New York City Department of Environmental Protection

Filtration Avoidance Annual Report

for the period January 1 through December 31, 2017

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Cover Photo by Kristen Artz, NYCDEP Photographer
Neversink River

Table of Contents

List of Figures

List of Tables

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
DUA	Day Use Area
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
HPC	Heterotrophic Plate Count
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
NASEM	National Academy of Sciences, Engineering and Medicine
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
NYCFFBO	New York City-Funded Flood Buyout Program
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
PFM	precision feed management
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
SAP	Streamside Acquisition Program
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
WFMP	Watershed Forest Management Plan
WFP	whole farm plan
WOH	West of Hudson
WRF	Water Research Foundation
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 2017, New York City continued to implement a broad array of initiatives as part of the City's source water protection program. Since the first Filtration Avoidance Determination (FAD) was issued in early 1993, the New York City Department of Environmental Protection (DEP) has completed 25 years of its innovative strategy, which is based on one simple premise: It is better to keep water clean at the source than allow it to get contaminated and have to clean it up. The result is that New York City consumers continue to enjoy affordable, high quality water.

The success of the program is the result of a considerable investment by the City in funding and countless staff hours, directed to sustaining 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 program's success 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 focusing on implementing initiatives that address current potential pollution sources and preventing 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.

At the end of 2017, DEP secured its latest FAD – the first ever to cover a full 10-year period, including comprehensive program plans through 2027. The latest FAD builds on the accomplishments to date and continues many of the programs that have been at the core of the water quality protection effort since the early 1990s. However, the City's protection strategy continues to evolve, to account for its achievements, changing watershed conditions and the latest thinking in water quality science and modeling. These program refinements ensure that DEP is proactively addressing current and future threats to water quality.

This annual report covers the period January 1, 2017, through December 31, 2017, and is compiled to satisfy the requirements of the Revised 2007 FAD. The 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.

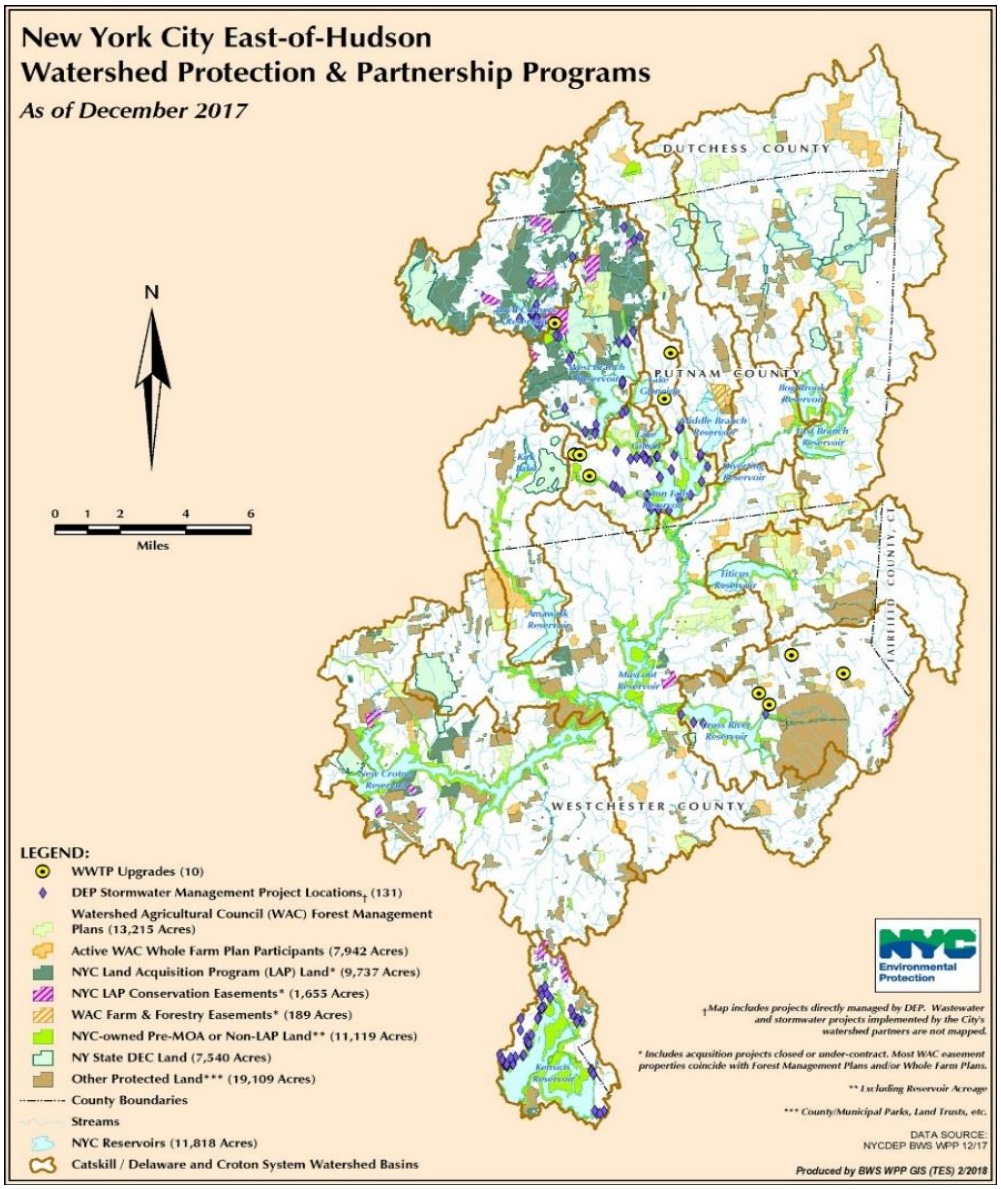

Figure 1.1 New York City East-of-Hudson watershed protection and partnership programs as of December 2017.

