and Replacement Program funded the repair or replacement of 244 septic systems under the various sub-programs. Since the program's inception, over 5,100 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, DEP provides funding to the CWC to pay 50% of eligible costs for pump-outs and maintenance. In 2016, the program subsidized 261 septic tank pump-outs. Since the program's inception, 1,712 septic tank pump-outs have been subsidized.

3.1.3 Other Septic Programs

The Small Business Septic System Rehabilitation and Replacement Program helps pay for the repair or replacement of failed septic systems serving small businesses in the WOH watershed. Through the CWC, eligible business owners are reimbursed 75% of the cost of repairs for failing commercial septic systems within 700 feet or less from a watercourse, 500 feet or less

from a reservoir, or within the 60-day Travel Time Area. The business owner is responsible for securing an approved DEP design and for the construction of the septic system remediation. In 2016, one small business received reimbursement for the repair or replacement of a failing septic system. Seventeen failing septic systems have been replaced since the program’s inception.

During 2016, there was no activity in the Cluster Septic System Program, which funds the planning, design, and construction of cluster systems in 13 WOH communities.

3.2 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. This includes septic system replacement, rehabilitation and upgrades; and operation and maintenance of the districts. CWMP projects have previously been completed in Bovina, DeLancey, Bloomville, Hamden, Boiceville, Ashland, and Trout Creek.

In 2016, CWMP projects were completed in Lexington and South Kortright. The Lexington project consists of a small diameter effluent sewer to a community septic system with pretreatment. The South Kortright project consists of a new conventional sewer system connected to an existing pump station with collected sewage pumped approximately six miles to the Village of Hobart wastewater treatment plant (WWTP). As part of this project, the Hobart WWTP was upgraded to handle the additional flow. See Figure 3.1 and Figure 3.2.



Figure 3.1 Installation of Orenco treatment units in Lexington.



Figure 3.2 Installation of storage units in South Kortright.

The remaining CWMP projects are Shandaken, West Conesville, Claryville, Halcottsville, and New Kingston. The CWC is working with these communities on the study phase of the projects. In 2016, DEP met with the CWC and their consulting engineers to discuss the draft preliminary engineering reports on Shandaken and West Conesville; both projects are expected to begin the design phase in 2017. Draft preliminary engineering reports for Claryville and New Kingston were completed in the second half of 2016 and are now under review. The draft preliminary engineering report for Halcottsville is anticipated in 2017.

3.3 Sewer Extension Program

The Sewer Extension Program funds the design and construction of wastewater sewer extensions connected to City-owned WWTPs discharging in the WOH watershed. The program's goal is to reduce the number of failing/potentially failing septic systems by extending the WWTP service to priority areas. DEP has completed projects in the towns of Roxbury (Grand Gorge

WWTP), Neversink (Grahamsville WWTP), and Hunter-Haines Falls/Showers Road (Tannersville WWTP). Program activities in communities with projects still underway in 2016 are highlighted below.

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

During the reporting period, DEP's contractor completed nearly all the remaining work on the pump station located east of the Pine Hill WWTP. The new sewer mains, laterals, and manholes are fully constructed and the project pump station has also been completed with the exception of some additional electrical work. DEP anticipates the project will be completed and the town will authorize property owners to connect to the sewer laterals in the first half of 2017.

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

In 2016, DEP's contractor completed work on two of the project's four sewer extension areas (Harold Finch Road-East and Academy Street). DEP anticipates the town will authorize property owners to make connections to the sewer laterals for these areas in the first half of 2017. During the reporting period, DEP's contractor also continued work on the other two extension areas (Bull Run Road and Harold Finch Road-West). For Bull Run Road, the contractor installed manholes, constructed laterals, and paved completed sections of the project area, while DEP secured approval from Delaware County on a bridge crossing. DEP expects construction of the Harold Finch Road-West extension will be completed in the first half of 2017 and the Bull Run Road extension will be completed in 2017's second half due to seasonal constraints on working in the stream.

3.4 Stormwater Programs

3.4.1 Stormwater Cost-Sharing Programs

Costs of stormwater measures resulting from complying with New York City Watershed Rules and Regulations (WR&R) are paid for by the Future Stormwater Controls Program to the extent they exceed costs of complying with state and federal requirements. The program funds 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 the additional compliance costs incurred from the WR&R: the WOH Future Stormwater Controls Program (administered by the CWC), and the Future Stormwater Controls Program (funded by the City). Eligible components of future stormwater projects can receive 100% reimbursement. This funding can come completely from the WOH program (municipalities and large businesses), completely from the Future Stormwater Controls Program (low-income housing projects and single-family home owners), or 50% from each program (small businesses).

Environmental Infrastructure

The City provided \$31.7 million to the CWC to administer the WOH stormwater controls program. From this allotment, the CWC has reimbursed over \$6 million to program applicants and transferred over \$17 million to other eligible watershed protection programs. The fund balance was approximately \$15 million at the end of 2016. Table 3.1 provides details for projects approved for funding under the two future stormwater controls programs.

Table 3.1 Future Stormwater Controls Program projects.

Applicant	Project	Approval Date	CWC Funding Only	Percent Funding CWC/DEP
Trac Land Vest, LLC	SWPPP for old Hunter Drive-In	1/5/16	\$10,538.36	50% / 50%
Chris Barber	SWPPP design/implementation for sub-division lot	2/2/16	\$29,572.00	100% CWC
Nick Bove Enterprise, LLC	Design of SWPPP for addition to building	2/2/16	\$3,275.00	50% /50%
Windham Foursome, LLC	Design of SWPPP for subdivision	2/2/16	\$15,536.32	50% / 50%
Andrew Penson	Additional funding - Design and construction of SWPPP	2/2/16	\$11,611.41	100% CWC
Delhi Rehabilitation and Nursing Center	Design and construction of new stormwater controls	4/5/16	\$162,410.23	50% / 50%
Masserson Properties	Design costs – The Roxbury at Stratton Falls	4/5/16	\$20,977.25	50% / 50%
Windham Foursome, LLC	Implementation of SWPPP for subdivision	4/5/16	\$274,653.89	50% / 50%
JGJMS, Inc	Prattsville Plaza – CWC advance payment of NYC 50% share	5/3/16	\$299,922.34	50% / 50%
Windham Carwash, LLC	O&M funds to maintain BMPs	5/3/16	\$5,000.00	50% / 50%
Chris Barber	Additional reimbursement for eligible construction costs	5/3/16	\$3,800.00	100% CWC

Applicant	Project	Approval Date	CWC Funding Only	Percent Funding CWC/DEP
3115 Route 28, LLC	Construction costs for new stormwater controls measures – parking lot and building extension	6/7/16	\$23,250.00	50% / 50%
Masserson Holdings, LLC	Implementation of stormwater controls – The Roxbury at Stratton Falls – subdivision	6/7/16	\$129,945.50	50% / 50%
Michael Lasofsky	Survey to show disturbance less than two acres	7/5/16	\$3,476.30	100% CWC
Four Goats, LLC	O&M costs for BMPs (previously Cannie D’s Corner Corporation)	9/6/16	\$14,948.00	50% / 50%
Chris Barber	Additional eligible construction costs	9/6/16	\$1,413.27	100% CWC
H.D. Lane VFC	Design and construction observation for stormwater controls associated with addition to fire hall	10/4/16	\$5,927.67	100% CWC
Town of Lexington	Design of new stormwater controls associated with construction of pavilion	10/4/16	\$450.00	100% CWC
Chris Barber	Additional eligible construction costs	10/4/16	\$1,500.00	100% CWC
Delhi Rehabilitation and Nursing Center	Stormwater controls associated with renovations to building	10/4/16	\$162,410.23	100% CWC
Catskill Watershed Corporation	Stormwater controls associated with handicapped ramp	12/6/16	\$10,028.20	100% CWC
Darlene Colandrea	O&M funding for stormwater BMPs	12/6/16	\$500.00	50% / 50%

Environmental Infrastructure

Applicant	Project	Approval Date	CWC Funding Only	Percent Funding CWC/DEP
Delhi Community Church	Design and construction of stormwater controls for addition to church	12/6/16	\$15,391.98	100% CWC

3.4.2 Stormwater Retrofit Program

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

Through 2016, 77 stormwater retrofit projects have been completed; 63 were construction projects and 14 were planning and assessment projects. In 2016, two construction projects were completed. Presently, there are 12 open construction projects and three open planning and assessment projects. Projects of both types are presented below in Table 3.2, Table 3.3, and Table 3.4.

Table 3.2 Stormwater retrofit construction projects completed in 2016.

Applicant	Project description	Project cost	Closing date
Margaretville CSD	Redesign of stormwater collection, conveyance, and treatment structures	\$129,254.08	12/21/16
Village of Delhi	Riverwalk – Phase I	\$31,823.12	10/6/16

Table 3.3 Stormwater retrofit construction projects open in 2016.

Applicant	Project Area	Project description	Status
Village of Tannersville	Hunter Foundation	Design and installation of stormwater collection, conveyance, and treatment structures	90% complete
Village of Delhi	Village of Delhi	Implementation of stormwater mitigation practices to reduce inflow and infiltration into the Delhi sanitary sewer collection system	Open

Applicant	Project Area	Project description	Status
Town of Shandaken	town highway garage	Design of stormwater collection, conveyance, and treatment structures	In design
Town of Shandaken	Hamlet of Pine Hill	Design of Pine Hill stormwater collection, conveyance, and treatment structures	In design
Town of Lexington	Hamlet of Lexington	Design and installation of stormwater collection, conveyance, and treatment structures	Construction
Delaware Valley Hospital	hospital	Design and installation of stormwater collection, conveyance, and treatment structures	Awaiting Construction Acceptance
South Kortright Central School	school campus	Design of stormwater collection, conveyance, and treatment structures	In Design
Greene County	Greene County	Sweeper/Vac Truck	Open
The Onteora Club	Onteora Club	Design of stormwater collection, conveyance, and treatment structures	In Design
Village of Margaretville	Main Street	Design of stormwater collection, conveyance, and treatment structures	Open
Delaware County	Delaware County	Vac Truck	Open
Windham Theatre	parking lots	Design of stormwater collection, conveyance, and treatment structures	Open

Table 3.4 Planning and assessment projects open in 2016.

Applicant	Grant amount	Funding Date
Town of Andes	\$35,275.00	2009
Town of Windham	\$46,625.00	2015
Village of Fleischmanns	\$46,875.00	2015

4. Protection and Remediation Programs

4.1 Waterfowl Management Program

For information on the Waterfowl Management Program, see the Waterfowl Management Program Annual report, which will be available on the DEP website after its submittal on September 30, 2017 (http://www.nyc.gov/html/dep/html/watershed_protection/fad.shtml).

4.2 Land Acquisition

When the City built the Catskill/Delaware (Cat/Del) System, the City acquired roughly 34,200 acres of land surrounding the reservoirs it constructed. By the end of 2016, following 20 years of Land Acquisition Program (LAP) activity, an additional 142,000 acres in the Cat/Del watershed has been secured, most in fee simple but also including conservation easements (CEs) acquired by the City and the Watershed Agricultural Council (WAC). This represents more than a four-fold increase in the amount of City-owned land — all based on voluntary transactions (over 1,600 individual negotiations and purchase contracts). In many basins, City land holdings have increased dramatically compared with pre-1997 ownership patterns (Figure 4.1).

In the Rondout basin, which is comprised entirely of Priority Areas 1A and 1B, the City has increased the number of protected acres by over 600%. In West Branch/Boyds Corners and

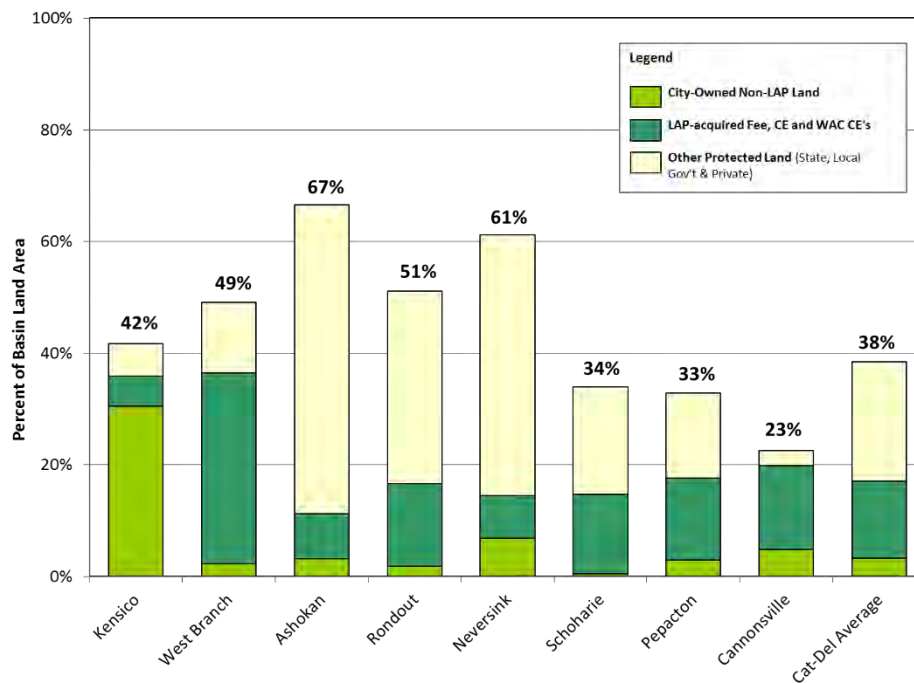


Figure 4.1 Percent of land protected in each Catskill/Delaware basin by real estate type.

Schoharie basins, acreage under City control has increased by 1,200%. In the Ashokan basin, City-owned buffer land is almost three times larger than before 1997. Overall, City-controlled land in the Cat/Del watershed (including CEs secured by both DEP and the Watershed Agricultural Council (WAC)) has increased to over 185,000 acres (including deals yet to close). In 1996, roughly 3.3% of the Cat/Del watershed (excluding reservoirs) was owned by the City and another 21% was protected by others such as New York State (NYS); today, roughly 16.5% is City-controlled, a major segment of the 38.4% of the Cat/Del watershed in total (excluding reservoirs) that is now under some form of permanent protection.

Based on water features and related criteria, the quality of acquisitions has also been high. In 1997 the City owned 5.8% of all riparian buffers (defined as 300 feet either side of a stream, excluding reservoirs, ponds and lakes). Today, the City (including all CEs) has protected 19.1% of all buffers. With those protected by others such as NYS, 39.9% of all buffers are permanently protected (this does not include the 100-foot buffers on private lands protected via City and/or state regulations). In addition, of the 15,190 acres of wetlands designated by the National Wetlands Inventory (NWI) and by the New York State Department of Environmental Conservation (NYSDEC) in the Cat-Del watershed, 18.2% (2,766 acres) have been protected since 1997.

Below are summaries of the main components of DEP's land acquisition activities during 2016.

4.2.1 Solicitation/Resolicitation

The Revised 2007 FAD requires a solicitation goal of 300,000 acres over the period 2012-2017. During 2016, 46,436 acres were solicited by DEP (including ancillary programs), which brings the total acreage solicited against the 300,000-acre goal to 267,853. Total acreage solicited by DEP since 1997 is over 460,000 against the overall program-wide requirement of 445,050.

4.2.2 Purchase Contracts in the Catskill/Delaware System

Through 2016, DEP (excluding WAC farm CEs) had executed 1,510 purchase contracts comprising 115,805 acres throughout the Cat/Del watershed at a cost of \$419 million (with additional soft costs for related site services of about \$39 million). Of these, 1,446 contracts totaling 109,748 acres have closed. During 2016, DEP closed 43 contracts comprising 2,569 acres and signed 44 purchase contracts accounting for 2,482 acres (Figure 4.2, Table 4.1, Table 4.2). Nine purchase contracts were executed by the WAC in 2016, securing another 1,567 acres in farm CEs. See Figure 4.3, Figure 4.4, and Figure 4.5 for images relating to properties protected during 2016.

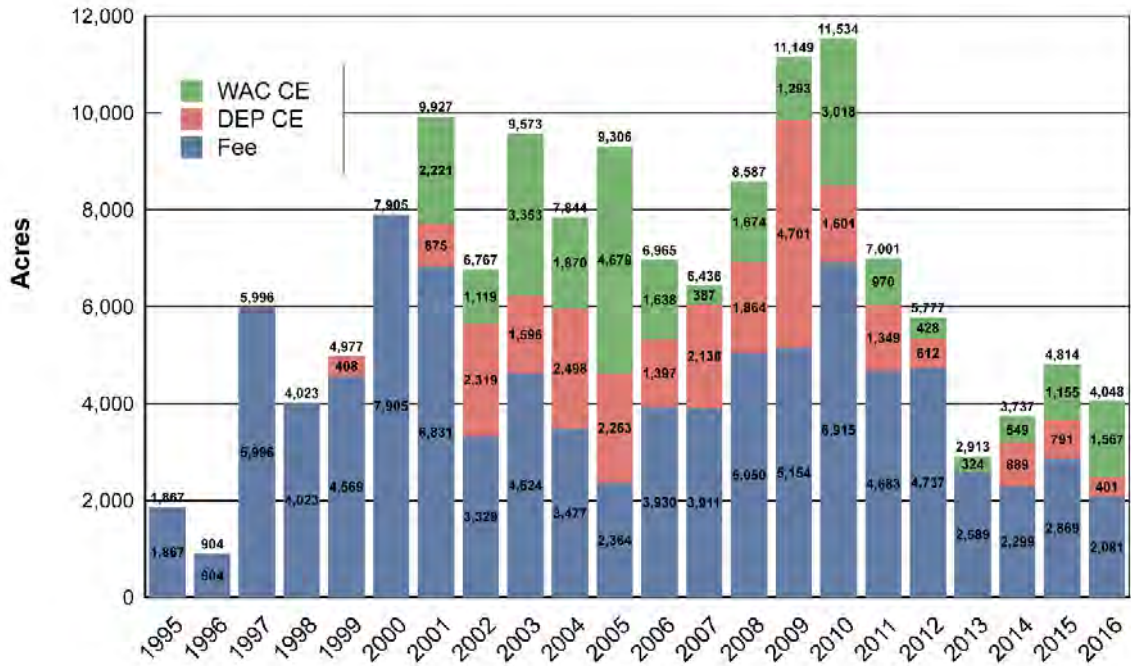


Figure 4.2 Acres in executed contracts by year and real estate type in Cat/Del System.



Figure 4.3 Acquired in 2016, parcel 5360 abuts DEP-owned land and sits within the 1,000-foot buffer of Kensico Reservoir.



Figure 4.4 A view of the Batavia Kill in the Town of Ashland from a 19-acre property acquired in 2016. The property includes 1,500 feet of stream frontage and abuts a 140-acre tract acquired in 2013.



Figure 4.5 View of a 247-acre property in Andes now protected by a conservation easement. The property includes streams, a pond, rolling meadows, and moderate slopes. Two building envelopes surround existing structures.

DEP Conservation Easements

During 2016, one CE totaling 401 acres was signed to purchase contract by DEP (Table 4.1), while five CEs totaling 958 acres were closed (Table 4.2). Overall, 168 CEs in the Cat/Del watershed totaling 25,700 acres are now closed or under contract.

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

Real estate type	Number of contracts	Acres	Average size of project (acres)	Purchase price
Reporting Period: 1995 to 2015				
Fee	1,299	88,024	68	\$339.5m
CE	167	25,299	151	\$70.4m
WAC CE	137	24,679	180	\$35.5m
Reporting Period: 2016				
Fee	43	2,081	48	\$8.2m
CE	1	401	401	\$0.9m
WAC CE	9	1,567	174	\$2.8m
Program-to-date Subtotals				
Fee	1,342	90,105	67	\$347.7m
CE	168	25,700	153	\$71.3m
WAC CE	<u>146</u>	<u>26,246</u>	180	<u>\$38.2m</u>
Grand Total	1,656	142,051	86	\$457.2m

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 (acres)	Purchase price
Reporting Period: 1995 to 2015				
Fee	1,243	83,440	67	\$324.4m
CE	160	23,739	148	\$70.0m
WAC CE	128	23,444	183	\$33.3m
Reporting Period: 2016				
Fee	38	1,611	42	\$6.7m
CE	5	958	192	\$1.3m
WAC CE	9	1,235	137	\$2.1m
Fee	1,281	85,050	66	\$331.0m
CE	165	24,697	150	\$69.3m
WAC CE	<u>137</u>	<u>24,679</u>	180	<u>\$35.5m</u>
Grand Total	1,583	134,427	85	\$435.9m

WAC Conservation Easements

During 2016, the WAC executed nine purchase contracts on farm CEs for 1,567 acres. Nine farm CEs were closed, bringing total acquisitions to 146 farm CEs equaling 24,679 acres of the 26,246 signed to contract. Some farm CEs have been subdivided since the original closings, which increases the number of CEs requiring stewardship needs but not the acres protected. During 2016, the WAC also appraised several forest CEs under the new Forest CE Program. The first forest CEs are expected to be signed to contract in early 2017.

The WAC's CE Programs, including the full cost of all acquisitions and program overhead, and virtually all stewardship costs, have been supported by a total DEP allocation of \$76 million to date. This includes \$70 million for the core Farm CE Program and \$6 million for the pilot Forest CE Program initiated in 2013.

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

During the reporting period, NYSDEC recorded one CE Deed that was conveyed by DEP covering two Land Acquisition Program (LAP) parcels on 29 acres. DEP also conveyed nine CE deeds covering 122 newly acquired properties and 9,573 acres which are yet to be recorded by NYS. To date, DEP has conveyed to NYS a total of 76 CEs on 999 DEP properties comprising 66,372 acres.

4.2.4 Technical Program Improvements

During 2016, DEP continued to make improvements to program documents and policies to maximize the LAP's competitiveness within the marketplace. For example, many landowners continue to take advantage of the City's contribution of up to \$5,000 for subdivision costs offered in the revised model purchase contract. DEP expanded on this in 2016 by providing up to \$3,000 to each seller for the capping, removal, or stabilization related to septic fields and wells. These incentives appear to have increased the rate of accepted offers from landowners whose properties involve such activities. Also during 2016, the Watershed Land Information System (WaLIS) was enhanced to support the new Streamside Acquisition Program.

4.2.5 NYC-Funded Flood Buyout Program

Following finalization of required enabling documents (a Process Document, the Stakeholder Agreement, and the Water Supply Permit modification) in 2016, the City-Funded Flood Buyout Program was able to proceed, with the CWC acting as coordinator for program outreach and assessment and overseeing the demolition of improvements in collaboration with DEP. A model contract was approved for City-owned lands and DEP is currently working with the Coalition of Watershed Towns on an approved model contract for lands intended for ownership by towns. There are seven active projects to date. Six have been appraised; one has an accepted offer and two are in contract.

4.2.6 Federal Emergency Management Agency (FEMA) 2012 Buy-Out Program

Following tropical storms Irene and Lee in 2011, DEP was asked to partner with numerous watershed counties on the acquisition of flood-damaged properties as part of FEMA’s Hazard Mitigation Grant Program (HMGP). DEP has since executed Flood Buyout Memoranda of Agreement (Flood MOAs) with Delaware, Greene, and Ulster counties.

Under the Flood MOAs, the counties are primarily responsible for landowner outreach, grant administration, and demolition of structures once a property is conveyed. The City covers soft costs and pays for the land value of properties not eligible for the 25% match required by the program. Acquired properties can be owned by either the City or local municipality, and all properties will be protected by both the standard FEMA deed restrictions filed locally and a conservation easement conveyed to NYS.

To date, purchase agreements have been signed with 16 owners in six Greene County towns, all of which have closed – the final one during 2016. Of those, eight were acquired by the City and eight by the local municipality. In Delaware County, 28 owners entered purchase agreements, of which 27 were closed by the end of 2016. In 2015, Delaware County withdrew 22 properties from the Flood MOA program, but these are in process of being closed under the FEMA program without further City involvement. It is expected that the City will be reimbursed for all of its expenses on these 22 properties and they will be permanently protected by others. The remaining six properties, on which the City is covering the costs for land and site services, remain in the Flood MOU program and five of the six have closed (all in 2016). In Ulster County, 16 property owners accepted purchase offers and six have closed (all in 2016), with the remaining closings expected in 2017.

4.2.7 Streamside Acquisition Program

Formerly called the Riparian Buffer Acquisition Program, the renamed Streamside Acquisition Program (SAP) experienced delays due to staff turnover within the City’s partner, the Catskill Center for Conservation and Development (CCCD). During 2016, this pilot program became fully operational and the CCCD initiated subcontracts with vendors, drafted model purchase contracts and other documents, and mailed 70 solicitation letters covering more than 700 acres. Eighteen landowners expressed interest, of which eight properties were visited and four appraisals ordered.

4.2.8 Water Supply Permit

The 2010 Environmental Impact Statement (EIS), which supported the 2010 Water Supply Permit (WSP), established watershed-wide projections for the LAP and individual projections for several WOH towns. In each case, it was determined that below the projection there would be no measurable economic impacts to the municipality. The 2010 WSP authorized the LAP to acquire up to 106,712 acres in the Cat/Del system through 2025 beyond the 102,287 acres acquired as of January 1, 2010.

Between January 1, 2010, and December 31, 2016, DEP signed contracts on 39,829 acres (37.3% of the total 106,712-acre limit), leaving a balance of 66,883 acres for potential acquisition pursuant to the WSP projections. During 2016, DEP acquisitions in several WOH towns approached, and in one case (Delhi), exceeded, the town-level projections of the 2010 EIS. Negotiations with stakeholders during 2016 addressed whether town-level projections should be adjusted, with DEP volunteering to commission a new study to assess the socioeconomic impact of acquisitions on land available for future development. This study is expected to be completed in April 2017. In the interim, DEP agreed to downwardly adjust its outgoing solicitation efforts in certain towns while continuing to accept inquiries from interested landowners. Despite these adjustments, DEP expects to meet the six-year solicitation requirement ending on December 31, 2017.

4.2.9 Cooperative Activities with Land Trusts

Enhanced Land Trust Program (ELTP) Through 2016 there was no activity within the five towns (six eligible properties) that joined the program in 2011. In addition, no towns, landowners, or land trusts changed their interest status during the six-month “opt-in” window that ended June 24, 2016. At this time, DEP does not expect this program to result in any projects.

Land Acquisition Activities by Land Trust or Non-Governmental Organizations Beyond activities under the four existing programs described above (ELTP, SAP, and both WAC CE programs), there were no properties acquired or paid for by the City that involved land trusts or non-governmental organizations during 2016.

4.3 Land Management

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

- 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

The City now manages 173,875 acres of land and reservoirs it holds in fee simple. This includes reservoir buffer lands (pre-Memorandum of Agreement (MOA) (1997)), MOA lands, and land along aqueducts. The average size of parcels acquired under the MOA since 1997 is 66 acres but assembled acquisitions have reached up to 3,545 acres.

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: standard inspections, focused inspections, and aerial inspections. The type of inspection a property receives depends on its priority, which is assigned based on its location, number of adjacent properties, the various uses conducted on the property (e.g., recreation, land use permit) and any history of trespass or encroachments.

Standard inspections are performed on “standard-priority properties,” parcels that have seen little or no trespass or encroachments, have little road frontage or experience slight public use. These properties receive a boundary inspection at least once every five years. Five-year boundary inspections are the most comprehensive type of inspection and include a traverse of all property boundary lines as well as the interior of the property. This ensures proper survey monumentation and maintenance of property boundary lines over the long term.

Focused inspections are performed annually on “high-priority properties.” These are parcels with high recreational use, a history of encroachments or repeated trespass, active land use permits or other projects, or many adjacent landowners.

DEP has conducted aerial inspections of conservation easements with great success, but it has not used them for fee lands. As the portfolio of lands continues to grow, however, it may be worthwhile to consider this approach for fee lands in the future.

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 DEP's Watershed Lands Information System (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 utilized as site-specific conditions dictate.

Conservation Easement Stewardship

DEP Conservation Easements

At the end of 2016, DEP had 172 closed CE properties totaling 25,085 acres in the Catskill, Delaware, and Croton watersheds. Figure 4.6 shows an example of a DEP CE property.



Figure 4.6 Example of a DEP Conservation Easement.

DEP conducts two annual inspections of all easements in compliance with the MOA's terms. DEP continues to perform annual aerial inspections for all CEs since this is an efficient alternative for inspecting properties, especially the larger ones, and because potential violations that could have serious water quality impacts — land clearing, construction, bridge or road building — are clearly visible from the air. Combined with a fall on-the-ground inspection (or a summer visit if problems are observed), aerial inspections provide a high level of protection for the City's investment.

In 2016, six new CE violations were discovered or confirmed. Three violations involved small areas (0.20 acres or less) of wetland or riparian area disturbance. Two violations involved the discovery of improvements extending from an adjacent outparcel or building envelope into easement areas where they are prohibited. The final violation was due to a small area (0.10 acre) of grading encroachment from a neighboring property during construction of a new septic system. Four of these violations were resolved in 2016 while the other two are underway with no anticipated issues.

Requests to conduct activities that require prior approval consisted primarily of timber harvests. Ten CE timber harvests took place in the Catskill and Delaware watersheds in 2016,

primarily to remove ash trees infected by emerald ash borer. One CE property was subdivided in 2016 and a restatement of easement terms with allocation of retained rights was recorded prior to the conveyance of the new lot. Two stream work requests were received in 2016 and are waiting on the submission of proposed work plans.

Several landowners have asked DEP to amend their early CE deeds that prohibited farming to add the modest farming allowance that is in the CE deeds used since 2006. We are reviewing this question and are requesting an opinion from the state attorney general’s office. We believe there is a public benefit to amendments that provide more uniform deed terms, simplify administration and enforcement, and allow low-risk activities such as hobby farming.

Watershed Agricultural Council (WAC) Conservation Easements and Stewardship

At the end of 2016, the WAC had 138 easement properties totaling 24,869 acres in the Catskill, Delaware, and Croton watersheds. DEP continues to play 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 adopted a conservation easement enforcement policy in late 2016 and will develop enforcement guidelines in 2017. WAC performed all required inspections of their easements in 2016, including aerial inspections.

4.3.2 Beneficial Use

Recreation

DEP’s water supply lands provide outstanding public recreational opportunities at 19 reservoirs and two controlled lakes and on water supply lands throughout the Catskill, Delaware, and Croton watersheds. These activities represent a way of life 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 attempts to allow expanded recreational opportunities in the watershed. DEP’s management priority is to allow and enhance those recreational activities compatible with water quality protection. In 2016, DEP opened an additional 1,100 acres of land for recreation, bringing the total lands and reservoirs available for public use to slightly over 133,000 acres. DEP continued to open WOH watershed lands as Public Access Areas (PAAs). Users of these

lands may hunt, hike, fish, or trap without a DEP Access Permit. Figure 4.7 provides a breakdown of the acres of land, by category, opened for recreation since 2003.

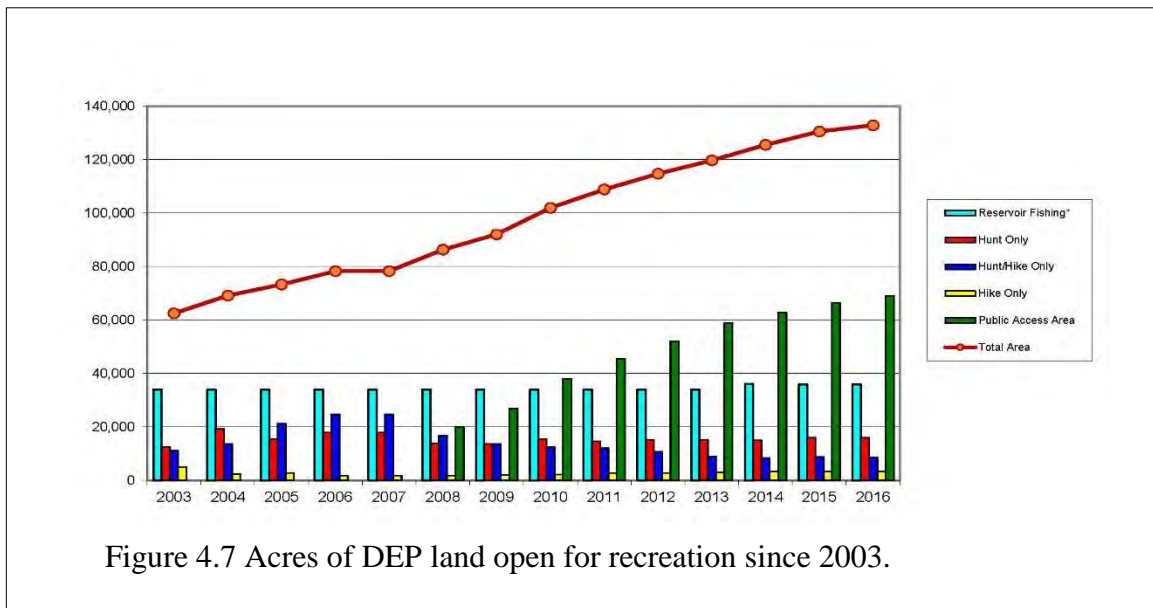


Figure 4.7 Acres of DEP land open for recreation since 2003.

DEP provided revocable land use permits to several partners for projects on City land. DEP also has several pending trail projects with the Catskill Mountain Club (CMC), the Town of Prattsville, and the New York-New Jersey Trail Conference (NYNJTC). Hiking trails (Figure 4.8) are routed so as to avoid sensitive areas such as wetlands and constructed to not create erosion and sedimentation. Use of these trails also provides an opportunity to educate visitors on DEP watershed protection efforts. In 2016, over 4,000 registered hikers utilized just three of DEP’s trail systems maintained by the CMC. DEP continued to develop its program to allow NYS-licensed guides to take clients on DEP lands and waters for hunting, fishing, hiking, and other activities allowed by DEP’s recreation rules.



Figure 4.8 View from Shavertown Trail.

Permits were issued to an additional five guides in 2016, for a total of 36 approved guides. Other activities to enhance recreational opportunities included five public Fishing Days, two on Ashokan Reservoir and one each on Gleneida, Cannonsville, and Pepacton. Nearly 700 people participated in the fishing events. Additionally, DEP held a clean-up day on nine reservoirs with several partner organizations and 264 volunteers. Over 13,000 pieces of trash and recyclables were picked up.

In 2016, DEP participated in its fifth season of the Deer Management Assistance Permits (DMAPs) Program from NYSDEC. In 2016, 65 deer were harvested out of a total of 310 permits issued. Since 2012, 1,048 permits

have been issued and 209 deer have been harvested, a 20% success rate. By providing additional deer-hunting opportunities on DEP reservoir lands, the DMAPs will help DEP resource managers reduce the negative impacts of deer overbrowsing on forest regeneration. DEP will continue to consider ways to improve DMAP success rates and investigate expansion to other deer-impacted areas in the watershed.

Fishing Boat Program

DEP has provided for the historical use of fishing boats on DEP reservoirs (Figure 4.9).

Individuals must register their boats and obtain a permit from DEP to store their fishing boat on City reservoirs. All boats, prior to storage, must be steam cleaned and remain on their assigned reservoir. Currently, DEP has over 13,000 fishing boats permitted throughout the watershed. Boat owners must renew their registration every two years and abide by DEP regulations for safe storage and use. DEP regulates the number of allowable boats for each reservoir, closing reservoirs or boat storage areas to new boats when they reach capacity. These limits are based on

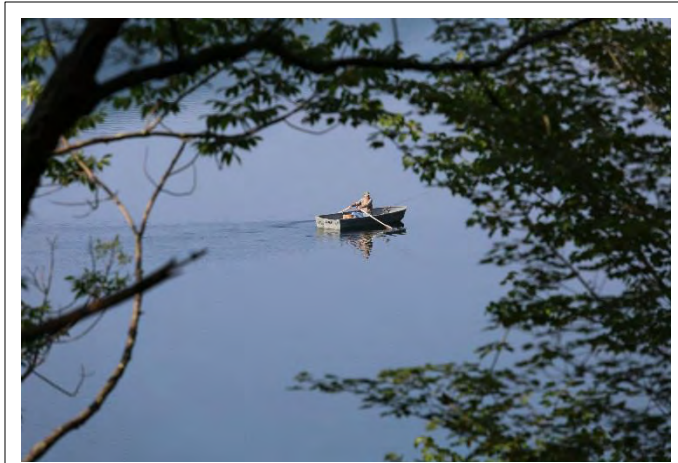


Figure 4.9 Fisherman on Pepacton Reservoir.

the DEP Boat Area Rapid Assessment, which utilizes several factors including safety, erosion, buffer health, and other natural indicators to establish limits. The fishing boat program is very popular with the public and provides for a safe and diverse use of DEP reservoirs.

Recreational Boating Program

In 2016, DEP issued 756 recreational boat tags (canoes, kayaks, sailboats, sculls) for the four reservoirs covered by the program (Cannonsville, Pepacton, Neversink, Schoharie) (Figure 4.10, 4.11). Kayaks were by far the most popular vessel followed by canoes. In addition, canoe and kayak rental vendors rented 912 vessels. The intention of the rental program is to increase recreational boating participation by making vessels easily available.



Figure 4.10 Kayakers utilizing the Recreational Boating Program.

DEP worked with partners to secure and maintain storage racks at boat launch

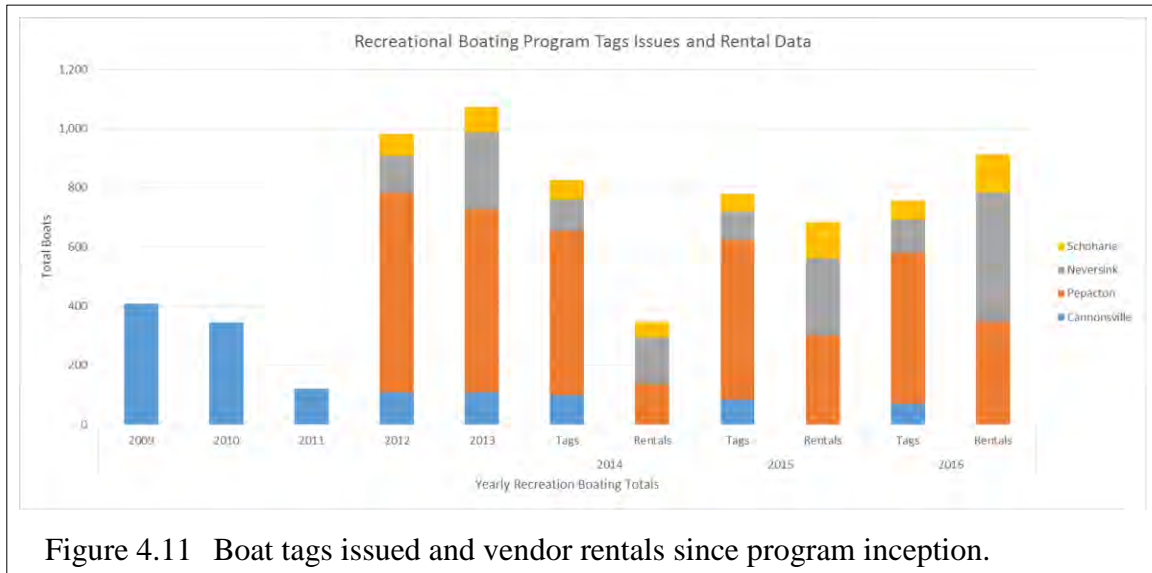


Figure 4.11 Boat tags issued and vendor rentals since program inception.

areas throughout the program area. These racks are available to the public and rental vendors to store registered boats with a seasonal tag. DEP staff regularly inspected boat launch areas and steam-cleaning vendors, removed garbage, and performed routine maintenance.

The recreational boating program caused very little, if any, interference with existing boaters who store their rowboats on the reservoirs for fishing; nor were any safety issues, such as rescues, encountered. There were a few incidents of vessels being put into reservoirs without being properly steam cleaned. Both DEP staff and concerned recreational users approached the violators and informed them of the requirements. DEP increased outreach to boaters and installed additional signage at boat launch sites to prevent such occurrences. Proposed recreation rules, once enacted, will expand the recreational boating season to May 1-November 30, a popular request of the public.

Trolling Motor Program

Since 2013, DEP has been implementing a pilot Trolling Motor Program on Cannonsville Reservoir. The program requires trolling motors with sealed marine-type batteries and the batteries need to be attached to vessels to prevent spillage into the water. Motors must be steam cleaned with propeller removed by a DEP-trained and certified steam cleaning vendor. Permits are issued for single-day use; 113 trolling motor permits were issued in 2016. (Figure 4.12)

Watershed Stewards

In 2016, DEP launched its Watershed Land Steward Program as a way to engage recreational users as volunteers to assist with the protection and improvement of DEP watershed lands. Volunteers at Kensico and Pepacton reservoirs helped by picking up trash, making sure boats were stored properly, and talking with their fellow anglers and boaters. The participants

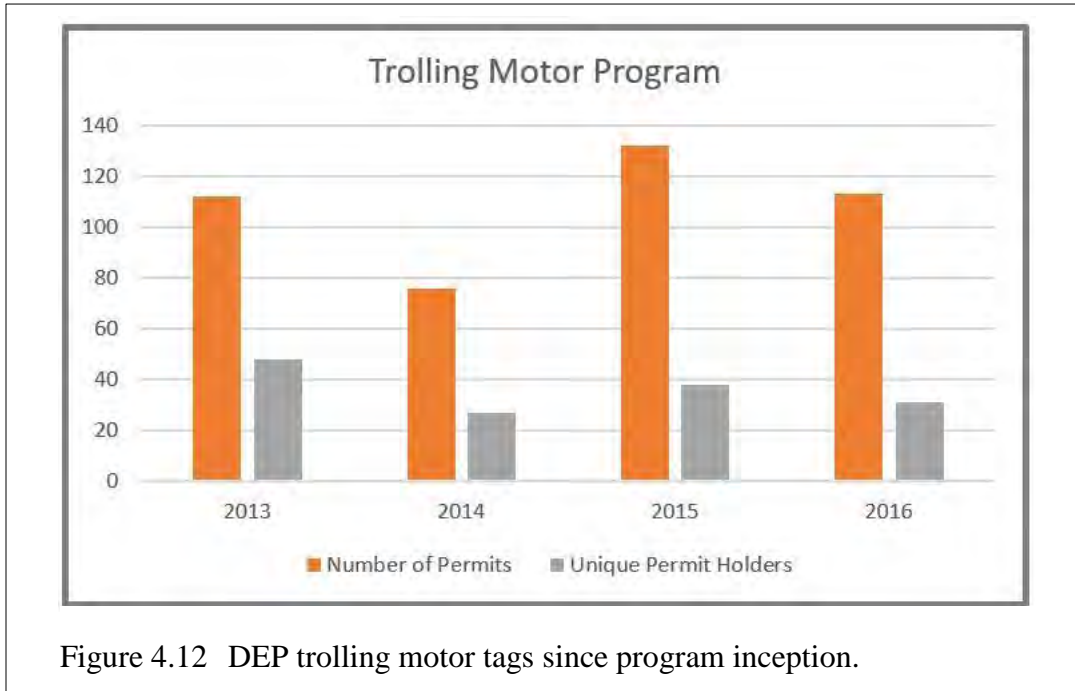


Figure 4.12 DEP trolling motor tags since program inception.

functioned as ambassadors for their respective reservoirs. DEP hopes to assign additional stewards to more reservoirs in 2017.

During training, volunteers learned about the City’s recreation rules and invasive species that could threaten the City’s water supply. The stewards kept in touch with DEP staff, reporting problems and sharing interesting stories from the watershed.

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-wide 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. Most of the farmers using City lands are enrolled in the WAC’s Whole Farm Plan Program (WFP). Farmers enrolled in this program adopt whole farm plans, which helps ensure good farming practices are utilized. These plans are generally developed for private land but can be adapted for use on City lands and include various agricultural Best Management Practices (BMPs) such as soil stabilization techniques. Some of



Figure 4.13 Typical hay field under agricultural use agreement.

the agricultural lands the City purchases under the Land Acquisition Program (LAP) (see Section 4.2) have Conservation Reserve Program (CRP) and/or Whole Farm Plan BMPs already installed on them, such as fencing and tree planting, which the City, as landowner, must maintain. The most common agricultural use on City land is the harvesting of hay (Figure 4.13). In 2016, DEP approved 12 new projects covering 220 acres for a total of 126 projects in 26 different towns covering 2,976 acres. Many project areas were inspected in 2016 and no issues were observed. On projects where no riparian area existed prior to City purchase (they were being farmed right up to the streambank), the mandated 25-foot-wide buffers are developing nicely.

4.3.3 Forest Management

DEP has an active Forest Management Program staffed by five geographically-based foresters, an environmental planner, and one supervisor/coordinator. In October 2016, the fifth watershed forester was hired and assigned to the Cannonsville and Pepacton basins to support the growing forest management workload there because of continued land acquisition. The program is responsible for the scientific assessment and active management of forest resources on City land, which includes conducting forest management projects. Most of these projects are timber harvests with some salvage and restoration projects. The overall program goal is to promote forest vigor, resistance, and resiliency to protect and enhance water quality. In 2016, the program continued implementation of the 2011 Watershed Forest Management Plan (FMP) developed in conjunction with the U.S. Forest Service (USFS) to guide forest management activities on City-owned land.

Two semiannual Forestry Interdisciplinary Technical Team (FITT) planning meetings were held in 2016 to address long-range forest planning and project management, bringing together more than 30 DEP resource specialists. As part of the FITT process, field meetings were also held throughout 2016 to develop site-specific project plans on four new forest management projects. FITT field meetings were also held on two forest management projects about a year after their completion to assess the project's accomplishments. These assessments provide guidance and direction to improve future projects.

Table 4.3 lists the number of forest management projects and acres currently in each phase of the development process as outlined in the City's Forest Management Plan Conservation Practices as of December 31, 2016.

Throughout 2016, DEP implemented and managed four reactive forest management projects across the watershed, all of which involved salvaging timber that was damaged and/or blown down by storms or impacted by emerald ash borer (EAB). The majority of this work occurred in the Ashokan and Cannonsville basins where harvesting continues. (Figure 4.14)

Table 4.3 Forest management projects by phase.

CP process phase	Number of projects	Acres
Initiation	3	278
Planning	5	443
Implementation	8	821
Completion	8	665
Total	24	2207

Emerald ash borer, an invasive insect, continued to spread westerly through the Ashokan basin and impact all ash trees, which comprise 7% of City-owned forest land. Due to the rate of EAB spread in the Ashokan basin, DEP continues to implement an EAB mitigation strategy as opposed to managing EAB spread. The strategy focuses on identifying dense stands of ash, ash harvesting from forest stands to manage the forest change, and reducing the potential public health and safety risk caused by the decline and death of roadside ash trees on City lands. To achieve these goals, DEP has been implementing ash harvests in the western portion of the Ashokan basin that have dense stands of ash. DEP continues to monitor and map EAB’s spread into other basins, particularly the Rondout and Schoharie basins, and plan basin mitigation strategies. DEP also implemented a partnership with the New York State Department of Transportation to reduce hazards from roadside trees killed by EAB, primarily Route 28 in the Ashokan basin, and initiated the development of a DEP hazard tree management plan.



Figure 4.14 Harvesting EAB infested ash in the Ashokan basin.

4.3.4 Invasive Species Management

Invasive Species Working Group

The Invasive Species Working Group (ISWG) was formed within DEP 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 three times in 2016 and found it necessary to form a sub-committee to address chemical control of *Hydrilla verticillata* (Hydrilla) in New Croton Reservoir. The ISWG discussed ongoing rapid response efforts for Hydrilla in

New Croton Reservoir and the development of the Invasive Species Strategy that was submitted as a FAD deliverable at the end of 2016. Progress also continued on the implementation of the ISWG's Early Detection and Rapid Response Plan (ED/RR) for invasive species.

Elements of the ED/RR plan implemented in 2016 include:

- Completion of a two-year contract with SUNY Oneonta to conduct aquatic invasive species (AIS) surveys on DEP's terminal reservoirs for inventorying and mapping AIS occurrences. SUNY Oneonta compared traditional sampling techniques with environmental DNA. These are DNA fragments floating in water that may be amplified by markers through the use of polymerase chain reaction (PCR) techniques. Results from the surveys indicate traditional methods are currently more effective for a broad multi-species survey.
- Recreational boat launch areas on Cannonsville Reservoir were surveyed for aquatic and terrestrial invasive species in order to detect any new introductions as soon as possible following increased boating activities. The only invasive species on DEP's priority list found were the rusty crayfish and Japanese knotweed. These have likely been present for many years and not the result of increased boating.
- Silver vine (*Actinidia polygama*) was reported by the Lower Hudson Partnership for Regional Invasive Species Management (PRISM) on City lands near the New Croton Reservoir in 2015 and is only the second known infestation in the state. DEP began controlling this population in coordination with the Lower Hudson PRISM to stem its spread on City and neighboring private lands.
- Outreach was conducted on early detection aquatic invasive species at the Cold Spring Farmers' Market on July 9, 2016.
- Training on early detection species was provided for the 2016 DEP Police Academy on November 1, 2016.

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 in the state. In 2016, DEP's representative chaired the committee. In 2016, the ISAC supported the DEC's Invasive Species Coordination Unit staff in developing a five-year education and outreach plan and a rapid response framework. Other topics covered included discussion of how the state can support federal policy to prevent the introduction of forest pests and also develop a program to support management of agricultural invasive species.

DEP attended three ISAC meetings in 2016 and two ISC meetings to provide the ISAC report.

Invasive Species Management

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

Hydrilla (New Croton Reservoir)

DEP installed benthic barriers at the New Croton Reservoir boat launch to suppress the growth of Hydrilla. Aquascreen, a brand of aquatic weed mat, was used to shade and compress the growing plants so boats could get in and out of the launch area without fragmenting the plant beds. Less than one acre was controlled.

DEP also participated in public meetings in the Village of Croton-on-Hudson to share plans and coordinate with DEC on the eradication of Hydrilla from the Croton River system.

Japanese Barberry (Ashokan Reservoir)

DEP conducted invasive species management in advance of several forest management projects to help ensure the projects met their objective of increased forest regeneration. A certified applicator applied glyphosate to control three acres of Japanese barberry at the Waldo Smith Forest Management Project site and approximately 10 acres at the Bushkill Forest Management Project. The Bushkill project was a continuation of treatments that began in 2015. Treatment success will be evaluated in spring 2017.

Tree of Heaven (Croton Falls Reservoir)

DEP controlled approximately one acre of tree of heaven to promote regeneration of native tree species at a restoration site on Drewville Road near Croton Falls Reservoir. The trees were removed and treated with triclopyr by a certified applicator in order to prevent regrowth.

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 2016, DEP worked with the Catskill Regional Invasive Species Partnership (CRISP) on prioritizing of hemlock stands in the Catskills for treatment with biological control. DEP participated in CRISP quarterly meetings, served on the executive committee, and aided in decision making on project funding.

Lower Hudson Partnership for Regional Invasive Species Management (PRISM)

In addition to the silver vine response, DEP participated in a survey for giant hogweed within the watershed with the Lower Hudson PRISM and NYSDEC. Five plants were found on City lands in the hamlet of Mahopac and were controlled by the Lower Hudson PRISM field crew.

4.4 Watershed Agricultural Program

The Watershed Agricultural Program (WAP) is administered by the Watershed Agricultural Council (WAC) using DEP funds and technical assistance provided by the USDA Natural Resources Conservation Service (NRCS), Delaware County Soil and Water

Conservation District (SWCD), and Cornell Cooperative Extension (CCE). The USDA Farm Service Agency also provides technical and financial assistance for the Conservation Reserve Enhancement Program (CREP).

The 2016 accomplishments of the WAP are summarized below. There were no WAP-related research activities to report during 2016. For information relating to the WAC Farm Easement Program, please refer to Section 4.2 (Land Acquisition Program). Additional details about the WAP's accomplishments can be found on the WAC website (nycwatershed.org).

The current known universe of active large farms in the WOH watershed is 210 farms, of which 193 (92%) are enrolled in the WAP and 185 of these participants (96%) have Whole Farm Plans (WFPs). During 2016, new WFPs were developed on two large farms, one small farm and one East of Hudson (EOH) farm. In 2016, the WAP completed 64 WFP revisions and one small farm withdrew from the program.

To date, the WAP has developed 256 WFPs on large farms (185 remain active), 115 WFPs on small farms (97 remain active) and 77 WFPs on EOH farms (67 remain active). In summary, 349 of the 448 total WFPs developed to date remained active at the end of 2016. By comparison, 351 WFPs were active at the end of 2015. During 2016, six farms became inactive (three large farms, two small farms, and one EOH farm) and one inactive large farm became active. For the 351 total active WFPs at the end of 2015, the WAP conducted 324 annual status reviews (92%) during 2016, which exceeds the 90% FAD metric.

In 2016, the WAP implemented 228 BMPs on large, small and EOH farms at a total cost approaching \$1.7 million. These figures include 167 BMPs on large farms (\$1.3 million), 22 BMPs on small farms (\$0.2 million) and 39 BMPs on EOH farms (\$0.2 million). Also included was the repair or replacement of 82 BMPs on large farms and four BMPs on small farms. To date, more than 7,300 BMPs have been implemented on all watershed farms at a cost exceeding \$58.7 million; these figures include 5,435 BMPs on large farms (\$46.0 million), 1,193 BMPs on small farms (\$6.6 million), and 694 BMPs on EOH farms (\$6.1 million). In 2017, the WAP anticipates implementing approximately 200 BMPs on WOH farms (~\$2.5 million) and approximately 30 BMPs on EOH farms (~\$357,800).

During 2016, the WAP completed 60 new or updated nutrient management plans (NMPs) on active large, small and EOH farms. A total of 167 large farms are following NMPs, of which 95% are considered current (developed within the last three years). A total of 86 small farms are following NMPs, of which 88% are considered current. Also during 2016, a total of 117 farmers participated in the WAP's Nutrient Management Credit Program.

In 2016, forty-three CREP contracts (472.6 acres) expired and were re-enrolled, eighteen contracts (172.7 acres) expired and were not re-enrolled by choice of the landowners, and one contract was canceled (2.6 acres). A total of 1,824.8 acres of riparian forest buffers are currently enrolled in 182 active CREP contracts representing 145 different landowners.

The WAP conducted 28 farmer education programs in 2016 that were attended by 870 participants, of which 42% were watershed farmers, 34% were other farmers, and the rest were students, agribusinesses or agency staff. An estimated 28% of all WAP participants attended at least one farmer education program during 2016. Highlights included the Catskill Regional Agricultural Conference, Grass Finishing Beef Field Day, and several farm tours and workshops covering livestock production, forage quality, cover crops, and business planning.

The WAC Economic Viability Program continued to implement the Pure Catskills Campaign, reaching more than 55,000 people through its print guide, e-newsletters, and marketing website (purecatskills.com). In 2016, the WAC Economic Viability Program provided support to a regional food hub in Hamden (Lucky Dog Farm); coordinated and maintained the Pure Catskills Marketplace; and attended or sponsored over 15 events to promote the diversity of agricultural and wood products from the region.

Finally, 2016 marked the first full implementation year of the WAP's Precision Feed Management Program (PFM), with 21 feed management plans being completed. Throughout the year, PFM planners visited participating farms an average of once per month to assist them with developing and implementing feed management goals, strategies, and decision-making. Feed management monitoring has begun and benchmarks have been initiated to measure success.

4.5 Watershed Forestry Program

The Watershed Forestry Program is a partnership between DEP, the WAC, and the U.S. Forest Service (USFS) that supports and promotes well-managed working forests through stewardship planning and management assistance, BMP implementation, professional training for loggers and foresters, and forestry education programs for landowners and school groups. This report summarizes the 2016 accomplishments of the Watershed Forestry Program along with the Filtration Avoidance Determination (FAD) mandated evaluation of 5-year-old Watershed Agricultural Council (WAC) forest management plans.

In 2016, the WAC funded the development of 66 forest management plans representing approximately 13,388 acres, which includes approximately 10,269 forested acres and 10 riparian acres (one riparian plan). With the exception of one plan developed for a WAC agricultural easement holder, all plans completed during 2016 were either enrolled or re-enrolled in the NYS Forest Tax Law (480-a tax abatement program).

During 2016, 52 Management Assistance Program (MAP) projects were completed, including 24 timber stand improvement projects, 14 wildlife improvement projects, 12 invasive species control projects, and two tree planting/deer fencing projects. The MAP was launched in 2006 and 553 MAP projects have been completed since then, with timber stand improvement and wildlife improvement representing 76% of all completed projects to date.

In 2015, the WAC launched an interactive website called MyWoodlot.com that educates landowners through online modules and helps them create customized plans with personalized

goals and management activities based on their individual interests. Sixty-seven landowners created MyWoodlot profiles in 2016, for a total of 115 profiles to date; 39 of these profiles (34%) belong to staff, committee members and partners. The website contains 42 goals, 182 activities, 490 pieces of how-to information, and 76 blogs and feature stories available as educational content for interested landowners. Website diagnostics suggest more than 7,000 unique users visited MyWoodlot.com during 2016.

The Watershed Forestry Program continues to support the implementation of BMPs during timber harvests and the establishment of riparian buffers through the Croton Trees for Tribes Program. During 2016, the WAC funded the completion of 49 road BMP projects and 14 stream-crossing projects. The WAC also loaned out seven portable bridges, distributed 11 free BMP samples, and completed seven Croton Trees for Tribes projects. These latter projects included 220 trees and shrubs planted along 205 linear feet of streams (0.26 acres).

In collaboration with Cornell Cooperative Extension and the NYS Trained Logger Certification Program, the Watershed Forestry Program sponsored nine professional workshops during 2016 attended by 88 participants. Approximately 95 loggers working in the Catskill/Lower Hudson region remained certified during 2016.

Also during 2016, the Watershed Forestry Program conducted the Green Connections School Partnership Program, the Watershed Forestry Institute for Teachers, and the Watershed Forestry Bus Tour Grants Program. The 2015-2016 Green Connections program was completed for four partner schools (approximately 155 students), while the 2016-2017 Green Connections program was launched with eight partner schools (approximately 180 students). Twenty-six teachers attended the Watershed Forestry Institute for Teachers held at the Taconic Outdoor Education Center in Putnam County. Over 30 bus tours were conducted for about 2,000 participants (primarily New York City students), including Trout in the Classroom field trips, Green Connections field trips, Croton Trees for Tribes planting events, and educational visits to a watershed model forest. The four model forests hosted dozens of educational programs and outreach events reaching thousands of youth, landowners, and other visitors.

4.5.1 Forest Management Planning and Stewardship

In 2016, DEP and the WAC evaluated the five-year implementation status of 82 WAC plans that were completed in 2011 by 76 landowners. A total of 998 plans have been evaluated during the past 14 years. The evaluation consists of a Year-1 Survey, a Year-5 Survey, and an assessment of landowner participation in various stewardship and implementation programs.

Seventy-one percent of the plans completed in 2011 were in Delaware County, 11% were in Ulster, and the remaining 15 plans were in Greene, Sullivan, Westchester, and Fairfield, CT. For the 998 plans evaluated to date, 62% were in Delaware County, 14% were in Greene, and less than 10% each were in other watershed counties.

Seventy-eight percent of the plans completed during 2011 contained some type of silvicultural prescription in their 15-year work schedules, with commercial thinning and timber stand improvement (TSI) representing the most common prescriptions. Approximately 82% of all plans had a stream on the property, of which an estimated 58% recommended a new crossing to accommodate future timber harvest (portable bridges comprised 64% of the recommended stream crossings). Approximately 93% of the plans had an existing forest road on the property, of which an estimated 24% were characterized as eroding or needing BMPs. Approximately 50% of the plans recommended new roads be installed during future timber harvests. All of these statistics are consistent with the cumulative results from prior year evaluations.

Thirty Year-1 Surveys were returned by landowners in 2011; this represents a 37% response rate based on 82 plans. For the 998 plans evaluated to date, the cumulative response rate is 45% (451 returned surveys). All respondents indicated their satisfaction with their plans and 97% felt having a plan would improve their stewardship. All respondents indicated they would retain the services of their forester, 87% indicated they would use a certified logger for a future timber sale, and 43% indicated their intent to enroll in the 480-a tax abatement program. Sixty percent of respondents expressed interest in other forestry programs, primarily education workshops (66%) and road/trail improvements (56%).

Forty-two Year-5 surveys were returned in 2016; a 51% response rate based on 82 plans. Ninety-three percent of respondents still own their property, of which 74% indicated they consulted their plans; 79% felt their stewardship had improved; 54% percent retained their foresters; 30% participated in workshops or events; and 56% said they enrolled in the 480-a program. For those respondents who indicated they conducted a timber sale during the past five years, 73% said they hired a professional forester or certified logger. All of these statistics are consistent with the cumulative results from prior year evaluations.

Finally, the 76 landowners who completed the 82 WAC plans in 2011 participated in various land stewardship or conservation programs. At least 31 landowners enrolled all or part of their properties in the 480-a program. Thirty-six landowners updated their plans since 2011 while four updates are in process. Sixteen landowners were approved for 22 road BMP projects, of which 20 were completed and two remain active. Twenty-one landowners were approved for 46 MAP projects, of which 42 were completed and four remain active. Two landowners sold 434 acres to DEP in fee simple, five landowners enrolled 839 acres in a DEP conservation easement, 12 landowners enrolled 2,558 acres in a WAC easement, and another landowner is pending enrollment of 212 acres in a WAC easement.

4.6 Stream Management Program

The goal of the Stream Management Program (SMP) is to restore and protect stream system stability and ecological integrity by facilitating the long-term stewardship of watershed streams and floodplains. In 2016, the SMP completed projects once postponed due to floods while designing and constructing new projects targeting water quality and local problems;

assessed and monitored past stream projects; provided technical assistance to communities and an array of education and training opportunities; and advanced technical knowledge through stream feature inventories, bank erosion hazard indices, reference reach surveys, bankfull discharge calibration surveys, and suspended sediment source distribution studies.

4.6.1 Stream Management Plans and their Implementation

In 2016, the SMP partners continued implementation of stream management plans through the Stream Management Implementation Program (SMIP), the Catskill Streams Buffer Initiative (CSBI), and the Flood Hazard Mitigation Program (FHMP). Throughout the year, DEP and its SMP partners continued to meet with advisory councils and working groups to remain responsive to local concerns and prioritize projects for SMIP funding. Table 4.4 summarizes the total number of SMIP awards funded in 2016 as well as to date (since 2009). For the 191 SMIP grants awarded to date, 128 have been completed, 44 are in process, and 19 are at the design stage. Basin-specific accomplishments are reported below, and more detailed information can be found at catskillstreams.org. A summary of CSBI projects are reported in Section 4.7.

Table 4.4 Number of SMIP awards by category for 2016 and totals to date (2009-2016).

SMIP Category	2016	Total
Education and Outreach	7	47
Recreation and Habitat Improvements	1	14
Stormwater and Critical Area Seeding	1	7
Highway/Infrastructure	9	39
Landowner Assistance/Streambank Restoration	1	29
Planning and Research	6	30
Flood Hazard Mitigation	6	25
Total	31	191

Ashokan Basin

Through DEP’s partnership with Cornell Cooperative Extension (CCE) of Ulster County and the Ulster County Soil and Water Conservation District, the Ashokan Watershed Stream Management Program (AWSMP) advanced numerous projects in 2016, including the monitoring of seven stream restoration projects, the development of a stream management plan for Woodland Creek, and a stream feature inventory and bank erosion assessment study on Maltby Hollow. The AWSMP website (ashokanstreams.org) continues to be an excellent portal for accessing stream management news and publications, upcoming event announcements, and synopses of past events.

In 2016, the bi-annual Catskill Environmental Research and Monitoring Conference was held with over 160 people in attendance. The keynote address was provided by Joshua Ginsberg of the Cary Institute of Ecosystem Studies, titled “Inside the Blue Line: Looking at the Catskills as a 136-Year Experiment in Natural Recovery.”

Eight new SMIP awards were announced in 2016 totaling \$395,502, with the research awards reflecting the priority topics identified by the Ashokan Stream Access & Recreation Working Group. Also in 2016, the AWSMP completed Local Flood Analysis (LFA) projects for Phoenicia and Mount Tremper, while advancing LFAs for Boiceville and West Shokan to the draft report stage. DEP and its local SMP partners support LFA efforts through participation in the Flood Hazard Mitigation Working Group, the Shandaken Area Flood Assessment and Remediation Initiative (SAFARI), and the Olive Flood Advisory Committee.

Delaware Basin

In partnership with the Delaware County Planning Department and DEP, the Delaware County Soil and Water Conservation District (DCSWCD) continued to advance stream restoration, riparian buffer, and flood hazard mitigation efforts in 2016 as recommended in the Action Plan for the East and West Branches of the Delaware River. Priority in 2016 was placed on SMIP and restoration project design and construction, with the DCSWCD hiring three engineering consultants to support future projects. A SMIP grant was awarded to the Water Street Floodplain Restoration Project in the Village of Walton as recommended by the LFA.

Also in 2016, the Fleischmanns-Clovesville LFA was completed and adopted by the Village of Fleischmanns. A draft Arkville LFA was also completed and should be finalized and ready for acceptance by the town in 2017. Meetings of the Walton Flood Commission continued to advance the Walton Tributaries LFA for East Brook, West Brook, and Third Brook. The Town and Village of Walton were approved by the FEMA Community Rating System (CRS), while flood commissions and advisory groups in Delhi, Hamden, and Andes continued to advance their LFAs. For these communities, consultants modeled potential floodwater elevation reduction alternatives and evaluated possible flood hazard mitigation strategies.

Rondout and Neversink Basins

In 2016, the Rondout Neversink Stream Program (RNSP), led by Sullivan County Soil and Water Conservation District, approved eight SMIP awards totaling \$500,841, including the assessment and design of sediment and flow transport capacity at culverts that are potentially hydraulic constrictions. A new research category for SMIP was launched in 2016, with priorities identified by a committee of regional scientific advisors. The RNSP also coordinated the third annual Angler's Symposium and launched the annual "Stream Shorts" film series.

Also in 2016, the RNSP completed the LFA for Sundown (Rondout Creek) and four smaller flood hazard mitigation projects identified in the Claryville LFA. The RNSP executed two engineering design and two surveying requirements contracts to support the development of stream restoration projects. Through these contracts, design began on three high priority hillslope stabilizations that are contributing significant fine and coarse sediment. The RNSP also confirmed its restoration site prioritization with additional field analyses and continued the validation of reference reach sites to inform natural channel geomorphic designs.

Schoharie Basin

In 2016, the Greene County Soil and Water Conservation District (GCSWCD) and the Schoharie Watershed Advisory Committee moved ahead with an array of stream management plan recommendations, including the funding of 11 new SMIP proposals at a cost of \$356,908; the completion of four CSBI projects and three stream feature inventories; annual monitoring on nine former stream restoration projects; and, through the roadway seeding program, the seeding and mulching of 21.5 acres. Five Local Flood Analyses (LFAs) were launched in the towns of Ashland, Conesville and Hunter, and the villages of Tannersville and Hunter.

Working with DEP, the GCSWCD completed the following SMIP projects that were awarded prior to 2016: Conine Park Enhancements (Prattsville), South Gilboa Road Culvert Replacement (Gilboa), Schoharie Streambank Stabilization and Riparian Planting at Kozak (Jewett), Schoharie Watershed Stream Crossing Workshop, Cranberry Road Culvert Upgrade (Hunter), Schoharie Watershed Stream Crossing/Culvert Design, and the Town of Hunter Land Use Regulation Review and Development Guidelines.

Also during 2016, the GCSWCD hosted its 10th annual Schoharie Watershed Summit, “Streams to Tunnel: Watershed Management in the Schoharie Basin,” attended by more than 100 people. The eighth annual Schoharie Watershed Month included nine events attended by 231 residents. Events included a student/amateur art exhibit, screening of the “RiverWebs” film, a Schoharie Reservoir bus tour, a volunteer riparian planting, a student trout release, a local stewardship lecture series, an Upper Schoharie guided walk, and the “Rejuvenary River Circus” performed by the Arm-of-the-Sea Theater.

4.6.2 Flood Hazard Mitigation Program

Prior to Tropical Storm Irene, the SMP’s primary flood mitigation emphasis was to address riverine erosion that threatened infrastructure and undermined hillslopes. The new Local Flood Hazard Mitigation Program (LFHMP) addresses both inundation and erosion hazards, thereby offering communities the tools they need, together with state and federal resources, to improve resilience and sustainability in a changing climate. The LFA process helps to identify and recommend flood hazard mitigation projects, which can be eligible for SMIP funding or the CWC’s Flood Hazard Mitigation Implementation Program (FHMIP).

Throughout 2016, DEP and its partners continued to work with communities and their consultants through the LFA process. These municipally based LFAs recommend mitigation options including modifying floodplains; treating hydraulic constrictions at bridges; relocating residential, business, and critical facilities; and elevating or flood-proofing structures. In 2016, LFAs were completed in four municipalities, substantially advanced in seven municipalities, and initiated in five municipalities. Figure 4.15 depicts the locations and status of LFAs in watershed communities. To date, eight completed LFAs have been accepted by municipalities. DEP and its SMP partners have committed over \$1.3 million in SMIP funding and hundreds of staff hours to support this effort. Copies of completed LFAs are available at catskillstreams.org.

Some communities with completed LFAs have begun to seek funding through the CWC FHMIP to implement their recommendations. In 2016, the CWC received applications to purchase properties for the relocation of a lumberyard in Windham and the town hall and highway garage in the Town of Shandaken. Additionally, the CWC funded a feasibility study for relocating a business on Main Street in Phoenicia while the Village of Walton advanced a feasibility study for the relocation of utilities on Water Street. DEP amended its contract with the CWC to allow FHMIP funds to be used to secure oil and propane tanks in floodplain areas in all West of Hudson municipalities without the requirement for completing an LFA. The CWC has committed or spent \$414,084 on five projects to date.

During 2016, the SMP continued to provide technical support and coordination for the New York City-Funded Flood Buyout Program (NYCFFBO), which is reported in Section 4.2. The SMP contributed to the preparation of program guidance documents and the development of template contracts for sale and conservation easements, in addition to working with municipal flood commissions, county agencies, and the CWC on various activities.

4.6.3 Stream Studies

In 2016, the SMP launched a coordinated Stream Studies Program to provide scientific support to stream management implementation. The first three projects include: (1) revising the Catskill Mountain Regional Bankfull Discharge and Hydraulic Geometry Regression Relationships (“Catskill Mountain Regional Curves”); (2) starting the Esopus Creek watershed

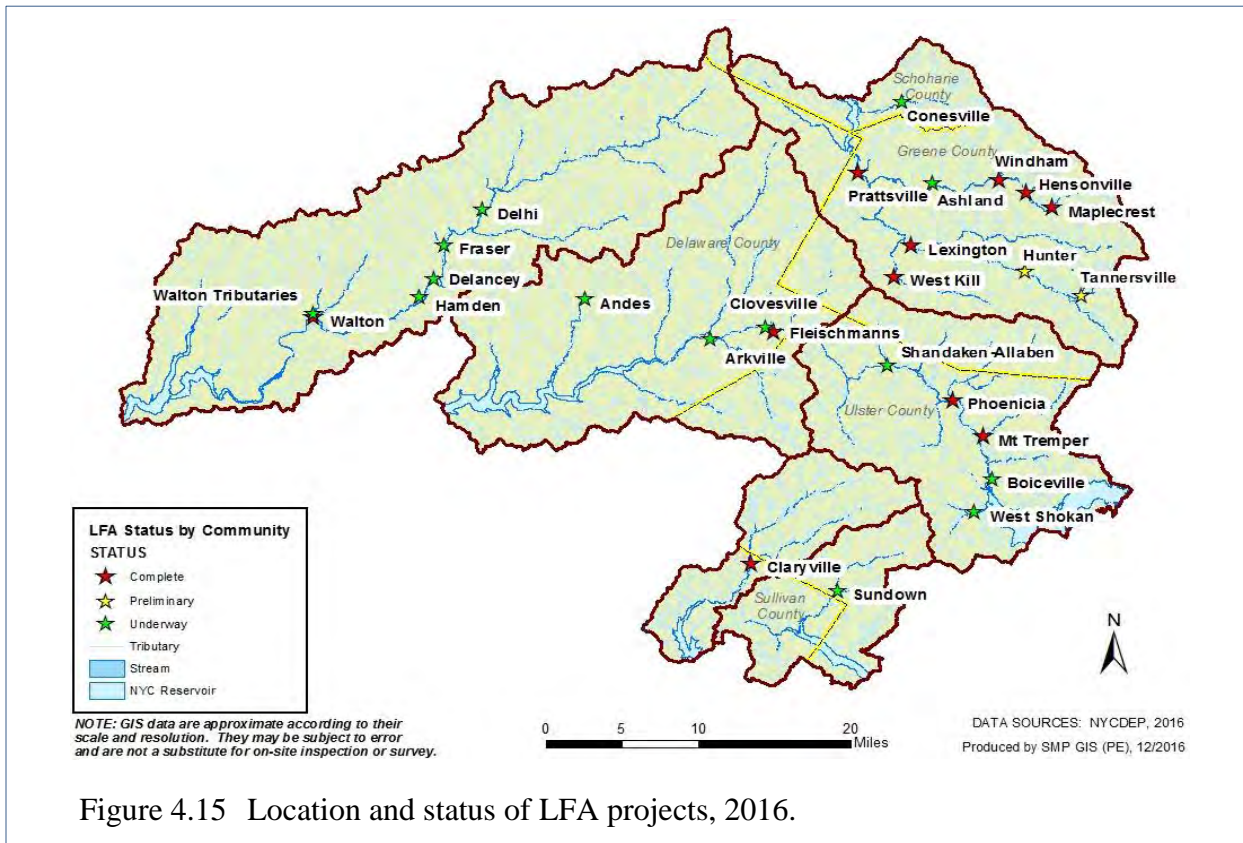


Figure 4.15 Location and status of LFA projects, 2016.

and Stony Clove Creek watershed turbidity/suspended sediment monitoring studies (“Turbidity/Suspended Sediment Studies”); and (3) advancing the Geomorphic Reference Reach Study.

In 2016, the Catskill Mountain Regional Curves were updated with six new USGS stream gage study reaches ranging in drainage area from 5 to 97 square miles. An additional study reach that was surveyed in 2005 as a validation data set was also incorporated, bringing the total number of study reaches to 25.

The 10-year Turbidity/Suspended Sediment Studies officially started in 2016 with the installation of monitoring stations in the Esopus Creek and Stony Clove watersheds; these stations include two types: Primary (to compute suspended sediment load and “turbidity load”) and Secondary (to monitor turbidity). Eight Primary and two Secondary monitoring sites are now installed in the Esopus Creek to monitor trends from the main tributary streams and Esopus Creek. Six Primary and 14 Secondary monitoring sites are now installed in the Stony Clove and will be used to evaluate hydrologic and geomorphic conditions influencing suspended sediment and turbidity, and to evaluate stream restoration projects. The full Study Design Report is available on the DEP website.

In 2016, DEP resumed a previous effort to develop a database of fluvial geomorphic reference reach data intended for use in applying Natural Channel Design methods to stream restoration projects. This project uses a multi-phase protocol starting with GIS-based assessment to identify candidate sites, field reconnaissance to further screen candidate sites, field surveys for selected sites and repeat surveys to validate selected sites. Six candidate sites were evaluated in the field, two were surveyed, and a validation survey was completed for a previous site.

4.6.4 Stream Projects

In 2016, the SMP completed a total of 11 projects, treating 1.2 miles of stream length at a total cost of \$3,845,397; this includes a DEP investment of \$2,829,578. Table 4.5 depicts the basin, project type and length of each 2016 project. To date, the SMP has treated 39.8 miles of stream length, including CSBI projects. Figure 4.16 depicts the geographic locations of the projects. The two water quality driven FAD projects completed in 2016 are reported below. Additional details and photographs are available at catskillstreams.org.

Table 4.5 Summary of SMP projects completed in 2016.

Basin	Type of Project	Name of Project	Length (ft.)
Ashokan	Streambank Stabilization	Stony Clove at Wright Road - Hillslope	650
	Stormwater/Infrastructure	Mine Hollow Culvert	50
Delaware	Full Channel Restoration	W. Branch Delaware – More Project	1,500
	Recreation	Boat Launch at Hamden Covered Bridge	100
	Recreation	Walton Boat Launch	100
	Full Channel Restoration	Boyds CREP	1,250
	Streambank Stabilization	Palmatier CREP	120
Schoharie	Streambank Stabilization	Schoharie Creek – Kozak (incl. planting)	1,500
	Stormwater/Infrastructure	South Gilboa Culvert	280
	Stormwater/Infrastructure	Cranberry Road Culvert	150
	Full Channel Restoration	Batavia Kill – Big Hollow Repair	600

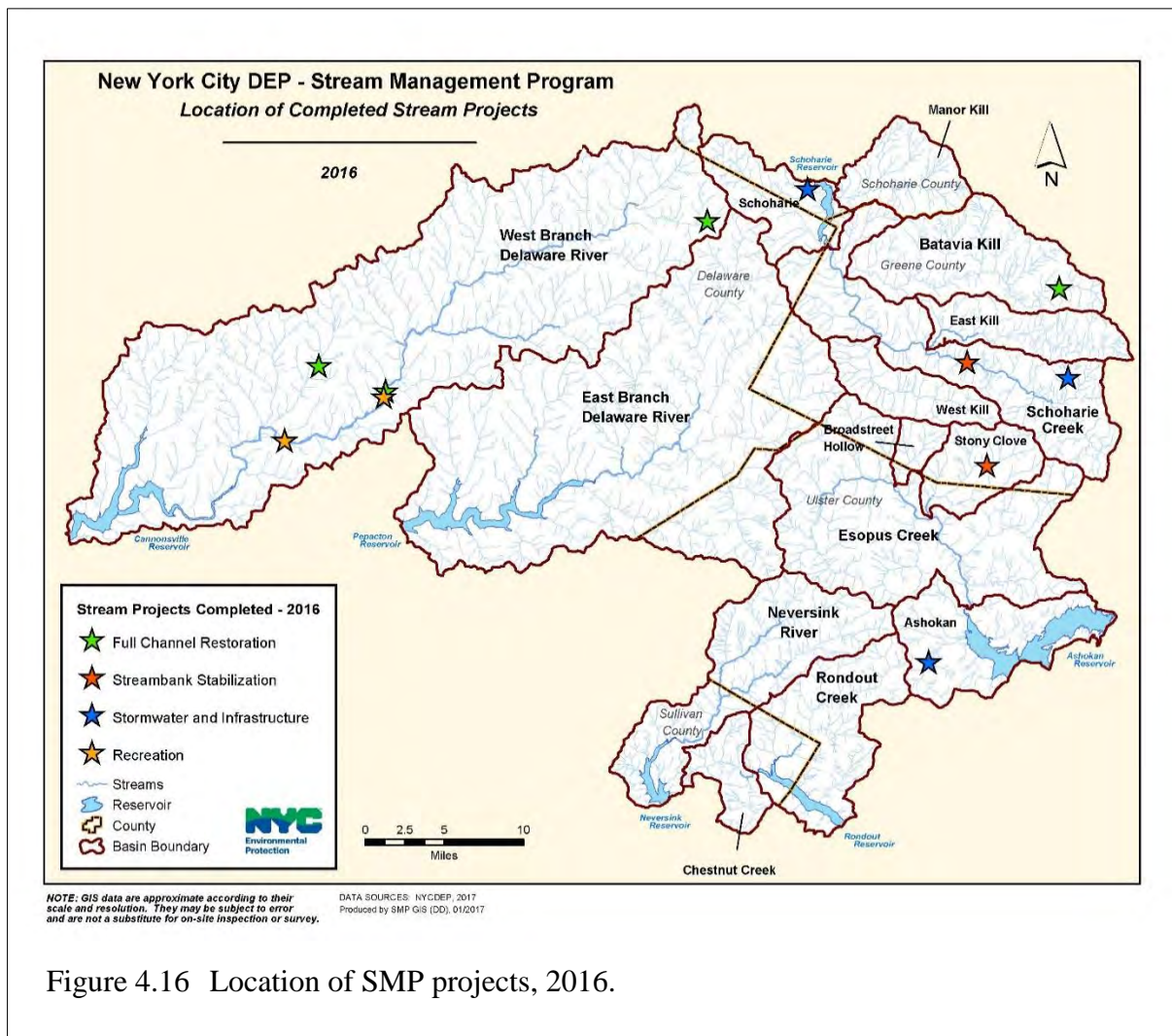


Figure 4.16 Location of SMP projects, 2016.

Wright Road Hillslope Stabilization Project

This project focused on stabilizing a hillslope along the Stony Clove Creek in the Town of Hunter, adjacent to the Wright Road Stream Project constructed in 2015. The toe of this massive slope failure was armored as part of the previous channel restoration work, but because the hillslope continued to slide and contribute fine sediment to the stream, a geotechnical



Figure 4.17 Wright Road hillslope before construction.



Figure 4.18 Wright Road site after construction.

assessment was conducted to determine and monitor the failure mechanism. The project included the installation of a drainage network to capture and redirect groundwater, along with extensive debris clearing and regrading of steep areas. The project was completed in partnership with the USDA Emergency Watershed Protection Program at a total cost of \$1,221,771, with DEP contributing \$305,442. Figure 4.17 and 4.18 depict conditions before and after construction at the Wright Road site.

West Branch Delaware River Restoration Project at the More Property

Located in the Town of Hamden, this project site was identified in the West Branch Delaware River Stream Management Plan as lacking adequate riparian buffer that posed a threat to streambank stability and water quality. Significant previous storm events had contributed to an over-widened channel condition that induced gravel deposition within the reach and exacerbated down-valley meander migration. Eroding streambanks on both sides of the channel resulted in sediment and nutrient loading into the river system. Project goals included eliminating additional soil loss of the eroding farm field; creating a stable channel alignment and geometry for adequate sediment transport; and installing a riparian buffer for channel stability and improved water quality. Channel restoration included the installation of streambank boulder revetment covered with topsoil and interplanted with live willow and dogwood stakes. A constructed riffle was installed to provide stream bed grade control, and boulder deflector vanes were also installed for additional streambank protection. Bioengineering treatments consisting of willow brush matting, willow fascines, and sod mats were also installed along the streambank, followed by the planting of 1,250 native trees and shrubs along the floodplains to establish a healthy riparian buffer for long-term water quality protection. The total construction cost for the project was \$1,295,897. Figure 4.19 and Figure 4.20 show the More property prior to and after construction.



Figure 4.19 More property before construction.



Figure 4.20 More property after construction.

4.7 Riparian Buffer Protection Program

DEP values the importance of riparian buffers as a critical component of its Long-Term Watershed Protection Strategy. Privately owned lands contain approximately 66% of the total riparian buffer acreage in the Catskill/Delaware watershed. Many of these riparian buffers are protected to some degree by various watershed programs and partnerships. For instance, hundreds of Whole Farm Plans and Watershed Forest Management Plans have been implemented throughout the watershed, while the Conservation Reserve Enhancement Program (CREP) has enrolled more than 1,800 acres of buffers in federal contracts. Further information on these programs can be found in Sections 4.4 and 4.5. This section will highlight the protection of riparian buffers on publicly-owned or controlled lands, while describing the progress of the Catskill Streams Buffer Initiative (CSBI).

4.7.1 Activities on City-owned or Controlled Land

LAP considers 300-foot boundaries on either side of a watercourse as important buffers to protect, and these areas are deemed a principal eligibility requirement under the “natural features criteria” set forth in the MOA. Through 2016, 39.9% of the entire Cat/Del watershed was protected by public ownership or conservation easements held by DEP, WAC, NYSDEC, or other entities such as municipalities and land trusts. This area includes roughly 87,175 acres of all stream buffers in the Cat/Del watershed. Since 2004, DEP has increased the percentage of protected stream buffers from 7.5% to 16.8%. Through the LAP, DEP also funds the pilot Riparian Buffer Acquisition Program, renamed the Streamside Acquisition Program, which is described in Section 4.2.

DEP carefully considers the presence or absence of riparian buffers when it reviews requests from outside parties or makes determinations about projects on City-owned lands. For example, when allowing agricultural use of City-owned lands, DEP requires a minimum of a 25-foot buffer between farming activities and the stream. Proposals planning to maintain a buffer greater than 25 feet receive 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. Where needed, DEP provides suggestions on how to avoid or mitigate these impacts. DEP secures stream crossing permits as required by the NYSDEC and takes extra measures during forestry operations to select best management practices, such as temporary bridges or arch culverts, to minimize impacts on the stream and floodplain.

4.7.2 Catskill Stream Buffer Initiative

The CSBI is an integral component of DEP’s SMP and a cornerstone of the City’s efforts to protect and enhance riparian buffers. Where gaps in the landscape are evident, the CSBI works to enhance the extent of riparian buffers through vegetation mapping, riparian corridor planning, buffer restoration, invasive plant removal, and extensive education and outreach. For example, the 2016 annual meeting of the interagency Riparian Buffer Working Group focused on understanding forest health issues impacting riparian buffer establishment and future conditions.

Plantings are an essential ingredient of natural stream bank stability and providing Catskill native plant material continues to be one of the unique aspects of the CSBI. To provide native plant materials, careful consideration must be given to plant selection, propagation, and grow-out techniques. These efforts have led to local genotype planting stock available not only to the CSBI but also to other stream restoration projects initiated by DEP and its partners. The supply of Catskill native plants is made possible through contracts with the Greenbelt Native Plant Nursery and One Nature, LLC. Seeds from native Catskill plants are collected, cleaned, and propagated at Greenbelt and then grown to gallon-sized trees and shrubs at One Nature. In 2016, DEP and its partners received 5,000 gallon-sized trees and shrubs. To date, over 49,500 gallon-sized trees and shrubs from locally collected seed have been provided. Due to low survivorship, the CSBI no longer produces herbaceous plugs or tree/shrub tubelings.

DEP works with five local coordinators at county SWCDs to support and implement the CSBI throughout the WOH watershed. As a first step, the CSBI coordinators develop Riparian Corridor Management Plans (RCMPs) for interested landowners, which guide project design and educate landowners on the importance of their riparian buffer. Since 2009, 124 RCMPs have been completed, including 13 written in 2016. Four of these RCMPs will guide future riparian buffer restoration projects.

In 2016, the CSBI successfully completed 19 riparian buffer restoration projects on 9.5 acres over 1.77 miles of stream length, as summarized in Table 4.6. These projects installed 3,295 native Catskill plants and over 2,000 linear feet of bioengineering treatments consisting of

native willow species mostly harvested from within the watershed. To date, the CSBI has completed 187 projects spanning 104 acres and over 16.5 miles of stream length (Figure 4.21); these projects installed nearly 138,500 plants (including 49,000 trees and shrubs, 72,000 plugs, and 17,500 tubelings), all species native to the Catskill region. In 2016, planting activities also took place on five non-CSBI stream restoration projects, enhancing riparian vegetation with 5,415 trees and shrubs, 10,207 live stakes, and roughly 3,900 feet of bioengineering treatments.

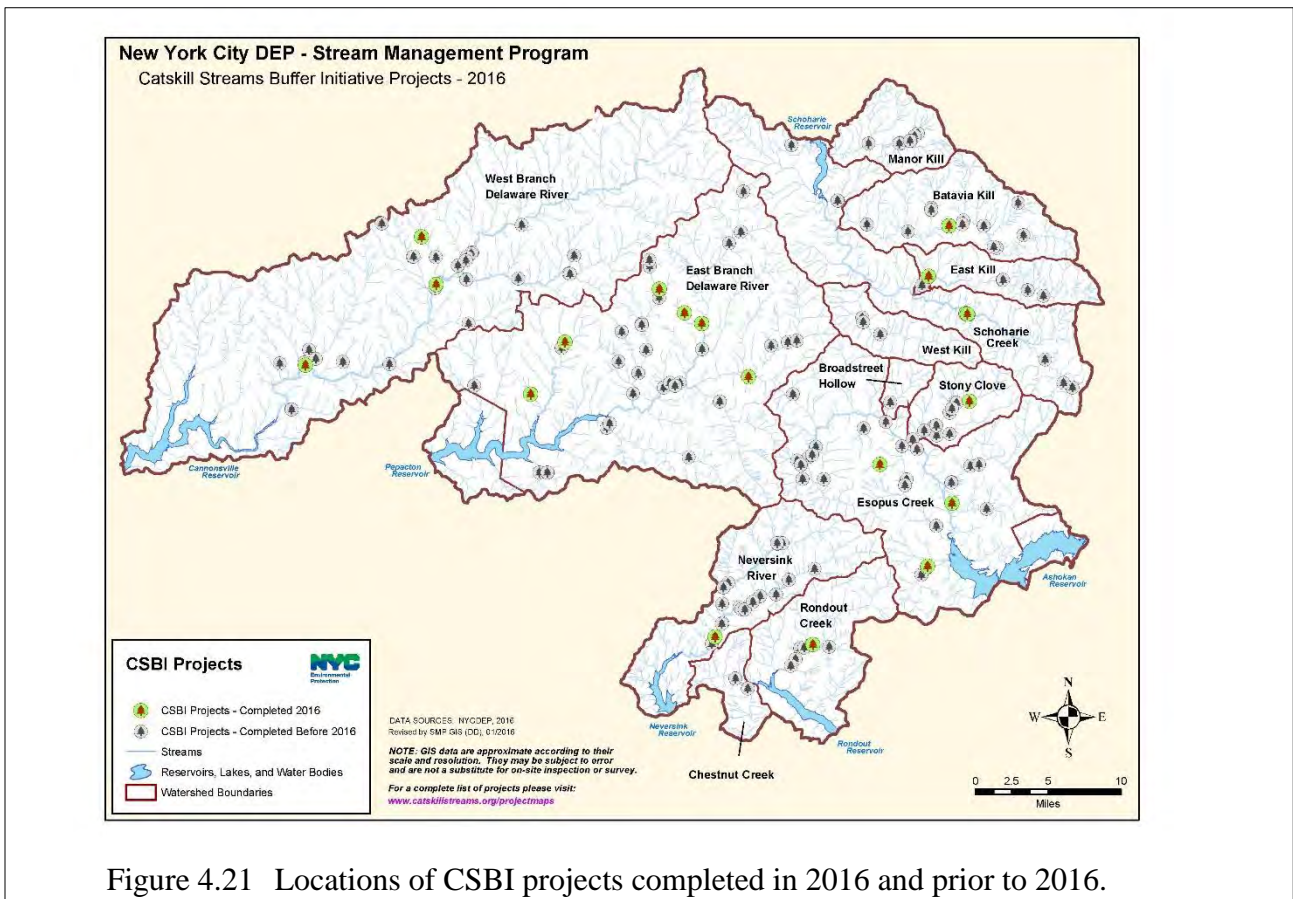


Figure 4.21 Locations of CSBI projects completed in 2016 and prior to 2016.

Table 4.6 CSBI restoration projects, 2016.

Project name	County	Basin	Linear feet	Area (acres)
South Street Planting	Greene	Schoharie	640	1.31
Posch Planting	Greene	Schoharie	300	0.34
Sawicki Planting	Greene	Schoharie	120	0.10
Deming Road Planting	Greene	Schoharie	675	1.94
Schoenburg Bioengineering Project	Sullivan	Neversink	480	0.88
Capawana	Sullivan	Rondout	622	0.10
Catskill Interpretive Center Buffer Demo	Ulster	Ashokan	188	0.20
Moran Bioengineering Project	Ulster	Ashokan	620	0.79
Menla Mountain Retreat	Ulster	Ashokan	290	0.96
Wright Road	Greene	Ashokan	360	0.62
Depot Street Planting/Knotweed Control	Delaware	Pepacton	130	0.25
Oliver Farm Restoration	Delaware	Cannonsville	1,250	1.30
Bussey Hollow Knotweed Control	Delaware	Pepacton	335	0.12
Mead Road Knotweed Control	Delaware	Pepacton	560	0.16
Bragg Hollow Knotweed Control	Delaware	Pepacton	100	0.03
Kelly's Kayak Knotweed Control	Delaware	Pepacton	370	0.07
Ballantine Park	Delaware	Pepacton	1,915	0.22
Camp Shankitunk Camper Planting	Delaware	Cannonsville	300	0.03
Walton Green Space Volunteer Planting	Delaware	Cannonsville	100	0.10
Total			9,355	9.50

Of the 19 CSBI projects installed in 2016, two projects (Moran and Schoenburg) involved extensive bioengineering design and installation processes that provided skill-building

opportunities for treating a wider range of future bank issues. For example, the Schoenburg project in the Neversink basin (Figure 4.22) treated the eroding bank by stabilizing a graded slope with root wad revetment (Figure 4.23), together with willow fascines and stakes (Figure 4.24).



Figure 4.22 Eroding streambank before bioengineering treatment.



Figure 4.23 Installing root wad revetment.

In 2016, the Ashokan CSBI team partnered with NYSDEC to install a model riparian buffer as an educational tool at the Catskill Interpretive Center in Mount Tremper. The Delaware CSBI team dedicated a significant effort to Japanese knotweed mitigation, while the Schoharie CSBI team collaborated with Riverkeeper and the Student Conservation Association to organize volunteer planting events.

In addition to installing plants, the CSBI also removes significant stands of invasive plants that threaten the viability of riparian plantings. Of the 18 buffer restoration projects planned and implemented in 2016, six were focused solely on invasive removal. In addition, three CSBI projects initiated in past years were revisited in 2016 to continue multi-year Japanese knotweed mitigation efforts. Removal techniques include stem injection and foliar application of herbicides, as well as hand or mechanical pulling.

Following installation, CSBI projects are monitored at regular intervals for a goal of five years using a protocol developed specifically to document the survival and growth rates of individual plant species, assess the effectiveness of installation techniques, and to understand factors having the greatest influence on project success. Seventy-



Figure 4.24 Stabilized streambank after bioengineering treatment.

one sites were monitored in 2016, of which 14 sites were monitored for the first time. There are currently 114 active CSBI vegetation monitoring sites. Through partnerships with Ulster County Community College and the State University of New York, summer interns assist CSBI coordinators in monitoring plantings and managing plant materials.

4.8 Wetlands Protection Program

Wetlands provide many functions that help maintain the high quality of surface waters in the watershed. They detain storm and flood flows, prevent erosion, ameliorate nutrients and pollutants, sequester carbon, and support high biodiversity and productivity. Through mapping and monitoring, DEP’s Wetlands Program characterizes the distribution, conditions, and functions of these important ecosystems to support their protection and management. DEP protects wetlands through regulatory means, including the Watershed Rules and Regulations, along with its review of federal, state, and municipal wetland permit applications in the watershed. DEP also protects wetlands through voluntary initiatives such as the watershed agricultural, forestry, and land acquisition programs. Finally, DEP employs conservation practices to ensure management of its own lands is conducted in a manner that is protective of wetlands.

4.8.1 Permit Review

DEP receives notification of all major and a subset of minor Article 24 wetland permit applications in the watershed as agreed upon in Addendum A of the 1993 MOU between DEC and DEP. DEP also receives notification of 404 permit applications in the watershed, as well as all wetland permit applications from Connecticut towns in the watershed. A subset of towns within the EOH watershed forward their wetland permit applications for DEP’s review. DEP reviews all these submittals and provides comments when alternatives to avoid, minimize, or mitigate wetland and water quality impacts are identified. Project plans are often modified in response to DEP’s comments, resulting in less wetland and/or adjacent area impacts than originally proposed.

In 2016, DEP reviewed 27 wetland permit applications, all of which were located in the EOH watersheds, with three in Cat/Del basins (Kensico and West Branch). Fourteen 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 within 100 feet of such wetlands. Eight municipal and five federal (those applications filed under Section 404 of the Clean Water Act, P.L. 92-500, as amended by P.L. 95-217) wetland applications were also reviewed. Note that two activities were reviewed under both federal and State jurisdictions (Table 4.7, Figure 4.25).

Protection and Remediation Programs

Table 4.7 Wetland permits reviewed in 2016.

Crossroads at Baldwin Place	NYSDEC	Amawalk	AA disturbance
Mancini Building Corp	NYSDEC	Amawalk	AA disturbance
Atlantic Bridge Project	NYSDEC	Amawalk, Muscoot, New Croton	Temporary wetland, AA disturbance
Greenbriar Sec.6 Lots 35 and 36	NYSDEC	Croton Falls	Wetland (0.009 ac), AA disturbance
Meadowland Extension	NYSDEC	Croton Falls	AA disturbance
D'Agostino Property-Pietsch Gardens	Town	East Branch	AA disturbance
Metro North Harlem Line Bridge Replacement	USACE	East Branch	Temporary wetland disturbance
Pietsch Garden Cooperative	Town	East Branch	AA disturbance
Zakerin Property	Town	East Branch	AA disturbance
32 Bedford Road	Town	Kensico	Wetland, AA disturbance for restoration
Lowenstein Property	NYSDEC	Kensico	Wetland (pond dredging), AA disturbance
Lake Dutchess	USACE	Middle Branch	Aquatic nuisance species management
Matfus Property	NYSDEC	Muscoot	Wetland (0.01 ac), AA disturbance
131 Fields Lane	NYSDEC	Muscoot	AA disturbance
Glickenhau	USACE	Muscoot	AA disturbance
Goldens Bridge Community Associate Inc.	USACE	Muscoot	Lake disturbance (dredging)
Yasgur Residence	NYSDEC	Muscoot	AA disturbance
Deutsch Property	NYSDEC	New Croton	AA disturbance
Leonard Park Stormwater Retrofit	NYSDEC	New Croton	AA, WOTUS disturbance (0.07 ac)
Lieto Drive Project	USACE	New Croton	Wetland (invasive species removal), AA disturbance
14 Twopence Road	NYSDEC	New Croton	Wetland (invasive species removal), AA disturbance
14 Twopence Road	Town	Titicus	Watercourse, AA disturbance
43 June Road	Town	Titicus	AA disturbance
Baxter Road LLC Foxy Meadow Farm	Town	Titicus	AA disturbance
Strutt Residence	Town	Titicus	Wetland (0.09 ac), AA disturbance
Pine Pond	NYSDEC	West Branch	Aquatic nuisance species management

Twelve (48%) of the activities reviewed were for disturbance only within the adjacent area, with another 32% for temporary impacts for actions such as aquatic nuisance species management, pond dredging, and restoration. Three of the permit applications (12%) were for permanent encroachments, all of which were less than 0.1 acre. For the applications reviewed, wetland encroachments were minimal in 2016 and DEP focused its comments to ensure best

management practices for erosion and sediment control were followed and proposed wetland and buffer mitigation was appropriate.

DEP reviewed and provided comments on the U.S. Army Corps of Engineers' proposal to reissue and modify Nationwide Permits, which are set to expire in March 2017. These comments were included in an August 2016 letter to the U.S. Army Corps of Engineers, which supported maintaining current disturbance thresholds, requested interagency coordination for proposals in the City's watershed through the preconstruction notification process, and suggested language to increase clarity and consistency for applicants.

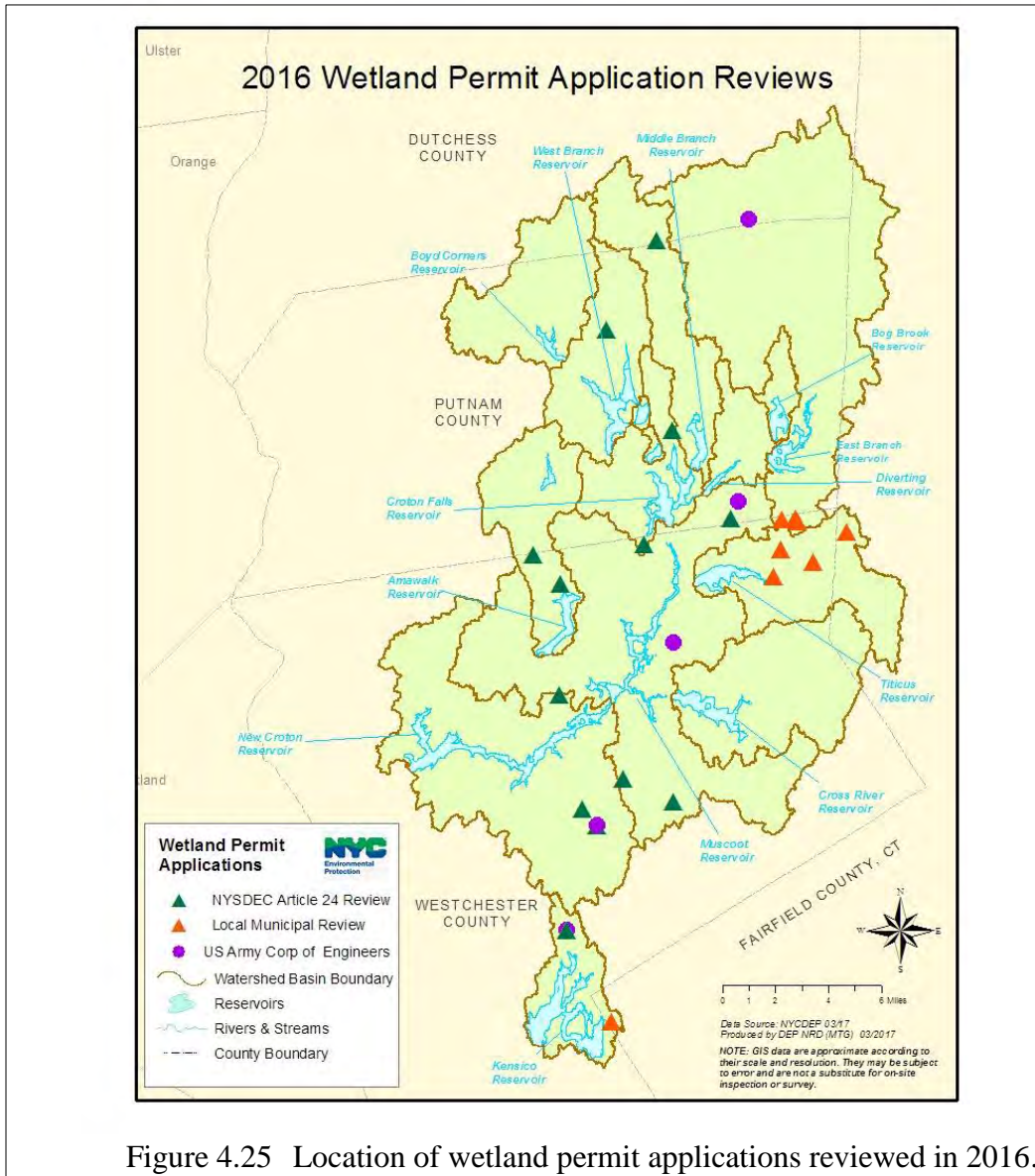


Figure 4.25 Location of wetland permit applications reviewed in 2016.

4.8.2 Land Acquisition

According to the National Wetlands Inventory (NWI) and NYSDEC Freshwater Wetland maps, there are approximately 15,190 acres of wetlands in the Cat/Del watershed. Since 1997, DEP has protected 2,776 acres or 18.2% of these wetlands through its Land Acquisition Program. This includes 36 acres of wetlands acquired in 2016. (See Section 4.2 for details of the Land Acquisition Program). Additionally, pre-MOA DEP lands contain an additional 973 acres (6.4%) of wetlands, with an additional 1,266 acres (8.3%) of wetlands located on state or other protected lands. This amounts to roughly 33% of wetlands in the Catskill/Delaware watershed being located on protected lands. Table 4.8 summarizes the number and acreage of wetlands protected through acquisition for both the Catskill/Delaware and Croton watersheds.

Table 4.8 Wetlands acquired or protected by NYC Land Acquisition Program in the Catskill/Delaware and Croton systems as of December 31, 2016.

<i>Description</i>	<i>Acres</i>	<i>% of Total Watershed Acreage</i>	<i>% of Total Land Acquired</i>	<i>% of Total Wetlands or Deepwater Habitats in System</i>
Catskill/Delaware:				
Total Acreage of Entire Watershed	1,048,660			
Total Acreage of Wetlands (both NWI and DEC-regulated) in Entire Watershed (excluding Deepwater Habitats**)	15,190	1.45%		
Total Acreage of Deepwater Habitats in Entire Watershed	28,335	2.70%		
Total Acreage of Wetlands and Deepwater Habitats in Entire Watershed	43,526	4.15%		
Total Lands Under Contract or Closed by NYCDEP as of 12/31/16†*:	139,279	13.28%		
<i>Within those total lands under contract or closed:</i>				
Total Acreage of Wetlands (both NWI and DEC-regulated, excluding Deepwater Habitats**)	2,766		1.99%	18.21%
Total Acreage of Deepwater Habitats**	186		0.13%	0.66%
Total Acreage of Wetlands and Deepwater Habitats**	2,952		2.12%	6.78%
For Croton:				
Total Acreage of Entire Watershed	212,700			

<i>Description</i>	<i>Acres</i>	<i>% of Total Watershed Acreage</i>	<i>% of Total Land Acquired</i>	<i>% of Total Wetlands or Deepwater Habitats in System</i>
Total Acreage of Wetlands (both NWI and DEC-regulated) in Entire Watershed (excluding Deepwater Habitats**)	20,025	9.41%		
Total Acreage of Deepwater Habitats in Entire Watershed	10,808	5.08%		
Total Acreage of Wetlands and Deepwater Habitats in Entire Watershed	30,834	14.50%		
Total lands under contract or closed by NYCDEP as of 12/31/16†*:	1,984	0.93%		
<i>Within those total lands under contract or closed:</i>				
Total Acreage of Wetlands (both NWI and DEC-regulated, excluding Deepwater Habitats**)	97.1		4.89%	0.48%
Total Acreage of Deepwater Habitats**	1.6		0.08%	0.02%
Total Acreage of Wetlands and Deepwater Habitats**	98.7		4.97%	0.32%

* Source: WLCP GIS, December 31, 2016. Note: Acres are calculated directly from areas of GIS polygons and therefore may not match exactly other acreage totals submitted by DEP. Watershed statistics calculated from LiDAR-derived 1m basin boundaries updated Fall 2013.

** Categories considered "Deepwater Habitats" include reservoirs or large lakes (L1), unconsolidated bottom (L2UB), riverbeds (RUB & RRB) or streambeds (RSB). Categories considered wetlands include Palustrine Systems and exclude the Deepwater 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.

Statistics produced by T. Spies, BWS WPP GIS, 1/31/2017

4.8.3 Wetland Mapping

In 2016, DEP continued to evaluate the findings of the 2015 pilot study demonstrating how the use of LiDAR-derived datasets and high resolution aerial photography in Object Based Image Assessment increases the completeness and accuracy of wetland mapping and connectivity assessment. An assessment of the EOH pilot areas demonstrated a 92% feature accuracy rate, as compared to 77% for the current National Wetlands Inventory. Feature accuracy refers to the correct identification of an area as wetland or upland on the map. DEP presented the findings of this project at the Society of Wetland Scientists annual conference in Corpus Christi, TX and at the Watershed Science and Technical Conference in Saugerties, NY.

4.8.4 Wetland Monitoring

DEP gains information on the characteristics and functions of watershed wetlands through long-term monitoring of 18 wetlands comprising 116 acres in the Cat/Del watersheds. In 2016, DEP continued to collect data from automated monitoring wells in the reference wetlands. The wells measure water-table level at 6-hour intervals and provide a long-term hydrologic record for various wetland types. These hydrographs can inform wetland restoration and creation design, and help detect long terms trends due to climactic conditions.

In 2016, DEP also re-sampled 50 vegetation plots from 10 wetlands originally sampled in 2005. The remaining reference wetlands will be re-sampled in 2017. Data will be analyzed to identify changes in wetland species composition over the 11-12 year period. Long-term monitoring informs management decisions by detecting impacts from invasive species, surrounding land use, changing climactic conditions, and long term succession.

4.8.5 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. As part of this review, DEP wetland scientists delineate on-site wetlands, which are treated as exclusion zones where no disturbance occurs under normal circumstances. Moreover, the 100-foot-wide area surrounding wetlands is considered a special management zone, where tree removal and equipment operation is limited. In 2016, DEP delineated six wetlands for proposed forest management projects on City lands. These delineations also provide DEP with field-scale data on the characteristics of wetlands on city lands and inform remote wetland mapping efforts.

4.8.6 Education and Outreach

In addition to sharing the results of the pilot LiDAR wetlands mapping project with peers at conferences, Wetlands Program staff led an interpretive walk at a



Figure 4.26 Wetland outreach program in North Castle, NY.

wetland in North Castle (Figure 4.26), prepared a press release for National Wetlands Month (May), and hosted a field exercise for a SUNY Ulster college class at two wetlands near the Ashokan Reservoir. Staff also attended the World Fishing & Outdoor Expo in Rockland County and the Delaware County Fair, where the DEP’s educational pamphlet on wetlands in the watershed was distributed.

4.9 East of Hudson Non-Point Source Pollution Control Program

The East of Hudson (EOH) Nonpoint Source Pollution Control Program seeks to address wastewater-related and stormwater-related nonpoint pollutant sources in the four EOH Catskill/Delaware basins: West Branch, Croton Falls, Cross River, and Boyds Corners.

4.9.1 Wastewater-Related Nonpoint Source Pollution Management Programs

DEP supports Westchester and Putnam counties’ efforts to reduce the potential impacts of improperly functioning or maintained subsurface sewage treatment systems (SSTSs). Westchester, Putnam, and their municipalities continue to implement the septic requirements of the NYSDEC MS4 General Permit that became effective in 2011. As required by the MS4 permit, programs are in place for inspection, maintenance, and rehabilitation of septic systems.

In 2016, DEP continued implementation of the Septic System Rehabilitation Reimbursement Program in the West Branch and Boyds Corners basins in partnership with the New York State Environmental Facilities Corporation (EFC). The program provides up to 50% reimbursement for homeowners to rehabilitate deficient septic systems or to connect their homes to an existing sewage collection system. Residents with a demonstrated financial hardship may have their share reduced to 25%. The program has been rolled out in phases based on the distance between a property and the nearest watercourse. During the reporting period, six residents signed up with the program.

Also in 2016, DEP initiated a septic program in the Croton Falls and Cross River basins and completed the initial mailing to eligible residents. The program provides funding to residences that have a demonstrated financial need by reimbursing part of the costs to rehabilitate eligible failing septic systems or connect those systems to a sewage collection system. EFC administers the program, which covers the eligible portions of the Croton Falls and Cross River basins (within 200 feet of a watercourse) not otherwise covered by the other available septic reimbursement programs. DEP implements the program based on the potential risk a failing septic system might have on reservoir water quality.

4.9.2 Stormwater-Related Nonpoint Source Pollution Management Programs

To further reduce pollutant loading from stormwater runoff, DEP is working on two nonpoint-source reduction projects: Maple Avenue (Town of Bedford, Westchester County) and Drewville Road (Town of Carmel, Putnam County). The Maple Avenue project design plan and stormwater pollution prevention plan are complete and all permits are in place.

For the Drewville Road project, DEP secured approval of the joint permit application in 2016. Carmel renewed the tree-cutting and wetland permits and also granted final site plan approval. DEP secured design approval and is working to resolve an additional permitting requirement with Carmel for tree removal within the limits of disturbance. DEP is currently processing the payment to the town for the engineering fee to allow tree work to proceed. The Maple Avenue and Drewville Road projects will be bid together.

4.9.3 Stormwater Facility Inspection and Maintenance

The Facility Inspection and Maintenance Program ensures previously constructed stormwater remediation facilities continue functioning as designed. New facilities brought on line are added to the routine inspection program. Maintenance during the first year of a facility's life is completed under the warranty in the construction contract and under DEP's maintenance contract thereafter. Inspection and maintenance follow procedures contained in the maintenance contract.

4.9.4 Croton Falls/Cross River Funding Program

DEP established a \$4.5 million grant program to reduce stormwater pollution in the Cross River and Croton Falls basins. DEP later agreed to reallocate these funds toward the municipalities that participated in a regional stormwater entity in the EOH watershed. DEP issued the full payment to the EOH Watershed Corporation (EOHWC) for their use to satisfy municipal obligations under Section IX.A.5.b of the NYSDEC MS4 General Permit. All of these funds have been expended on stormwater retrofit projects.

4.10 Kensico Water Quality Control Program

4.10.1 Wastewater-Related Nonpoint Source Pollution Management Programs

Septic Reimbursement Program

The Kensico Septic System Rehabilitation Reimbursement Program is implemented through the EFC and reimburses part of the costs to rehabilitate eligible failing septic systems or connect those systems to an existing sewage system. In 2016, the EFC mailed an annual reminder letter to eligible residents about the continuing availability of funding. Based on responses, EFC continues to update the database and sign interested participants into the program as appropriate. In 2016, repairs were completed at two sites in the Kensico basin.

West Lake Sewer

The West Lake sewer trunk line, owned and maintained by the Westchester County Department of Environmental Facilities (WCDEF), conveys untreated wastewater to treatment facilities elsewhere in the county. DEP previously funded the installation of a remote monitoring system for the trunk line to provide real-time detection of problems such as leaks, system breaks, overflows, and blockages. There have been no overflows or indications of concern since the

system’s installation. WCDEF operates and maintains the units and the units appear to be working well.

DEP also visually inspects the trunk line annually to assess the condition of exposed infrastructure. The most recent annual full inspection was performed in May 2016. Routine partial inspections were also conducted throughout 2016 in association with ongoing maintenance of Kensico stormwater BMPs near the line. No defects or abnormalities have been noted during the reporting period.

4.10.2 Stormwater Management and Erosion Abatement Facilities

BMP Construction, Inspection and Maintenance

DEP has constructed 47 stormwater management and erosion abatement facilities throughout the Kensico watershed to reduce pollutant loads conveyed to the reservoir. The facilities, shown in

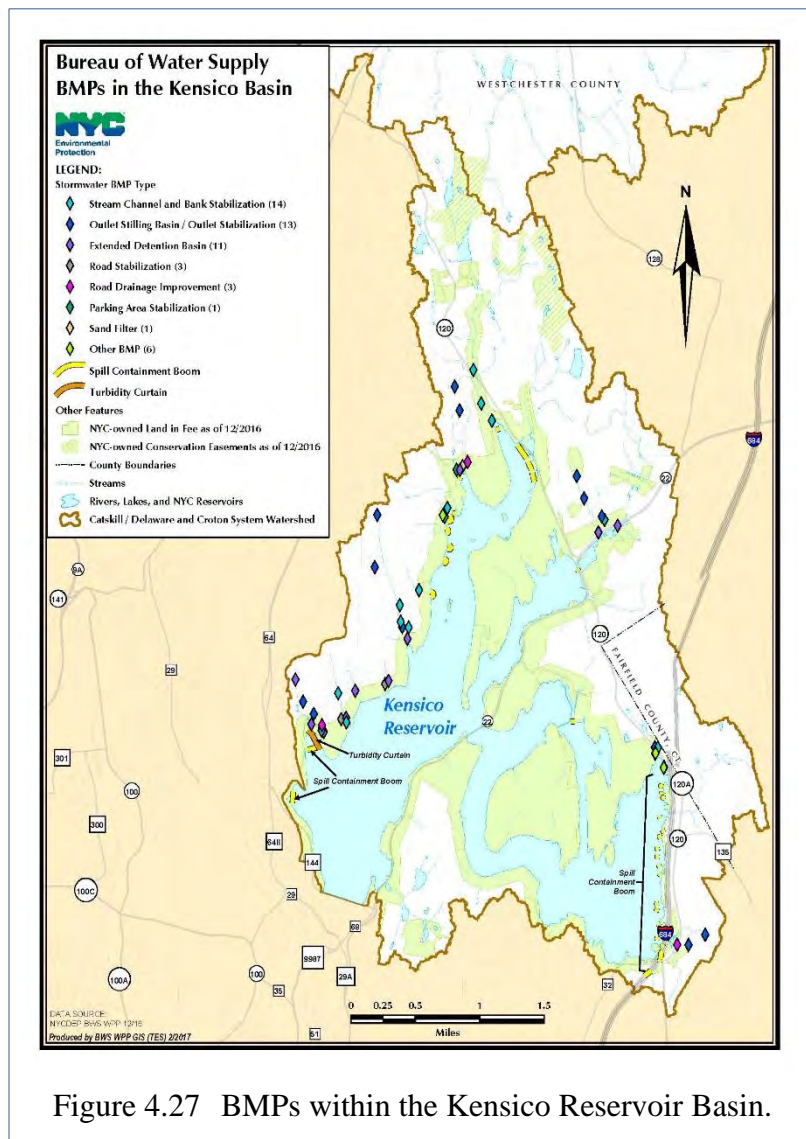


Figure 4.27, were routinely inspected and maintained throughout the reporting period in accordance with the operation and maintenance guidelines. Maintenance consisted of grass mowing, vegetation removal, tree removal, and sediment and debris removal. All BMPs are performing as designed.

Wildlife Sanitary Survey

The Kensico Reservoir Wildlife Sanitary Surveys were in response to tropical storms Irene and Lee causing elevated levels of fecal coliform bacteria in Kensico Reservoir. Since significant precipitation events can result in overland flow of water, DEP implemented these surveys to reduce the potential for wildlife excrement being flushed into the reservoir near the Delaware Shaft 18 intake. DEP identified sampling locations based on proximity to the water intake location. Figure 4.28 shows a map of the area surveyed prior to significant precipitation events. DEP developed a system of locating, identifying, and removing wildlife excrement, particularly where wildlife latrines had developed, in advance of a significant precipitation event.



Figure 4.28 Kensico Reservoir wildlife sanitary sampling locations.

These surveys are a proactive effort to reduce fecal coliform bacteria and other human pathogens from potentially entering the water supply.

During 2016, DEP and its contractor conducted three wildlife sanitary surveys (Table 4.9). Trained wildlife biologists and technicians collected, identified, and disposed of wildlife fecal excrement. Results of the sanitary surveys revealed that excrement from white-tailed deer (*Odocoileus virginianus*) and raccoons (*Procyon lotor*) were most commonly identified and removed.

Table 4.9 Kensico Reservoir 2016 wildlife sanitary surveys.

Date of Survey	White-tailed Deer	Raccoon	Eastern Cottontail Rabbit	Canada Geese	Red Fox	Total
2/2/2016	29	9	0	3	0	41
2/23/2016	32	0	5	0	1	38
9/3/2016	19	0	0	6	0	25

Spill Containment Facilities

DEP maintains spill containment equipment around Kensico Reservoir to improve spill response and recovery and to minimize water quality impacts. In 2016, DEP conducted routine maintenance at the spill boom sites to ensure they are available in the event of a spill. There were no spills requiring the deployment of booms.

Turbidity Curtain

DEP continues to monitor the extended primary curtain and the back-up turbidity curtain designed to direct flows from Malcolm and Young brooks farther into the body of the reservoir. DEP inspected both curtains during 2016 to ensure they are properly functioning. No immediate repair work was required and the curtains functioned as intended

4.10.3 Other Watershed Programs

Shoreline Stabilization

The Catskill Upper Effluent Chamber (CATUEC) is situated along the southwest shore of Kensico Reservoir. DEP previously explored the possible need for a shoreline stabilization project to mitigate the resuspension of near-shore materials near CATUEC during wind events. Since CATUEC has been offline since 2012, DEP will undertake a further review of a potential shoreline project as part of the site selection under the Catskill Aqueduct pressurization project.

Shaft 18 is also situated along the southwest shore of Kensico Reservoir. Since the Catskill/Delaware UV Disinfection Plant was placed in service, all water in the Kensico Reservoir flows through the Delaware effluent chamber at Shaft 18. Increased reliance on Shaft 18 and changing weather patterns necessitates shoreline stabilization measures near the chamber to maintain turbidity levels that comply with state and federal water quality standards. Stabilization measures will include approximately 700 linear feet at the western shoreline and approximately 475 linear feet at the cove area (See Figure 4.29).

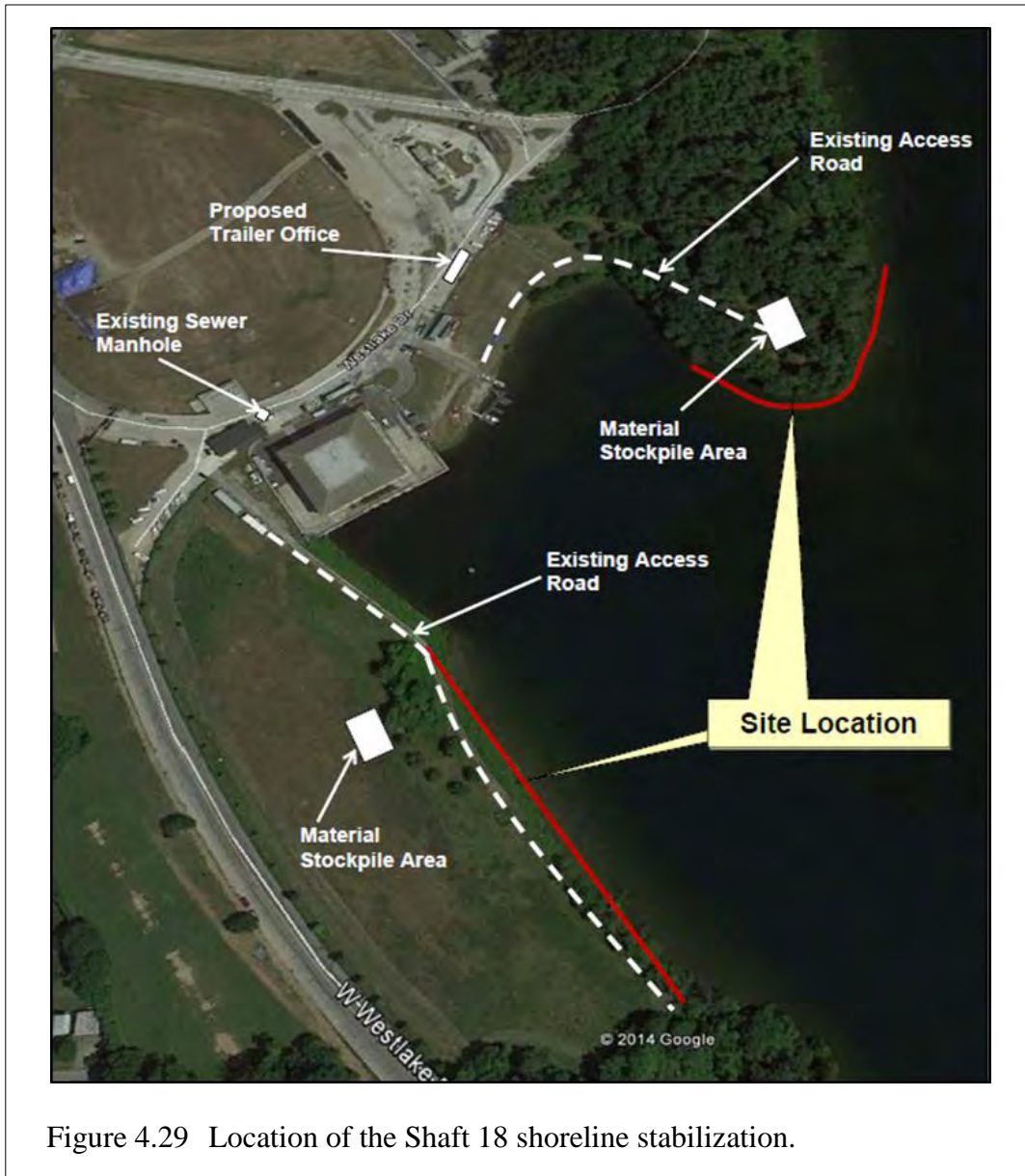


Figure 4.29 Location of the Shaft 18 shoreline stabilization.

In 2016, DEP completed the project's design to stabilize the shoreline on both sides of Shaft 18. DEP secured approval from the Public Design Commission, worked with the Town of Mount Pleasant to obtain the necessary permits, and signed off on the permit package sent to the US Army Corps of Engineers for its approval.

Route 120

Project completed.

Westchester County Airport

Because the Westchester County Airport is located near the Kensico Reservoir, DEP continues to review any activities proposed there. The Westchester County Department of Public Works and Transportation is developing an airport master plan, which is currently in the information-gathering phase. In 2016, DEP met with airport representatives on the main terminal's future expansion. DEP also commented on the DEIS to construct a 980-space parking garage and reviewed the draft airport lease agreement between Westchester and Empire State Airport Holdings, LLC. DEP informed the parties of DEP's regulatory role with regard to land development or facility expansion that may result from a finalized lease agreement and provided comments at a hearing held by the County Board of Legislators.

In 2016, DEP also met with Westchester County officials, their consultants, the NYSDEC, and the Watershed Inspector General regarding ongoing efforts to address an uncapped landfill at the Westchester County Airport. The county agreed to develop plans for a control measure to prevent accumulated iron flocculent, noted at the base of the landfill within an unnamed stream, from being discharged to Kensico Reservoir. Additionally, the county agreed to prepare an investigation plan that would include installing new groundwater monitoring wells immediately downgradient of the landfill; perform sampling and laboratory analysis of groundwater from that monitoring point; and excavate test pits within the landfill followed by visual inspection of wastes, field screening, sampling, and laboratory analysis.

The county shared results of soil samples collected from eight test pits excavated within the landfill in 2016. The report indicated exceedances for certain metals. The county has since commenced procurement of services to proceed with additional groundwater sampling and the design and implementation of a permanent flocculent/sediment trap within the impacted unnamed stream.

4.11 Catskill Turbidity Control

4.11.1 Implementation of Catskill Turbidity Control Alternatives

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 beneath the streambed armor. The design of the Catskill System takes local geology into account and provides for settling within Schoharie Reservoir, 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 the SWTR turbidity standards (5 NTU) at the Kensico effluent. But occasionally after extreme rain/runoff events in the Catskill watershed, DEP has used aluminum sulfate (alum) as chemical treatment to control high turbidity levels.

Since 2002, DEP has undertaken several studies and implemented significant changes to its operations to better control turbidity in the Catskill System. Many of these measures have been implemented pursuant to the 2002 and 2007 FADs and the Shandaken Tunnel and Catalum SPDES Permits. A comprehensive analysis, the Catskill Turbidity Control Study, was conducted by DEP with the Gannett-Fleming-Hazen and Sawyer JV in three phases between 2002 and 2009. Based on the results of this study, DEP selected several implementation alternatives: a system-wide Operations Support Tool (OST) that allows DEP to optimize reservoir releases and diversions to balance water supply, water quality, and environmental objectives; an interconnection of the Catskill Aqueduct at the Delaware Aqueduct Shaft 4 to improve overall system dependability; and structural improvements to the Catskill Aqueduct stop shutter facilities. The Catskill-Delaware Interconnection and the Catskill Aqueduct stop shutter facilities projects both achieved functional completion in 2016.

Operations Support Tool

OST couples computer models of reservoir operating rules and water quality; assimilates near real-time data on stream flow, water quality, and reservoir levels; and ingests streamflow forecasts to predict reservoir levels and water quality up to a year into the future. It is a decision support system — water supply managers make decisions based on guidance from OST in combination with other forecast information; knowledge of system infrastructure status and other conditions; water supply BMPs; and years of experience operating the system. Since late 2013, DEP has used OST almost daily to better inform reservoir operations and planning.

Several enhancements were made to OST in 2016 via a contract with Hazen and Sawyer, which worked closely with DEP Reservoir Operations and Water Quality Modeling staff. In addition, a software application, the Forecast Diagnostic Tool (FDT), was also developed. FDT displays the current inflow forecasts compared to a range of historical data (min, max, percentiles) and to the past several days' worth of observations and forecasts. This allows modeling staff to quality control the forecasts, which informs interpretation of model output and

may lead to coordination with the National Weather Service to revise and reissue the forecasts if anomalous forecasts are discovered. Verification statistics were computed on a set of inflow reforecasts and provided in database format with a browser-based data exploration tool. A new base run (the set of rules underlying the daily model runs performed by DEP staff) was developed and tested. The modifications were based on experience using OST, full implementation of new infrastructure such as the Croton Filtration Plant, and current thinking on system management. The new base run includes improved routines for reservoir subsystem balancing, refined Croton system operations now that the Croton Filtration Plant is operational, and modified water quality-based operating rules. Additionally, a new PhD-level hydrological modeler was hired in 2016 to further enhance DEP’s OST modeling staff.

National Academies Expert Panel review

In September 2016, the National Academies of Science (NAS) commenced a two-year project to conduct an expert panel review of the City’s use of OST for water supply operations, and identify ways the City can more effectively use OST to manage turbidity. The expert panel has several goals:

- Evaluate the effectiveness of the City’s use of OST for water supply operations, and identify ways in which the City can more effectively use OST to manage turbidity.
- Evaluate the performance measures/criteria the City uses to assess the efficacy of the Catskill Turbidity Control Program and recommend additional performance measures if necessary.
- Review the City’s proposed use of OST in evaluating the proposed modification to the Catalum State Pollutant Discharge Elimination System Permit as well as the alternatives to be considered in the environmental review of those proposed changes.
- Review DEP’s existing studies of the potential effects of climate change on the City’s water supply to help identify and enhance understanding of potential future concerns in the use of OST.

The NAS chose expert panel members for their extensive practical experience in the following areas: reservoir operations; drinking water treatment; water quality, water quantity and watershed modeling; water-quality monitoring and statistics; and hydro-climate systems and dynamics. The NAS also ensures that the experts are not directly connected to the New York City water supply and are free from any potential conflicts of interest or biases. The list of potential panel members was noticed for public comment on October 31st for 21 days. No public comments were received and the final multidisciplinary committee members are -

1. Debra S. Knopman, chair, RAND Corporation
2. Eugene J. LeBoeuf, Vanderbilt University
3. Jerome B. Gilbert, National Academy of Engineering, independent consultant, Orinda, CA

4. Kimberly L. Jones, Howard University
5. John E. Tobiason, University of Massachusetts, Amherst
6. James G. Uber, Citilogics and the University of Cincinnati
7. Paul L. Freedman, LimnoTech
8. Robert M. Hirsch, U.S. Geological Survey
9. Monica B. Emelko, University of Waterloo
10. Karen Seligman Sklenar, The Cadmus Group, Inc.
11. Cynthia E. Rosenzweig, NASA and Columbia University
12. Eric F. Wood, National Academy of Engineering, Princeton University

The expert panel will meet five times during 2017. The first meeting was held January 4-6, 2017. The first three meetings will have some sessions open to the public, including opportunity for direct public comment to the panel. Additionally, the public can always submit comments through the project website (dels.nas.edu/Study-In-Progress/Review-York-City/DELS-WSTB-14-02).

Catalum Consent Order and Environmental Review

Rain events in October and December 2010 caused elevated turbidity levels in the Ashokan Reservoir. In addition to alum at Kensico, DEP also utilized the Ashokan Release Channel as part of a strategy previously approved by NYSDOH and EPA to ensure all drinking water standards were met. Using the channel raised concerns from communities along the Esopus Creek downstream of the reservoir.

In February 2011, NYSDEC commenced an administrative enforcement action against the City for alleged violations of the Catskill Aqueduct Intake Chamber Catalum SPDES Permit (NY0264652) regarding operation of the Ashokan Release Channel and alum addition. NYSDEC and DEP negotiated a consent order to resolve the alleged violations, which took effect in October 2013. The consent order included penalties, environmental benefit projects, a schedule of compliance, and an Interim Release Protocol for operation of the Ashokan Release Channel.

In June 2012, consistent with the consent order, DEP requested a modification to the Catalum SPDES Permit to incorporate turbidity control measures in water diverted from Ashokan Reservoir and to postpone dredging of alum floc at Kensico Reservoir until completion of certain infrastructure projects. The proposed modification is subject to environmental review under the State Environmental Quality Review Act (SEQRA), for which NYSDEC is lead agency. NYSDEC released a draft scope for the Catalum environmental impact statement (EIS) for public comment from April 9, 2014, to August 29, 2014. Over 900 comments were received from over 550 commenters. NYSDEC and DEP continue to evaluate the comments and potential changes to the scope and a final scope is expected in 2017.

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 encompassing all areas of the watershed, including sites at aqueducts and water supply intakes (keypoints), streams, reservoirs, and wastewater treatment plant (WWTP) facilities. DEP’s monitoring objectives for 2016 are documented in the Watershed Water Quality Monitoring Plan (WWQMP) (DEP 2016a) and associated addenda, which are designed to meet the broad range of DEP’s regulatory and informational requirements. The plan prescribes monitoring to achieve compliance with all federal, state, and local regulations; meet the terms of the Revised 2007 FAD (NYSDOH 2014); enhance the capability to make predictions of watershed conditions and reservoir water quality; and ensure delivery of the best water quality to consumers through ongoing surveillance.

The overall goal is to establish an objective-based water quality monitoring network that provides scientifically defensible information regarding the protection and management of the New York City water supply. The plan’s objectives have been defined by the requirements of those who ultimately require the information, including DEP program administrators, regulators, and other external agencies. 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 requiring ongoing attention: compliance, FAD program evaluation, modeling support, and surveillance monitoring. Many specific objectives fall within these major areas.

Compliance - The compliance objectives are focused on meeting the regulatory monitoring requirements for the New York City watershed. This includes the Surface Water Treatment Rule (SWTR) (USEPA 1989) and its subsequent extensions, the New York City Watershed Rules and Regulations (WR&R) (DEP 2010), the Croton Consent Decree (CCD) (until it was terminated on Sept. 6, 2016), administrative orders, and State Pollutant Discharge Elimination System (SPDES) permits. The sampling sites, analytes, and frequencies are defined in each objective according to each permit, rule, or regulation.

FAD program evaluation - USEPA had specified many requirements in the 2007 FAD (USEPA 2007) meant to protect public health and NYSDOH has continued to specify requirements in the Revised 2007 FAD. These requirements form the basis for the City’s ongoing assessment of watershed conditions, changes in water quality, and any modifications to the strategies, management, and policies of the Long-Term Watershed Protection Program (DEP 2016b). The City also conducts a periodic assessment of the program’s effectiveness using DEP’s water quality monitoring data. Program effects on water quality are reported in the

Watershed Protection Summary and Assessment reports (e.g., DEP 2016c), which have been 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 those models; updating of data necessary for the models' development; 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. Aqueduct monitoring provides flow and reservoir operations data to support reservoir water balance calculations. The water balance and reservoir water quality data are needed to test, apply, and further develop DEP's one- and two-dimensional models. The meteorological data collection provides critical input necessary to meet both watershed and reservoir modeling goals. The modeling program's 2016 activities are summarized in the 2016 Multi-Tiered Modeling Program Annual Status Report (See Section 5.2 for details on accessing the report.).

Surveillance monitoring - The surveillance monitoring chapter of the WWQMP contains several objectives that guide the short-term operation of the water supply system, help track the status and trends of constituents and biota in the system, and also focus on aqueduct monitoring for operational decisions. Other objectives relate to developing a baseline understanding of potential contaminants (trace metals, volatile organic compounds, and pesticides) and summarize how DEP monitors for 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 reservoirs' water quality to be aware of developing problems and to pursue appropriate actions.

5.1.2 Additional Water Quality Monitoring

In addition to routine monitoring, events or incidents may occur that necessitate additional water quality monitoring. Almost 300 additional watershed samples were collected for special investigations during 2016, including 138 stream samples, 121 reservoir samples, and 39 pathogen samples. Special investigations in 2016 included analyzing the elevated levels of *Giardia* cysts in the Mahopac WWTP effluent; determining any water quality impacts, in particular diesel range organics, from a tug boat that sank in Schoharie Reservoir; continued surveillance for diesel range organics leaking from a sunken tank in Pepacton Reservoir; looking for water quality impacts on Rondout Creek from the use of the Blue Hole as a very active swimming location; and determining the source of water found adjacent to the

Catskill Aqueduct in Garrison, NY and in Yonkers, NY.

Other examples of non-routine monitoring included significant storm events at Kensico Reservoir. In 2016, there were four storm events monitored using auto samplers on streams N5 and Malcolm Brook – one each in June and October, and two in November. When fecal coliform results appeared elevated, samples were sent to a contract laboratory to help identify the source.

DEP also utilizes a Robotic Water Quality Monitoring Network (RoboMon) as part of its routine monitoring program. Continuous data obtained by the network are critical for ensuring effective water supply management during storm events, providing early warning of water quality conditions, and helping form management actions that guide the water supply system’s operation. It also provides data essential for model development. The network includes fixed-depth buoys (including two under-ice buoys), profiling buoys, and several stream installations. The RoboMon network made almost 1.5 million measurements in the watershed in 2016.

5.1.3 Wastewater Treatment Plant Protozoan Monitoring

WWTP protozoan monitoring in Filtration Avoidance watersheds seeks to demonstrate that microfiltration and technologies deemed equivalent continue to perform well with respect to pathogen removal from the plants’ effluents. In 2016, DEP monitored eight WWTPs west of the

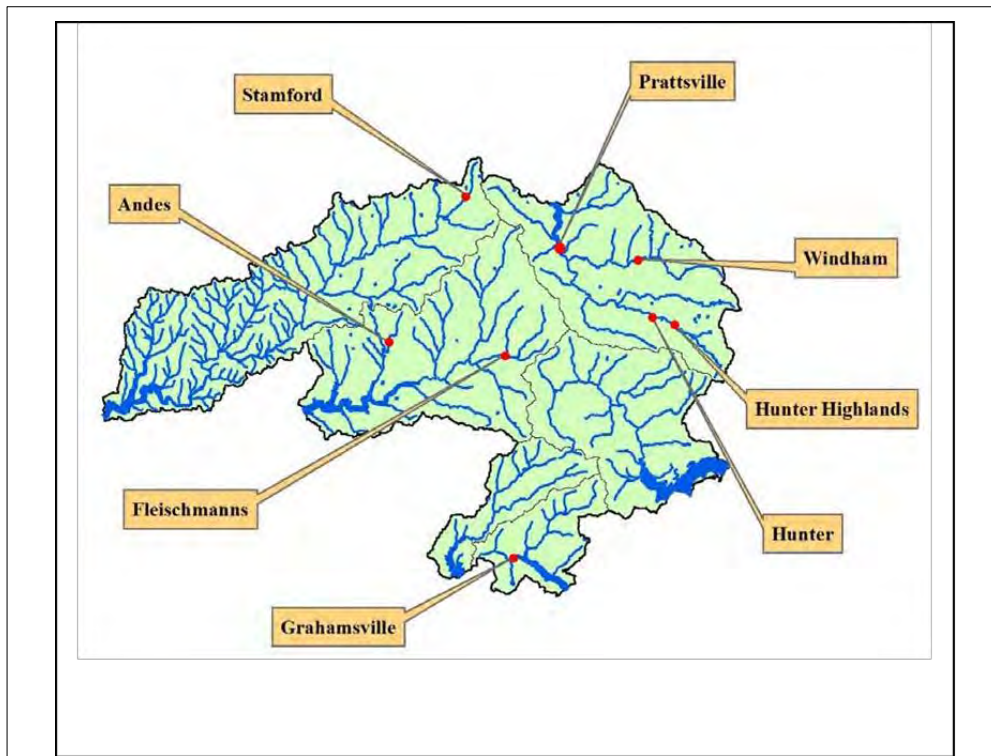


Figure 5.1 WOH wastewater treatment plants monitored for *Giardia* and *Cryptosporidium* in 2016.

Hudson River for protozoa (Figure 5.1) and two east of the Hudson River (Figure 5.2). The EOH WWTPs reside in the Croton Falls Reservoir watershed, a potential FAD basin (due to the pump station and connection to the Delaware Aqueduct). All ten plants were monitored quarterly for *Giardia* and *Cryptosporidium* in 2016.

Each sample analyzed for *Cryptosporidium* and *Giardia* involved the field filtration of 50 liters of plant effluent water. Samples were analyzed by DEP according to USEPA Method 1623.1 (USEPA 2012). The 40 samples were taken as scheduled in 2016 and three of these samples were positive for protozoans. Two of the positives came from plants west of the Hudson River (Hunter and Windham) and the third positive was from East of Hudson (Mahopac).

The first detection at a WWTP in 2016 was in a sample taken on January 25 at the Hunter WWTP. The sample had 1 *Cryptosporidium* oocyst $50L^{-1}$. The

Hunter plant staff reported no abnormal conditions around the time of the sample collection and there were no turbidity values above 0.1 NTU for days before and after the collection. There have been previous detections at the Hunter plant effluent around the time of the Martin Luther King, Jr. holiday weekend when increased patronage at the ski resort is likely.

The second protozoan detection was found at the Windham WWTP on August 23, with a result of 1 *Giardia* cyst $50L^{-1}$. Plant operators indicated there were no mechanical or process abnormalities observed which could have led to the detection. Flow rate, pumping, and chemical dosage were all operating within normal parameters. The daily turbidity report for that day indicated a maximum effluent turbidity of 0.29 NTU.

Although the location of the third 2016 protozoan detection was in a potential FAD basin, it did not impact the FAD watershed since Croton Falls pumps were not in operation in 2016.

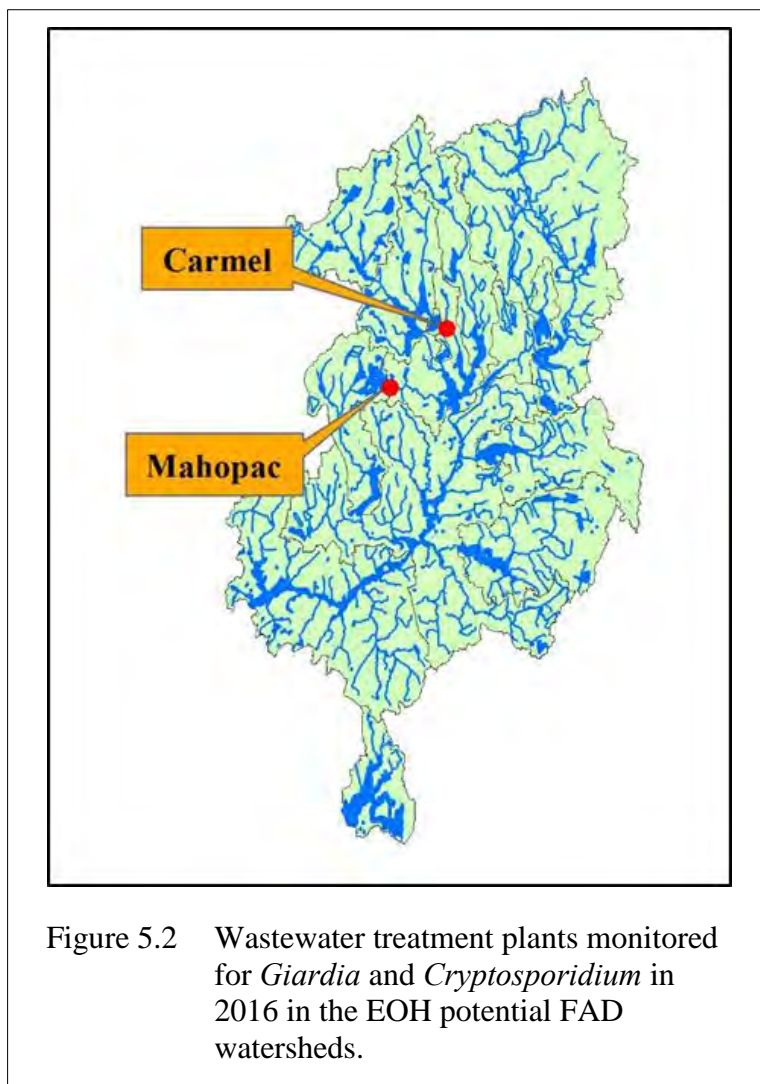


Figure 5.2 Wastewater treatment plants monitored for *Giardia* and *Cryptosporidium* in 2016 in the EOH potential FAD watersheds.

This detection was in November at the Mahopac WWTP. It resulted in a special investigation and follow-up samples after the unusually high count. On November 15, during heavy rain, a protozoan sample was taken at Mahopac WWTP with a result of 967 *Giardia* cysts and 2 *Cryptosporidium* oocysts 50L⁻¹. Operations staff determined that the microfiltration turbidity did not exceed 0.063 NTU the entire week. Even during the rain event and the days after, the facility did not encounter any issues with sand filtration or microfiltration. Operators did not observe any issues with process operations during this time period and the facility was considered to be functioning under normal operations. As a note, monthly fecal coliform results from the November 1 and December 6 samples were both <1 FC 100ml⁻¹.

The microscopy slide with 967 cysts and 2 oocysts was sent to a contract laboratory (University of Texas Public Health Laboratory) for molecular analysis. While the *Giardia* cysts were in abundance and at a much higher concentration than *Cryptosporidium*, no *Giardia* DNA was recovered. However, *Cryptosporidium* DNA was recovered. The results of the *Cryptosporidium* DNA analysis was a genotype associated with rodents.

A follow-up sample taken on November 22 came back negative for *Giardia* and *Cryptosporidium*. On December 5, research staff met with operators on site to try to determine potential contamination sources. The UV treatment area and effluent contact tanks were open to possible animal intrusion and had the potential for storm runoff to contaminate the final tank during precipitation events. It was also suggested that biofilm on the contact tank walls could be harboring (oo)cysts, which might then dislodge during sampling. On December 27, two additional samples were taken. One followed standard field filtration procedures. A second sample was collected while the walls and bottom of the tank were scraped to remove bio-film and agitated to re-suspend settled materials. Both of these samples were negative for *Giardia* and *Cryptosporidium*.

It is unusual to have so many *Giardia* negative for DNA but it may have been destroyed by the UV treatment at the plant (if contamination was prior to the UV treatment) or, perhaps, destroyed in the environment since cysts are not as resilient as oocysts. One may infer from the *Cryptosporidium* typing that the *Giardia* may also have been from a rodent source. However that is not conclusive.

Plant operations are not believed to have been a factor as the plant was reported functioning normally even during the rain event. Scraping and analysis of biofilm from the wall of the effluent tank ruled out the biofilm as a source of both protozoans. The most likely conclusion, based on the process of elimination, is that either surface runoff from the rain washed fecal material directly into the tank, or wildlife, in this case likely a rodent, got into the tank contaminating the original sample.

5.1.4 Water Quality Reports

Pursuant to the City's Long-Term Watershed Protection Plan (DEP 2016b) and as a FAD requirement (Section 5.1), DEP produces a Watershed Water Quality Annual Report, which is submitted to NYSDOH and USEPA in July of each year (e.g., DEP 2016d). This document covers water quantity (e.g., the effects of droughts or excessive precipitation during the reporting period); water quality of streams and reservoirs; Kensico Reservoir water quality; pathogen monitoring and research; and a summary of the major water quality modeling activities for the year. For the 2016 report (due July 2017), the document's limnology and hydrology components will draw largely from information obtained from approximately 200 routinely sampled reservoir and stream sites, resulting in over 4,800 samples and almost 54,000 analyses. Limnological profiles conducted during the sampling surveys added over 61,000 additional analyses. For the pathogen component, 537 routine samples were collected at 41 sampling sites (including keypoints) and analyzed for *Giardia* and *Cryptosporidium*, along with turbidity, pH, and temperature, for a total of more than 2,000 analyses. In addition, 48 samples were collected at seven sampling sites for human enteric virus (HEV) examination.

It is important that DEP monitor pathogen concentrations on an ongoing basis to be able to confirm their presence or absence in 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:

- Results from *Cryptosporidium* and *Giardia* weekly sampling at the Kensico effluent (DEL18DT) are routinely posted on DEP's website (<http://www.nyc.gov/html/dep/pdf/pathogen/path.pdf>).
- Results from *Cryptosporidium* and *Giardia* weekly sampling at the Kensico influents (DEL17 and CATALUM) and effluent (DEL18DT) are sent directly to regulators by email. With the termination of the Croton Consent Decree in September 2016, monthly sampling at CROGH ceased.
- Results from *Cryptosporidium* and *E. coli* weekly sampling at the Kensico effluent (DEL18DT) and the Croton Filter Plant raw water site (1CR21) are emailed directly to NYSDOH for Phase 2 monitoring for the Long Term 2 Enhanced Surface Water Treatment Rule.
- Monthly Croton Consent Decree Report (Issuance of this report ceased with the termination of the Croton Consent Decree in September 2016)
- Watershed Water Quality Annual Report (e.g., DEP 2016d)
- Drinking Water Supply and Quality Annual Report (e.g., DEP 2016e)
- Filtration Avoidance Annual Report (e.g., DEP 2015), or, every fifth year, the Watershed Protection Program Summary and Assessment (DEP 2016c)

5.2 Multi-Tiered Water Quality Modeling Program

For information on the work done by the water quality modeling group during 2016, please refer to the 2016 Multi-Tiered Modeling Program Annual Status Report, which will be available on the DEP website following its submittal on March 31, 2017 (http://www.nyc.gov/html/dep/html/watershed_protection/fad.shtml).

5.3 Geographic Information System

DEP utilizes its Geographic Information System (GIS) for multiple purposes: to support numerous FAD and MOA programs; to manage the City’s interests in water supply lands and facilities; to display and evaluate the potential effectiveness of watershed protection through maps, queries, and spatial analyses; and to support watershed, reservoir, and operational modeling efforts. 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). This report describes progress in providing GIS technical support; the completion or acquisition of new GIS data layers; improvements to GIS infrastructure; and dissemination of GIS data.

5.3.1 GIS Technical Support

During the reporting period, the GIS Program provided technical support and data development, including extensive Global Positioning System (GPS) fieldwork, for a variety of protection programs and modeling applications. GIS-derived graphics were also created for reports, posters, presentations, and peer-reviewed publications.

Customized statistical reports and maps were created depicting the breakdown of land ownership, land cover extent, hydrographic and topographic features, riparian and flood zones, water supply facilities, and MOA program implementation status over particular watershed basins or political boundaries. These spatial products were developed for engineering screening analyses, regulatory jurisdiction determination, program design and planning, emergency response, water supply operations, and public outreach on recreational opportunities.

In 2016, DEP concluded its multi-year advisory committee participation in the Water Resources Foundation (WaterRF) project “Using Geographic Information System (GIS) to Identify and Catalog Potential Contaminants Stored in Tanks Upstream of Drinking Water Intakes.” The final report, “A Methodology for Locating and Managing Dynamic Potential Source Water Contaminant Data,” is available at the following link:

<http://www.waterrf.org/Pages/Projects.aspx?PID=4581>.

Also during 2016, DEP completed training provided by the NYSDEC titled “NYS Floodplain Management Training.” This professional training course covered the National Flood Insurance Program, including the floodplain mapping development standards. As a supplement to this training, DEP also completed “FEMA Levee Mapping Training.”

5.3.2 Completion or Acquisition of New GIS Data Layers and Aerial Products

USGS, under an inter-governmental agreement with DEP, completed all sonar-generated bathymetric surveys of the six WOH reservoirs and delivered draft data to DEP for review and acceptance in 2016 (Figure 5.3). Final data deliverables include raw and corrected survey points, derived topographic surfaces of each reservoir bottom from those points, 2-foot contours of reservoir depth derived from each topographic surface, and stage-area-volume tables in 0.01-foot increments.

Based on these products, DEP completed a matrix of capacity changes for each reservoir since construction. Depth grids derived from the bathymetry are being used as inputs to reservoir water quality models. In addition, all official reservoir boundaries and their dependent data in DEP's version of the National Hydrography Dataset (NHD) have been revised from both new bathymetry and existing 1-meter topography according to recently corrected spillway elevations referenced to the North American Vertical Datum of 1988 (NAVD88).

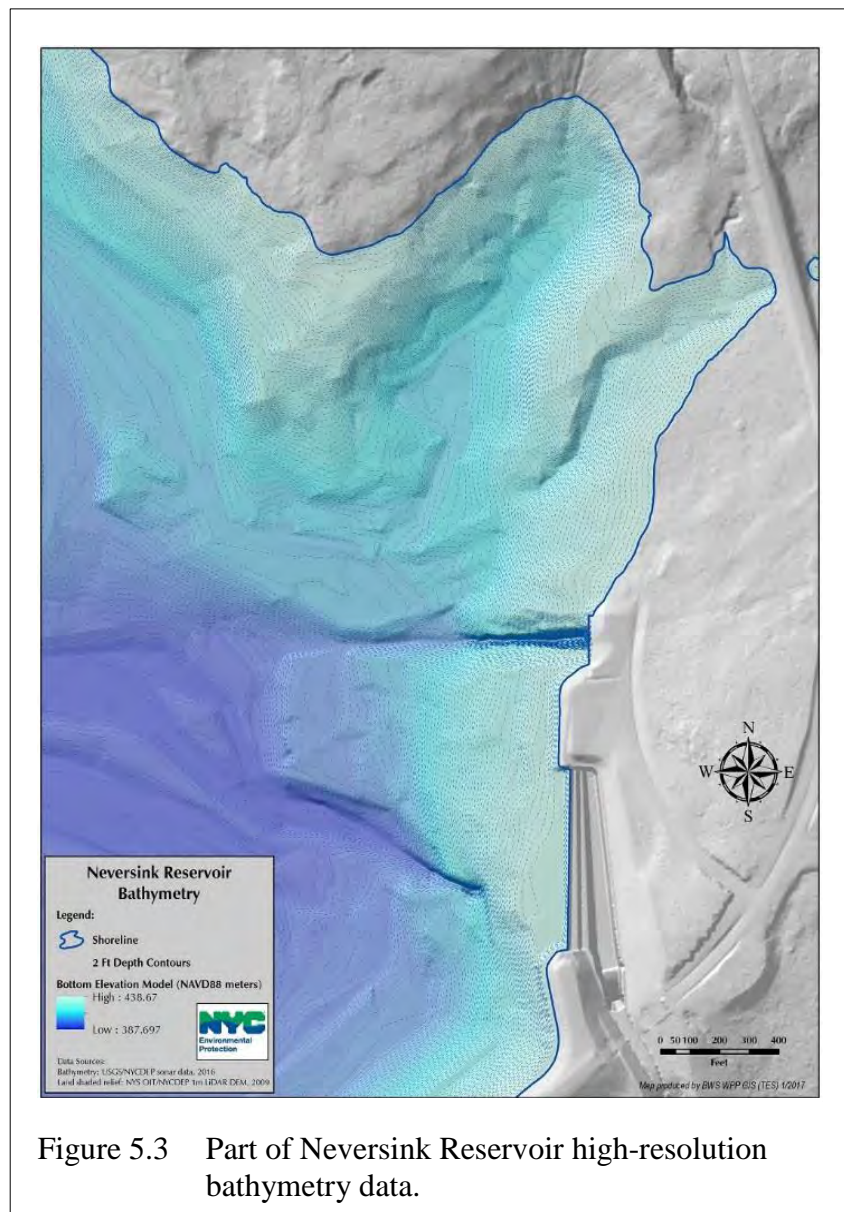
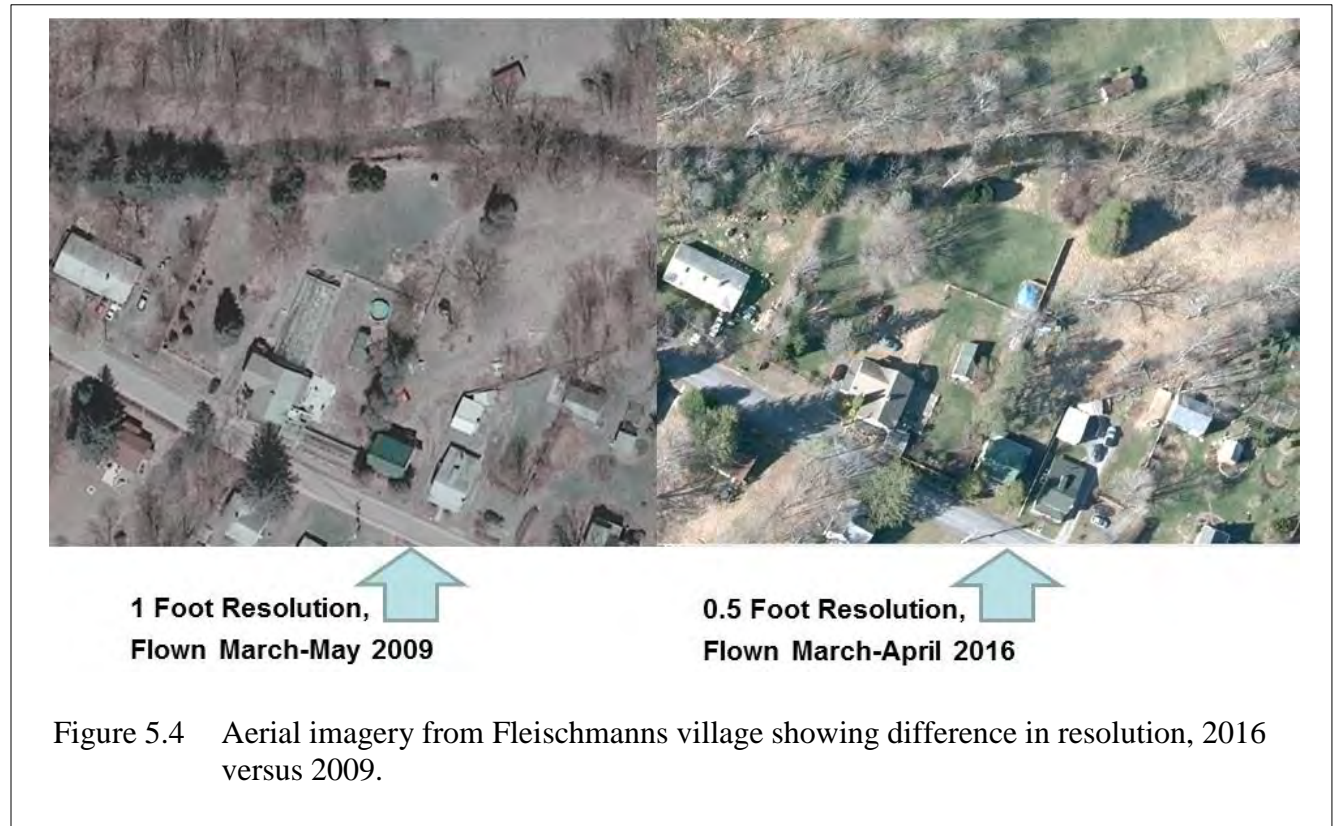


Figure 5.3 Part of Neversink Reservoir high-resolution bathymetry data.

Through partnership with the NYS Digital Orthoimagery Program, in 2016 all flyovers were completed to collect 0.5-foot leaf-off imagery to update DEP’s base map. The 2016 imagery was collected wall-to-wall for all counties containing any portion of the City’s watersheds or aqueducts. For roughly 60% of the cost of a previous 2009 aerial collection, DEP was able to double the area flown at a resolution four times higher as shown in Figure 5.4. Draft data was reviewed for quality assurance and comments were provided back to NYS. DEP will receive final deliverables in 2017.



Other major GIS data upgrades completed in 2016 include the development of data specific to the needs of the new Streamside Acquisition Program (SAP), such as program criteria, prioritized streams, and eligible properties. Using paper maps and parcel lists provided by towns, a new layer of EOH Designated Main Street Areas was developed for analysis and inclusion into various WaLIS maps. New datasets were obtained from the NYS GIS Clearinghouse, including known locations of dams in NYS and senate district boundaries. To track potential impacts on water supply infrastructure, DEP began assembling and documenting GIS data on gas pipelines since much of this data — especially for lateral or distribution connections — is not widely available or complete.

Several other existing feature classes were overhauled as part of ongoing data maintenance. These include mission-critical data sets for various DEP programs, such as county-

wide digital tax parcels, City-owned land or interests, state-owned land, water supply facilities, stream restoration projects, septic repairs, and engineering project locations. Based on field observations verified by DEP, semi-annual corrections and additions were made to National Hydrography Dataset (NHD) mapped water features, including all associated buffers, criteria tables, and layers dependent on that hydrography data. Annual updates on locations of sensitive, threatened, or endangered species on City-owned lands were received from the New York Natural Heritage Program (NYNHP). Under a less-frequent update cycle, the “MOA designated areas” layer was modified based on recent town resolutions.

Data refined for modeling needs included water quality monitoring and biomonitoring site locations provided by data samplers as part of the Laboratory Information Management System (LIMS) database. DEP snow monitoring and snow pillow locations were updated with revised information provided by the Operations Directorate.

5.3.3 GIS Infrastructure Improvement

Several components of GIS infrastructure were upgraded during the reporting period, including purchasing additional server space to accommodate DEP’s ever-expanding inventory of aerial data products and support future GIS data development projects. A second large format color plotter with built-in scanning was also procured and is now operating in the Kingston GIS laboratory. Maintenance was performed on numerous GPS units used by various programs, including replacing aging units, updating data dictionaries, updating software, and tracking inventory for all GPS hardware and software.

Throughout 2016, DEP continued to monitor and troubleshoot the performance of GIS and WaLIS software in watershed offices, and provide guidance or training to WaLIS users. Significant improvements in WaLIS and GIS speed were achieved in 2016 as DEP implemented solutions related to newer and more dense spatial data layers now being used in GIS and accessed through WaLIS.

DEP continues to manage the GIS library by creating and updating data sets; maintaining file geodatabase copies of the library; supporting spatial data development for WaLIS; installing, maintaining, and upgrading ArcGIS for desktop workstations; diagnosing database performance issues; updating schemas and servers to improve database speed; building and testing new geodatabase scripts; evaluating and refining user security levels on servers for different databases; and backing up all databases.

The GIS Program also develops, upgrades, and maintains WaLIS, which currently operates on the workstations of over 250 DEP users. During 2016, WaLIS version 10 was released with several error fixes, a significant update of the online “help” documentation, and a new version of Crystal Reports. A significant amount of new workflow, criteria, and map views were established to manage the solicitation process for SAP projects within WaLIS. An optional “news-feed” window was developed to alert users to check pertinent spatial links, journals, or attachments.

Also in 2016, we released an interactive mapping tool to help the public find properties open for fishing, hunting, hiking, and other recreational uses. The tool is linked to WaLIS and hosted on DEP's website (<http://www.nyc.gov/html/dep/html/recreation/index.shtml>).

5.3.4 Data Dissemination to Stakeholders

Using established in-house data sharing policies, the GIS Program reviewed all outside requests for GIS data and provided this data to watershed partners and interested parties as required. Over 50 stakeholders and communities are currently on a schedule to receive semi-annual data updates for newly-acquired and existing City-owned lands, and these parties were sent data in January and July 2016. Semi-annual updates to DEP's recreation data layer are also shared with Ulster County for their recreation website mapping application.

Throughout 2016, DEP's GIS program continued filling data sharing requests from the NYSDOH, NYSDEC, NYS Office of the Attorney General Watershed Inspector, CWC, EOH Watershed Corporation, FEMA, The Catskill Center, New York/New Jersey Trail Conference, New York Botanical Garden, The Conway School, and various watershed county and town offices. Requests for other GIS data layers were fulfilled for contractors and consultants working on various DEP-related projects, such as dam repairs and the Rondout-West Branch Tunnel (RWBT) Bypass Project.

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), 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) (N.Y.S. Environmental Conservation Law, Art. 8 (§8-0101 et seq.)), as well as local ordinances. Of these, the primary mechanism for protection of the water supply is the WR&R.

DEP's efforts focus 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) and active construction sites.

6.1 Project Review

Each project proposed in the watershed, including those DEP designed or sponsored, is reviewed to ensure compliance with the WR&R, as well as federal, state, and local laws. Projects requiring DEP review and approval include all wastewater treatment systems, projects requiring stormwater pollution prevention plans (SWPPPs), and the construction of certain impervious surfaces. In addition, DEP reviews and issues individual residential stormwater permits (IRSPs) and stream crossing/piping/diversion permits. DEP also ensures that during and after construction, projects requiring 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 sent to NYSDEC for special permits involving mining, timber harvesting, industrial activities, stream disturbance, and wetland incursions. These applications are forwarded to DEP for review and comment as provided for in the DEP/NYSDEC Memorandum of Understanding.

Table 6.1 lists the number of new projects received in 2016 in the EOH Filtration Avoidance Determination (FAD) basins. These projects are all stormwater; variance; and new or repaired commercial, institutional and multi-family SSTS applications. (See the biannual Filtration Avoidance 6.1 Project Activities reports for project summaries and maps showing project locations.) The new, delegated, and remediated individual SSTSs for these basins are listed in Table 6.2.

Table 6.1 New projects 2016 located in the EOH FAD basins.

Reservoir	Town	SP	IS	VA	Total
Croton Falls	Carmel	4			4
Kensico	North Castle	2			2
West Branch	Carmel	1		1	2
Totals		7		1	8

SP = stormwater and crossing, piping, diversion; VA = variance; IS = Intermediate SSTs

Table 6.2 All delegated (new and remediated) individual SSTs located in the EOH FAD basins.

Reservoir	Total Delegated SSSTs	Delegated New SSSTs	Delegated SSTs repairs	Approvals	Under Construction
Boyds Corners	5		5	3	
Cross River	12	11	1	10	6
Croton Falls	15	5	10	4	4
West Branch	12	11	1		1
Totals	44	27	17	17	11

All new and repaired SSTS applications in the Kensico, West Branch, Boyds 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 SSTs located in Dutchess County are reviewed and approved by DEP.

Table 6.3 lists new projects received in 2016 located in the WOH basins. These projects include new or repaired commercial, institutional, and multi-family SSTs. The “Other” projects include New York State Department of Transportation (NYSDOT) projects, mining applications from NYSDEC, timber harvesting, DEP Bureau of Engineering Design and Construction projects and stormwater retrofit projects. (See the biannual Filtration Avoidance 6.1 Project Activities reports for project summaries and maps showing project locations.) New, delegated, and remediated individual SSTs are listed in Table 6.4 (Catskill basins) and Table 6.5 (Delaware basins).

Table 6.3 New projects 2016 located in the WOH basins.

Reservoir	Town	CR	IS	OT	SC	CN	SP	SD	Total
Ashokan	Hunter						1		1
Ashokan	Olive			1					1
Ashokan	Shandaken	1		4				1	6
Ashokan	Woodstock			1					1
Cannonsville	Bovina						1	1	2
Cannonsville	Delhi			2			1		3
Cannonsville	Hamden							1	1
Cannonsville	Kortright					1	3	1	5
Cannonsville	Stamford							1	1
Cannonsville	Walton	1		2				1	4
Neversink	Denning						1		1
Neversink	Neversink	1							1
Pepacton	Andes						1		1
Pepacton	Colchester			1					1
Pepacton	Fleischmanns/V				1		1	1	3
Pepacton	Margaretville/V						1		1
Pepacton	Middletown			2					2
Pepacton	Roxbury							1	1
Rondout	Neversink	1	1						2
Schoharie	Conesville		1				1		2
Schoharie	Gilboa				1			1	2
Schoharie	Hunter	1	1			1	2		5
Schoharie	Jewett	1	1					2	4
Schoharie	Lexington			2			1		3
Schoharie	Prattsville			1	2		2		5
Schoharie	Roxbury	1					1		2
Schoharie	Windham		3	2			2		7
Totals		7	7	18	4	2	19	11	68

CR = intermediate repair; IS = intermediate SSTS; OT = other; SC = sewer collection; CN = sewer connection; SP = stormwater and crossing, piping, diversion; SD = stream disturbance.

Table 6.4 New, delegated, and remediated individual SSTs in the Ashokan and Schoharie basins, 2016.

Reservoir	Delegated SSTs	New SSTs	SSTS repairs	Approvals	Under construction
Ashokan	13	N/A ²	60	85	55
Schoharie	N/A ¹	29	56	86	75
Total	13	29	116	171	130

1 DEP does not have a Delegation Agreement with Greene or Schoharie Counties, so the number of delegated SSTs is not applicable to these reservoirs.

2 Reviews of new SSTs are delegated to Ulster County under that county's Delegation Agreement, so the results for new SSTs are reported here as delegated SST results.

Table 6.5 New, delegated, and remediated individual SSTs in the Cannonsville, Neversink, Pepacton, and Rondout Reservoir basins, 2016.

Reservoir	Delegated SSTs	New SSTs	SSTS repairs	Approvals	Under construction
Cannonsville	N/A ¹	23	67	92	85
Neversink			7	7	12
Pepacton	N/A ¹	16	50	66	60
Rondout	1	1	7	10	14
Total	1	40	131	175	171

1 DEP does not have a Delegation Agreement with Delaware County, so the number of delegated SSTs is not applicable to these reservoirs.

6.1.1 SEQRA Coordination

DEP conducts reviews of all 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 SEQRA 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), Supplemental Environmental Impact Statements (SEISs), Supplemental Draft Environmental Impact Statements (SDEISs), Draft Supplemental Environmental Impact Statements (DSEISs), and Findings to Approve or Deny. Table 6.6 presents a summary of all SEQRA reviews that occurred in 2016.

Table 6.6 SEQRA reviews in 2016.

Received	Reviewed	Comment Letters Issued	Ongoing Reviews*	SEQRA Process Closed*
132	134	101	75	81

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. (SEQRA Type I Actions are those actions or projects that the Lead Agency determines may have a significant adverse impact on the environment and require the preparation of an EIS.)

Table 6.7 2016 SEQRA review and status for significant Type I Actions.

Project name	Town/County	Basin	Description	Status
Access Northeast	Multiple towns/Westchester & Putnam	Multiple	Third phase of Algonquin Pipeline expansion that proposes to replace about 12.7 miles of existing pipeline from Somers to Southeast. Modifications to the existing compressor station in Southeast, and the metering and regulating stations located in Somers and Southeast.	DEP received and issued comment letter on draft Resource Reports. DEP received and issued comment letter on draft Scope.
Delhi Water System Improvements	(V) Delhi/Delaware	Cannonsville	Replacement of 3,500 feet of existing water main and installation of a well pump and new onsite treatment facility.	DEP received project notification and issued comment letter. Lead Agency issued a Negative Declaration.
Parking Garage at 11 New King Street	North Castle/Westchester	Kensico	Proposed multi-story parking garage to provide parking for the Westchester County Airport.	DEP received and issued comment letter on the DSEIS.

Project name	Town/County	Basin	Description	Status
Atlantic Bridge	Multiple towns/ Westchester	Multiple	Second phase of Algonquin Pipeline expansion that proposes to replace 6.3 miles of existing 26-inch diameter pipeline with 42-inch diameter pipe. Of the 6.3 miles, 4.0 miles of new pipeline will be installed in Yorktown and Somers. The metering station in Yorktown is also proposed to be upgraded.	DEP reviewed and issued comment letters on the Environmental Assessment and Draft Resource Reports.
The Vue	North Castle/ Westchester	Kensico	Proposed zoning amendment to allow development of 200 units and 420 parking spaces served by municipal water and sewer.	DEP received project notification and issued comment letter. Lead Agency issued a Positive Declaration and request for Scoping.
PepsiCo R&D Facility	Mt. Pleasant/ Westchester	Kensico	Proposed construction of a new 122,000 sq. ft. building and 125 additional parking spaces on the existing PepsiCo Inc. c/o Frito Lay campus to be served by municipal water and sewer.	DEP received project notification and issued comment letter. DEP received Lead Agency Positive Declaration and issued comment letter on draft Scope.
Baker Residential	Mt. Pleasant/ Westchester	Kensico	Proposed 116-lot residential subdivision to be served by municipal water and sewer.	DEP reviewed and issued comment letter on DEIS.

Project name	Town/County	Basin	Description	Status
Prattsville Water District	Prattsville/Greene	Schoharie	Proposed replacement and installation of at least one well, construction of control and improvements to the distribution system.	DEP received project notification and issued comment letter. Lead Agency issued a Negative Declaration.

6.1.2 Delegation Agreements

Westchester and Putnam counties review new, modified, and repaired SSTs in accordance with their delegation agreements with DEP. Ulster County performs reviews of new SSTs in accordance with its delegation agreement.

DEP received documentation concerning the review of 67 delegated SSTs during 2016. Twenty-three of these reviews were for projects located in the WOH watershed; 44 delegated SSTs were located in the EOH FAD Basins.

6.2 Enforcement Activities

DEP investigates and confirms SST failures, issues Notices of Violation (NOVs), pursues enforcement actions on failed SSTs, and refers certain criminal activity to 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 MOA program area.

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. 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.

In 2016, DEP Police:

- Completed 12,643 hours of training.
- Conducted 6,954 preliminary investigations.
- Conducted 480 long-term investigations related to pollution or terrorism.
- Patrolled 1,544,234 miles.
- Conducted 303,204 physical security inspections.

Also in 2016, the DEP Police made 28 arrests, issued 1,578 summonses, and served 923 Notices of Warning for violations of the New York State Penal Law, the New York State Environmental Conservation Law, the New York State Vehicle & 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, year-round-operating WWTP. A minimum of two compliance inspections per year are conducted during the operating season at seasonal surface-discharging facilities. Similarly, at least two such 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. This does not preclude DEP from performing inspections with greater frequency. DEP may also conduct unannounced facility inspections to manage instances of non-compliance, respond to abnormal or emergency operating conditions, react to mistakes or problems with self-monitoring data or record keeping, discuss DEP laboratory sampling results, oversee modifications or expansions to a facility, or fulfill special requests by DEP management.

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

Facility Compliance in the Catskill/Delaware Watershed

Thirty-five WOH WWTPs were inspected by DEP on a regular schedule in 2016. Of these, 28 are permitted for year-round discharge and seven for seasonal discharge. Three of the 35 are wastewater treatment facilities permitted to discharge to groundwater. These are the Chichester hamlet, Mountainside Farms, and Hanah Country Club. Three other facilities are classified as industrial non-contact cooling water discharges: Friesland Campina-DOMO, Kraft Dairy, and Saputo Foods. Altogether, DEP conducted 158 scheduled compliance and emergency response inspections in 2016.

Compliance with State Pollution Discharge Elimination System (SPDES) permits continued to improve among WWTPs in the Catskill/Delaware watersheds in 2016 due largely to the WTCPI Program.

On March 26, 2016, staff received notice of an overflow from the collection system serving the Town of Andes WWTP. The spill, coming from two manholes on County Road #1, was caused by accumulation of grease and gravel within the line. An estimated 20,000 gallons of sewage spilled, based on the amount of flow recorded at the treatment plant when compared to

normal influent flow readings. Normal flow was restored after the town contracted a jet truck to vacuum the line and remove the blockage. The operator notified NYSDEC and DEP by phone but was unable to file with the NY-alert system due to a password issue. New forms and passwords were established.

DEP participates in Compliance Conferences (CC) with 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 NYSDEC and local regulatory authorities, sends out a NOV letter prior to calling for a CC. DEP did not need to conduct any CCs in 2016 because many problematic and outdated facilities which exceeded their permits on a regular basis have since been connected to an upgraded facility, upgraded as a standalone facility, converted to subsurface discharge, or totally abandoned. This has greatly decreased the number of failed WWTPs.

The Walton WWTP experienced periodic violations for effluent turbidity during the 2016 monitoring period. NYSDEC issued an NOV on April 4, 2016. The condition of several treatment units (aeration tanks, grit removal, secondary clarifiers, Continuously Backwashing Upflow Dual Sand Filter, chemical usage) and the duration of turbidity violations were cited. The facility operator submitted a detailed response to the NOV on April 27, 2016, citing numerous process control adjustments and capital repair/replacement estimates. Changes in the chemical addition regime continue and solids removal from the clarifiers has been increased as necessary. Turbidity meter calibration frequency has been increased to maximize data confidence.

The preliminary, primary, and secondary treatment processes have operated satisfactorily, complying with all wet chemistry and bacteriological SPDES parameters. The turbidity violations, while likely due to an unknown substance being introduced into the collection system, may be the result of an issue within the sand filter. The facility, in concert with DEP, has commissioned a pilot study to define the appropriate media/gradation for current operation. Two standalone sand filters, functioning as a test second stage, have been connected to receive first stage filtered effluent. Two different sand sizes (7mm and 9mm) have been installed and each unit can adjust chemical addition to evaluate the effectiveness of the changes on effluent turbidity. The pilot is activated when the plant is under significant upset condition. At this point, sand filter pilot has been operational for less than one month; the treatment system has been stable and working well. The pilot system will operate for as long as necessary to determine whether filter media and revised chemical addition can address the turbidity issue.

Facility Compliance in the East of Hudson Watershed

The West Branch, Boyds 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 Boyds Corners basins. DEP does, however, 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 2016, DEP conducted 48 scheduled compliance and emergency response inspections for the WWTPs in the EOH FAD basins.

There are nine WWTPs in the West Branch, Croton Falls, and Cross River basins. All were in substantial compliance with their SPDES permit discharge limitations in 2016. Carmel Sewer District #2 WWTP did experience a sewage overflow from its collection on August 9, 2016, that was not entirely contained. Water quality, however, was not impacted. The operator responded to a manhole overflow at the intersection of Fowler Avenue and Route 301 near Lake Gleneida, but the spill was estimated to be less than 500 gallons and did not make it to the lake shore. The area was pumped and limed and a blockage cleared.

For monitoring of the Westlake Sewer Trunk Line, see Section 4.10.1.

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 the Harrison (Park Lane) pump stations and collection system throughout the 2016 monitoring period. The inspections revealed no abnormal conditions.

6.3.1 Sampling of WWTP Effluents

Sampling of surface-discharging WWTP effluents is conducted by DEP's ELAP-approved laboratories throughout the year.

In 2016, grab samples were collected monthly. In addition, composite samples were collected once for the year at non-City owned plants with composite sample monitoring requirements in their SPDES permits. For City-owned plants, the frequency was biweekly and these plants are listed in DEP's Watershed Water Quality Monitoring Plan (DEP 2016).

City-owned WWTPs were also sampled in accordance with SPDES permit requirements and, in most cases, one sample was collected each month. The samples were a combination of grab and composite samples, depending on the parameter, and were analyzed by DEP laboratories. The results were reported to NYSDEC in SPDES Discharge Monitoring Reports. Monitoring of non-contact cooling water discharges was discontinued in 2015.

In the Catskill System, 16 WWTP effluents were sampled in 2016 (four City-owned and 12 non-City owned) and composite samples were collected from nine plants that have the composite sampling requirement (four City-owned and five non-City owned). In the Delaware System, 13 WWTP effluents were sampled (two City-owned and 11 non-City owned). Composite samples were collected at nine of the Delaware WWTPs (two City-owned and seven non-City owned).

In the EOH System, there are 64 WWTPs with active SPDES permits. Only nine are in FAD basins and one of those has no discharge. Therefore, there are eight WWTPs sampled for the FAD EOH. Mahopac STP is the only EOH plant with composite sampling.

Overall in 2016, 1,876 analyses were performed (Kingston=1,858; Contract=18) on 311 effluent samples from WWTPs in the Catskill System (City=192; non-City=119). For the Delaware System, 1,612 analyses were performed for WWTPs (Grahamsville=711; Kingston=832; Contract=69) on 318 effluent samples (City=189; non-City=129). In the EOH System, 5,081 analyses were performed on 736 WWTP effluent samples.

Sampling data are shared regularly with DEP's Wastewater Treatment Plant Compliance and Inspection Program staff for the purpose of tracking compliance with SPDES-permitted effluent limits. Results are also reported to NYSDOH and USEPA semiannually in the Wastewater Treatment Plant Compliance Inspection Report as required by the revised 2007 FAD.

7. In-City Programs

7.1 Waterborne Disease Risk Assessment Program

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

- Obtain data on the rates of giardiasis and cryptosporidiosis in the City, 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 or phone calls to parasitology laboratories by WDRAP staff members — began in July 1993 for giardiasis and in November 1994 for cryptosporidiosis and continued through 2010. In January 2011, active laboratory surveillance was replaced with an electronic reporting system. The Electronic Clinical Laboratory Reporting System (ECLRS) was developed to ensure more rapid and complete accounting of diseases reportable to DOHMH. Collection of giardiasis and cryptosporidiosis case data via ECLRS is ongoing.

For all cryptosporidiosis cases and as needed for giardiasis cases, public health epidemiologists contact patients to verify the data provided in the case reports, to collect additional demographic and clinical information, and to identify possible sources of exposure. During 2016, surveillance for giardiasis and cryptosporidiosis was ongoing, and interviews were conducted. The 2016 preliminary count of cases reported to DOHMH among NYC residents is 893 cases of giardiasis and 193 cases of cryptosporidiosis. Ten giardiasis case interviews were completed and 157 cryptosporidiosis case patient interviews were completed.

An increase in cryptosporidiosis cases was noted in the fall of 2015 and continued into 2016. The increase was observed especially in the area of one of the university hospitals. Further investigation linked many of the early cases to “BioFire,” a polymerase chain reaction (PCR) test for multiple enteric organisms made newly available in the hospital. This test is now being used in additional laboratories in the City. Of all PCR specimens from NYC residents that were sent to the NYSDOH Wadsworth laboratory for confirmation in 2015, 84% were confirmed as *Cryptosporidium* positive and in 2016, 75.3% were confirmed positive.

Attempts were made to interview cases of cryptosporidiosis regardless of method of diagnosis. The increase in cryptosporidiosis cases observed in late 2015 is thought by DOHMH to represent an increase in testing, rather than an increase in cases, because of the availability of the PCR tests being ordered for people who would not ordinarily get a test for *Cryptosporidium*. (Cryptosporidiosis is believed to be underdiagnosed when PCR is not available as it is not included in a routine ova and parasite test).

New York City currently has four outbreak detection systems in operation. Each tracks a different indicator of gastrointestinal illness (GI) in the community.

These systems are not specific to giardiasis or cryptosporidiosis. Also, the systems are not specific for detecting waterborne illness. However, they are useful as an early-warning means and certain findings would trigger immediate investigation of source water quality, watershed conditions, and/or other parameters as deemed appropriate.

All systems rely upon the voluntary participation of the organizations providing the data and all were operational in 2016. In summary, there was no evidence of a drinking water outbreak in New York City in 2016. (A pool-related outbreak was detected and investigated). Following is a brief description of the syndromic surveillance systems in operation in NYC for detection of GI illness.

- Daily tracking of chief complaints (including GI symptoms) from hospital emergency department (ED) logs.
- DOHMH monitors and assists in the investigation of GI outbreaks in eight sentinel nursing homes.
- The number of stool specimens submitted to a clinical laboratory for microbiological testing are tracked.
- Sales of over-the-counter or non-prescription anti-diarrheal medications at major chain stores are monitored.

Each year a WDRAP Annual Report is prepared which provides considerably more detail than contained in this chapter. Those annual reports include more complete findings from disease surveillance and case follow-up (including demographic data and interview results for giardiasis and cryptosporidiosis cases); summary results from syndromic surveillance programs; and WDRAP program implementation information. The WDRAP Annual Reports are posted at: http://www.nyc.gov/html/dep/html/drinking_water/wdrap.shtml.

7.2 Cross Connection Control Program

To protect New York City's drinking water supply system from contamination, DEP has a robust water quality monitoring program and regularly performs sampling throughout the City to ensure all relevant state and federal standards are met. The Cross Connection Control Program, authorized by Subpart 5-1.31 of the New York State Sanitary Code, is one of the tools DEP employs to complement the water quality sampling program.

During 2016, the Cross Connection Control Program continued to exceed most of the milestones established by the revised 2007 FAD (NYSDOH 2014) for all reporting categories except one. The "Review Requests for Exemption" category is tracking close to but below the estimated frequency.

The Bureau's rigorous oversight and regulation of cross connection control/backflow prevention activity — which includes inspection, incident response, enforcement, and plan review — continues to provide an excellent level of protection for the City's public water supply system. A notable change in the program in 2016 was the addition of six new hearing dates per month for compliance violations before the Environmental Control Board. The Bureau is continuing a pilot program to accept online submissions for cross connection control through the Water and Sewer Permitting System (WSPS). That system allows backflow prevention device plan applications to be filed for review online. Initial and annual test reports are also accepted online through the WSPS pilot.

In 2016, DEP responded to three separate incidents related to a backflow or cross connection condition.

- June 1, 2016, Queens; An inspection stemming from a water-quality consumer complaint found residential buildings with multiple cross-connected wells internally joined to their potable water system. Violations were issued to sever the connected wells from the potable system and install backflow prevention devices. The City water supply was not affected.
- July 1, 2016, Queens; Inspectors found a cross connection at a car wash well. The pumps for the well were not operating and the check valves were not holding, causing the well water meter to malfunction. Violations were issued to correct all problems and the City water supply was not affected.
- February 11, 2016, the Bronx; A DEP field operations crew reported sudsy discharge from a hydrant after it was repaired and pressurized. Inspection of the area found a soap factory without a backflow prevention device on its water service lines. Violations were issued to install backflow prevention devices. The water main was adequately flushed and tested prior to being returned to service.

The metrics for this reporting period are presented in Table 7.1.

In-City Programs

Table 7.1 Cross Connection FAD milestones.

Annual and semi-annual 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 reviewed	Notices of Violation issued for failure to test annually
Jan.- Dec. 2016	3	5,613	2,317	5,984	4	351	5,572
FAD Requirement Anticipated Frequency*	As Needed	300-450/year	Estimated 225/year	Estimated 400/year	TBD	Estimated 400/year	Estimated 200/year

** Some activities are performed on an as-needed basis, therefore milestones for these activities are “as needed” or “estimated” since they are based on the programmatic participation of the NYC community. There is no established minimum level of response for backflow preventer plans accepted with self-certification.*

8. Education and Outreach

Throughout 2016, DEP continued to collaborate with the Catskill Watershed Corporation (CWC), the Watershed Agricultural Council (WAC), Cornell Cooperative Extension (CCE), Soil and Water Conservation Districts (SWCDs), the Catskill Center for Conservation and Development, the Catskill Regional Invasive Species Partnership (CRISP), the Lower Hudson Partnership for Invasive Species Management, and other partners to advance a comprehensive watershed education and outreach program. This collaboration strives to increase knowledge and awareness about the importance of source water protection, land use planning and stewardship, stream corridor protection, stormwater and wastewater management, flood response and preparedness, invasive species control, watershed recreation, land acquisition and conservation, riparian buffer protection, and other topics.

DEP directly disseminates information to all constituents in a timely manner through the agency's website (nyc.gov/dep), social media, press releases, and e-newsletters. In 2016, DEP launched an interactive digital mapping tool (nyc.gov/dep/recreation) that allows users to search over 130,000 acres of City-owned lands open for public recreation and locate properties for hiking, fishing and other types of outdoor activities. DEP also disseminated nine issues of its watershed recreation e-newsletter to approximately 92,500 subscribers by the end of 2016.

Another way DEP engages with watershed constituents is through recreational events and stewardship-based activities on City-owned lands. In 2016, DEP organized five Family Fishing Days at four different reservoirs that were attended by over 900 people. DEP also organized, supported, or participated in a wetlands walk, a youth pheasant hunt, a deer jaw ageing class, several forestry interpretive hikes and reservoir paddling events, and a Kensico Reservoir Boat Stewardship Training. DEP also collaborated with partners to organize a reservoir clean-up day at nine different reservoirs that engaged 264 volunteers.

Throughout 2016, one of the most significant ways DEP and its partners continued to inform and educate specific audiences was through targeted watershed programs. For example:

- The CWC Public Education Program awarded 26 education grants totaling \$164,906 to schools and organizations in the watershed and New York City. In support of this program, the CWC continued to host the watershededucators.org website. The CWC also sponsored a series of septic system maintenance workshops for homeowners and municipal training workshops for local officials.
- The Watershed Agricultural Program (WAP) conducted more than two dozen farmer education programs attended by 870 participants, including workshops, conferences, and farm tours. In addition, the WAC Pure Catskills Campaign (purecatskills.com) continued to promote the purchase of local products throughout the watershed and New York City.

- The Watershed Forestry Program supported a range of forest landowner education programs and opportunities (including the mywoodlot.com website). It also sponsored nine professional training workshops for loggers and conducted school-based programs for thousands of students and teachers in the watershed and New York City. The watershed model forests hosted dozens of forestry education programs during 2016, including logger training workshops, landowner woods walks, and various bus tours and field trips for students and teachers.
- The Stream Management Program supported and participated in dozens of educational programs and training opportunities for streamside landowners and local officials, including workshops, lectures, interpretive hikes, volunteer planting events, Schoharie Watershed Month, Ulster Creek Week, local flood commission meetings, and basin-specific project advisory committees. DEP also continued to support the catskillstreams.org website, which provides a valuable source of timely information for landowners, local officials, and stream professionals.
- The Land Acquisition Program worked with land trusts and local partners to inform watershed landowners and communities about a variety of land protection, land conservation, and flood buyout opportunities.
- The Trout in the Classroom Program engaged over 3,000 students and teachers from more than 150 schools in the watershed and New York City.
- DEP's Water Resources Art & Poetry Contest engaged over 1,800 students from more than 100 schools in the watershed and New York City.
- DEP's Education Office conducted more than 270 education programs for over 11,000 students, including classroom-based lessons at schools, colleges, and the Newtown Creek Visitor Center in Brooklyn. DEP also conducted professional development workshops and trainings for more than 1,000 educators from the watershed and New York City.

Finally, DEP and its partners sponsored or attended hundreds of community events and professional conferences throughout 2016 in all watershed counties and all five boroughs of New York City. These large-scale events are important venues for displaying and promoting watershed exhibits, conducting interactive demonstrations or scientific presentations, and disseminating information to a broad public audience. Highlights for 2016 include:

- Andes Community Day (hundreds of attendees)
- Bovina Farm Day (over 1,000 attendees)
- Catskills Creameries "Come Travel The Milky Way" Farm Tour (1,000 participants)
- Catskills Environmental Research & Monitoring Conference (150 participants)
- Clearpool Model Forest Maple Sugaring Event (250 participants)

- Delaware County Clean Sweep Event (approximately 500 participants)
- Delaware County Fair (over 75,000 attendees)
- DEP’s “City That Drinks The Mountain Sky” Manhattan Performance (1,000 attendees)
- DEP’s Newtown Creek Visitor Center Valentine’s Day Tour (300 participants)
- DEP’s Water-On-The-Go Program (over 800,000 visitors)
- Grahamsville Little World’s Fair (thousands of attendees)
- International Restaurant and Food Show (over 20,000 attendees)
- Lower Hudson Valley Engineering Expo (over 1,000 attendees)
- Margaretville Cauliflower Festival (thousands of attendees)
- NYC Watershed Science and Technical Conference (approximately 150 participants)
- New York State Woodsmen’s Field Days (thousands of attendees)
- Old Salem Horse Show (thousands of attendees)
- Phoenicia Elementary Earth Day (approximately 100 participants)
- Rockland County Sportsman’s Expo (thousands of attendees)
- Schoharie/Otsego Family Farm Day (approximately 300 attendees)
- Shandaken Day (hundreds of attendees)
- Siuslaw Model Forest Environmental Awareness Days (over 350 participants)
- Taste of the Catskills Local Food Event (over 5,000 attendees)
- Teatown Eagle Fest (thousands of attendees)
- Trout in the Classroom Fall Teacher Conference (150 participants)
- Ulster County Fair (over 50,000 attendees)
- West Kortright Fair (over 1,000 attendees)

9. Miscellaneous Reporting Provisions

9.1 Water Conservation/Demand Management

DEP values the role of water conservation and demand management in the responsible long-term management of New York City’s water supply. As a result, actual water demand is down more than 30% since the 1990s, despite increasing population (Figure 9.1). However, DEP must consider the increasing uncertainty of climate change — its predications of warmer temperatures and greater precipitation variability — in its management of the City’s water supply and the demand for this resource. Further, the leaking of the Delaware Aqueduct and its planned shutdown and repair in 2022 as part of DEP’s Water for the Future Program is a near-term certain event that provides an imperative not only to proactively manage, but also explicitly reduce, existing water demand to ensure adequate water supply through this period.

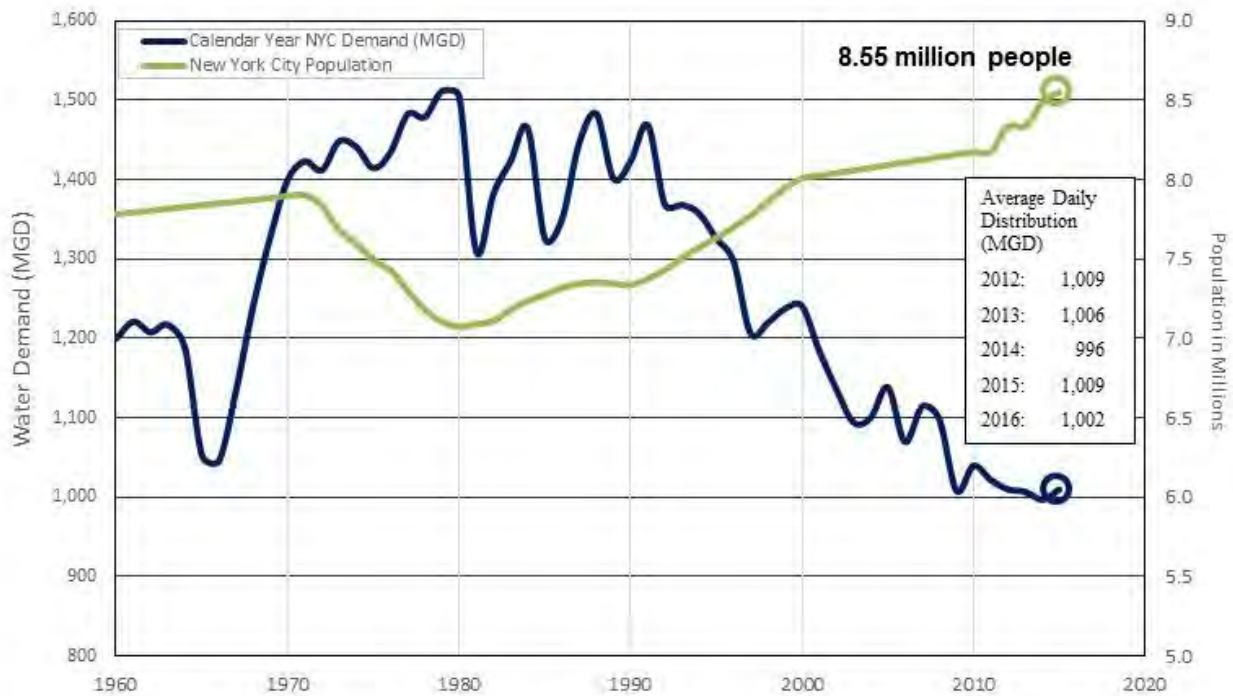


Figure 9.1 New York City water demand and population.

9.1.1 Water Demand Management Plan

DEP's water conservation efforts aim to reduce water use in New York City and upstate communities by 5%, or 50 million gallons of water, per day, from the 2012 demand level by the year 2020. The Water Demand Management Plan, which can be found at <http://www.nyc.gov/html/dep/pdf/conservation/water-demand-management-plan-single-page.pdf>, sets forth five major strategies DEP will implement to reduce water use. In 2014, DEP added an additional strategy. The six strategies are:

- Municipal Water Efficiency Program, which involves retrofits of city-owned properties.
- Residential Water Efficiency Program, which focuses primarily on the Toilet Replacement Program for multi-family buildings and other residential properties.
- Non-Residential Water Efficiency Program, involving collaboration with private sector organizations including businesses, hospitals, universities, and theaters.
- Water Distribution System Optimization, entailing system repairs and upgrades, managing water pressure, and refining water meter accuracy and leak detection.
- Water Supply Shortage Management, which encompasses the review and revision of plans to prepare for a drought and other water shortages.
- Upstate Wholesale Customers Demand Management Program, which targets demand management planning and implementation for wholesale customers north of the City.

Following is a summary of DEP's progress in 2016 concerning the implementation of the above listed strategies.

Municipal Water Efficiency Program

DEP established partnerships with several key municipal agencies and entities to support water efficiency measures in their facilities. Partners include the NYC Department of Education (DOE), the Department of Parks and Recreation (DPR), and the New York City Fire Department (FDNY).

In partnership with DPR, DEP funded 270 individual retrofit projects to replace continuously running spray showers with push button activated models. In addition, bathroom fixtures and plumbing will be updated in 2017 at two large recreation centers to further reduce water consumption.

Through its partnership with DOE, DEP also funded the replacement of over 23,100 toilets and urinals with high-efficiency models in 230 schools across all five boroughs. By June 2017, an additional 100 schools and 7,700 fixtures will be replaced. DEP anticipates 500 schools will be retrofitted by 2020, accounting for 40,000 total fixture replacements. Collaborating with CUNY, DEP funded the replacement of over 300 toilets and urinals at the City College of New York campus.

After years of coordination and planning, DEP is partnering with FDNY and is funding a water recycling and reuse project at the FDNY Chauffeur School on Randall's Island that is estimated to save 30,000 gallons per day.

In 2016, DEP completed its third Water Challenge at wastewater treatment plants (WWTPs) to encourage water reduction in DEP's own facilities. Of the 10 WWTPs that have participated in these challenges, five were able to achieve a 10% reduction over the previous year's baseline average. DEP also expanded its program to replace water hoses used to clean equipment at every treatment plant with high-efficiency models by doubling the amount of high-efficiency hoses at each plant. DEP is currently working to address inefficient water pumps and other equipment that could be replaced with high-efficiency models.

Residential Water Efficiency Program

In early 2014, DEP launched the Toilet Replacement Program. Eligible residential building owners who are part of the Multi-Family Conservation Program can receive \$125 vouchers to replace old, inefficient toilets with high-efficiency, WaterSense-certified models. DEP manages contracts with four toilet wholesale vendors to accept the vouchers and provide the toilets to consumers through the program's online application tool. Through 2016, the program has replaced 11,000 old toilets.

In addition to establishing the Toilet Replacement Program, DEP directed its contractor, Honeywell, to provide building owners with complimentary household water surveys to promote water conservation in their buildings. The surveys assist building owners with identifying opportunities for water savings and detecting leaks. In 2016, Honeywell conducted surveys in 3,040 individual apartments in 2,347 single-family apartment buildings. Honeywell also surveyed 900 multi-family buildings and 15,437 individual units within these properties.

Non-Residential Water Efficiency Program

DEP successfully launched three water challenges to different commercial sectors. Modeled after the Mayor's Carbon Challenge, participants are encouraged to reduce their annual water consumption by an average of 5% from their baseline year (measured as the 12-month period prior to the beginning of the Challenge). DEP prepares monthly reports to help participants track their consumption and their performance against the other benchmarked participants in the Challenge. DEP also hosts quarterly workshops to help participants learn how to make their facilities more water efficient.

In past years, challenges were issued to hotels and restaurants. On January 1, 2016, DEP launched a Water Challenge to hospitals. The three participants are Memorial Sloan Kettering, Queens Presbyterian, and Harlem Hospital and the challenge duration is two years to allow participants to study their seasonal water usage. DEP hosted workshops to give participants the tools to perform water audits and create water demand management plans for their properties. If

all hospitals achieve a 5% reduction at the challenge's conclusion, the savings achieved would be approximately 60,000 gallons per day.

Water Distribution System Optimization

Water distribution system optimization entails repairs and upgrades to the system, managing water pressure, and refining water meter accuracy and leak detection. In 2016, DEP surveyed 3,181.66 miles of water mains for leaks. As a result of leaks proactively found and repaired, DEP estimates that 1.58 million gallons of water per day were saved.

DEP recently implemented a more strategic approach to leak detection. In this new approach, local, borough-based teams properly trained in leak detection target specific areas served by older network mains more likely to need both preventive and corrective maintenance. These teams are able to respond rapidly to any identified problems compared to the slower response times experienced in many locations when DEP relied on one consolidated resource center. Leaking and/or vandalized fire hydrants can also result in significant water waste: an illegally opened fire hydrant can release more than 1,000 gallons per minute and drop pressure. In 2016, DEP repaired 11,690 hydrants, replaced 1,595, and provided other maintenance services to 11,429 additional hydrants.

DEP's efforts to achieve universal metering of all DEP water and sewer accounts is motivated by the need to reduce non-revenue water and promote conservation among water users by providing accurate information on their consumption. The universal metering initiative is also critical to measuring the success of many other demand management strategies. Accurate consumption data enables DEP to determine whether projected reductions in consumption among target consumer groups have been reached, or how demand management strategies may be adapted to improve their effectiveness. DEP replaced 3,902 large meters in 2015 and 804 large meters in 2016 (i.e., those over 1.5 inches in diameter).

Water Supply Shortage Management

In December 2016 the Mayor's Office of Operations and the City Law Department certified DEP's revisions to the "Emergency Drought Rules." The proposed revised title is "Water Shortage Rules," replacing the narrower focus of the previous title. The proposed revisions address water shortage emergencies due to circumstances other than natural conditions, such as planned and unplanned infrastructure outages and repair that New York City may face over the next several years. The proposed revisions also add, remove, and change certain water-use prohibitions during the different stages of water shortage emergencies to better reflect DEP's current understanding of City water use. DEP anticipates formal approval and adoption of the revised rules in 2017.

Upstate Wholesale Customers Demand Management Program

In 2014, DEP kicked off the demand management program for wholesale customers in upstate watershed communities. These customers make up 10% of the system's current consumption. As of 2016, DEP is working with 11 customers (approximately 85% of the total upstate wholesale consumption) to develop Demand Management Plans for their systems with a target 5% reduction in consumption. To date, nine wholesale customers are currently participating and two are pending participation. The Demand Management Plan for the Village of Ossining was finalized in May 2016. Eight Demand Management Plans are in draft form. DEP anticipates Ossining's Demand Management Plan will be implemented in 2017.

9.2 Updates to Drought Management Plan

Although precipitation, runoff, and storage levels were below normal in 2016, it was not necessary to invoke the City's Drought Management Plan. The probability of refill did not fall below 50% for the Catskill or Delaware Systems. However, the combined storage of the city's Delaware River Basin reservoirs (Pepacton, Cannonsville, and Neversink) fell below 40 percent. When this storage threshold is crossed, it triggers a drought-stage action.

On November 23, 2016, the Delaware River Basin Commission (DRBC) declared a drought watch for the entire Delaware River Basin. This action was passed with concurrence from the parties of the 1954 U.S. Supreme Court Decree, which includes the City and the states of New York, New Jersey, Pennsylvania, and Delaware. Out-of-basin diversions to New York City established by the 1954 decree were reduced. Delaware River flow objectives at Montague and Trenton, NJ were reduced. The primary drought management objective is to provide for conservation of reservoir storage for water supply and flow augmentation in the Delaware River and salinity control in the Delaware River estuary. The Delaware River basin-wide drought watch was lifted on January 18, 2017.

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 System 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 a prohibition on watering sidewalks and lawns between November 1 and March 31 and illegally opening fire hydrants.

9.3 Delaware Aqueduct Leak

DEP efforts to repair the Delaware Aqueduct continued in 2016. Major activities included:

- Tunnel dewatering preparation
- Rondout-West Branch Tunnel (RWBT) repair—site and shaft construction (contract BT-1) and tunnel design (contract BT-2)
- Hydraulic investigations of the RWBT
- Catskill Aqueduct repair and rehabilitation

Tunnel Dewatering Preparation

The 80 million gallons per day pumping station, which is capable of dewatering the RWBT under any expected conditions, is now ready to operate.

RWBT Bypass and Repair—Site and Shafts (BT-1) and Bypass Tunnel (BT-2)

The RWBT bypass project is being implemented through two contracts. Contract BT-1, for site and shaft construction, was completed in April 2016. (Figure 9.2)

The bypass tunnel contract, BT-2, is underway. Work performed under this contract will connect the shafts. Upon completion of this effort, the tie-in to the existing RWBT will



Figure 9.2 Aerial view of the Shaft 5B site.

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.

Hydraulic Investigations of the RWBT

Investigations of the RWBT helped DEP assess the nature and degree of leakage stemming from the aqueduct. Various efforts in 2016 to study the nature of the leak are described below.

- The Tunnel Monitoring Program continued under the DEL-LTA contract. 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. The monitoring efforts detected no substantial change in the structural condition of the tunnel in 2016.
- Surface investigations continued in areas of Roseton and Wawarsing, where water is leaking from the tunnel.
- The DEL-LTA contract will support autonomous underwater vehicle (AUV) and remote-operated vehicle (ROV) operations.

Catskill Aqueduct Repair and Rehabilitation

The Catskill Aqueduct Repair and Rehabilitation project is focused on the north section of the Catskill Aqueduct, which runs between Ashokan Reservoir and Kensico Reservoir, and includes three construction projects. The goal of one project is to inspect the entire aqueduct, repair any deficiencies (including concrete and mechanical components), and remove a biofilm layer on the tunnel walls. Removal of the biofilm will make it possible to visually inspect the tunnel walls and also improve the hydraulic characteristics of the tunnel, which in turn will restore tunnel capacity. The other two construction projects include building chemical addition facilities at the Ashokan Screen Chamber and the Pleasantville Alum Plant. All three projects are expected to go into the construction procurement phase this year, with construction starting late 2017 and early 2018. Also in 2016, the Rondout Pressure Tunnel and Wallkill Drainage Chamber Shaft, both of the Catskill Aqueduct, were inspected with a ROV.

References

- DEP. 2010. [New York City Watershed Rules and Regulations](http://www.nyc.gov/html/dep/pdf/recrules/regulations.pdf). 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>.
- DEP. 2015. Filtration Avoidance Annual Report for the period January 1 through December 31, 2014. Bureau of Water Supply. Valhalla, NY. 149 p. http://www.nyc.gov/html/dep/pdf/reports/fad_11_reporting_-_2014_fad_annual_report_03-15.pdf
- DEP. 2016a. [Watershed Water Quality Monitoring Plan. Directorate of Water Quality](#) (issued October 2008, first revision May 2009, second revision May 2016). Valhalla, NY. 264 p.
- DEP. 2016b. [2016 Long-Term Watershed Protection Program Plan](#). Bureau of Water Supply. Valhalla, NY. 96 p.
- DEP. 2016c. [2016 Watershed Protection Program Summary and Assessment](#). Bureau of Water Supply. Valhalla, NY. 419 p.
- DEP. 2016d. [2015 Watershed Water Quality Annual Report](#). Valhalla, NY. 193 p.
- DEP. 2016e. New York City 2015 Drinking Water Supply and Quality Report. Directorate of Water Quality. Flushing, NY. 20 p. <http://www.nyc.gov/html/dep/pdf/wsstate15.pdf>.
- NYSDOH [New York State Department of Health]. [2014. New York City Filtration Avoidance Determination. Final Revised 2007 FAD](#).
- 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]. 2007. [New York City Filtration Avoidance Determination. Final 2007 FAD](#).