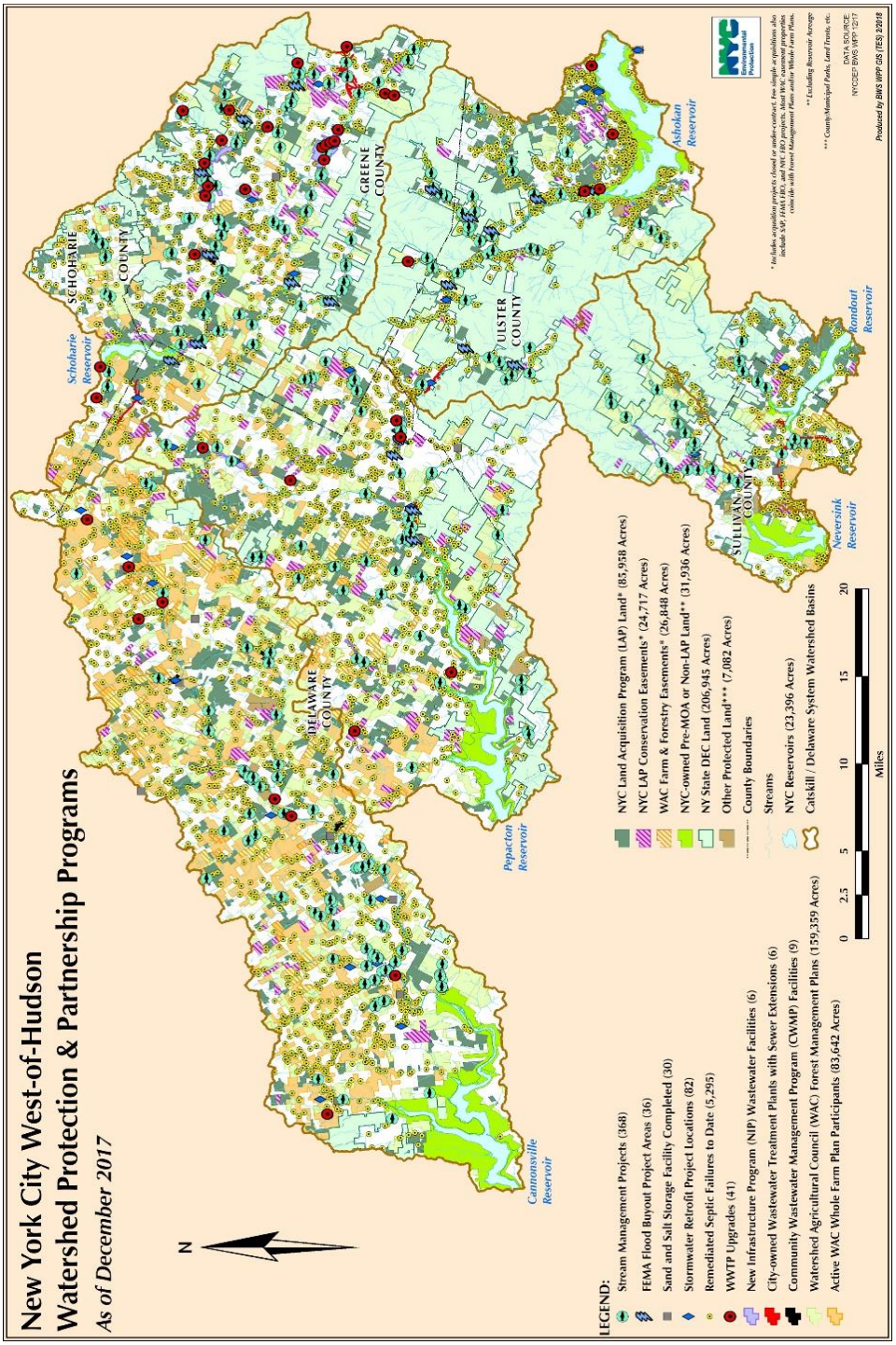

Figure 1.2 New York City West-of-Hudson watershed protection and partnership programs as of December 2017.

2. Federal and State Objective Water Quality Compliance

During 2017, DEP continued its comprehensive water quality monitoring efforts. New York City's sampling program is far more extensive than is required by federal or state law. Each year, the City collects tens of thousands of samples in the watershed and in the distribution system. In 2017, DEP collected 52,293 samples and conducted 615,815 analyses. Of these, DEP collected 36,121 samples and completed 401,195 analyses within the City. Once again, the results were notable: the City complied with the objective criteria of the Surface Water Treatment Rule (SWTR) (USEPA 1989).

On the tenth of every month, DEP provides both the U.S. Environmental Protection Agency (USEPA) and the New York State Department of Health (NYSDOH) with the results of its extensive monitoring program via the monthly Water Quality Report. This is issued in compliance with the requirements of the SWTR and other federal regulations in effect since 1991. The City, as an unfiltered surface drinking water supplier, must meet the SWTR specified objective criteria for the unfiltered Catskill/Delaware System and demonstrate this in the monthly Water Quality Report. The information provided below summarizes compliance monitoring conducted during 2017.

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 2017, all monitoring samples complied with SWTR-defined thresholds.

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

In 2017, the Catskill Aqueduct south of Kensico Reservoir was offline; therefore, DEP didn't collect any Catskill Aqueduct effluent fecal coliform samples 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 below the established limit was 100%.

As shown in Figure 2.1, in 2017 the six-month running percentage of positive raw water fecal coliform samples at the Delaware Aqueduct effluent from Kensico Reservoir was zero, well below the maximum percentage of positive samples allowed under the SWTR.

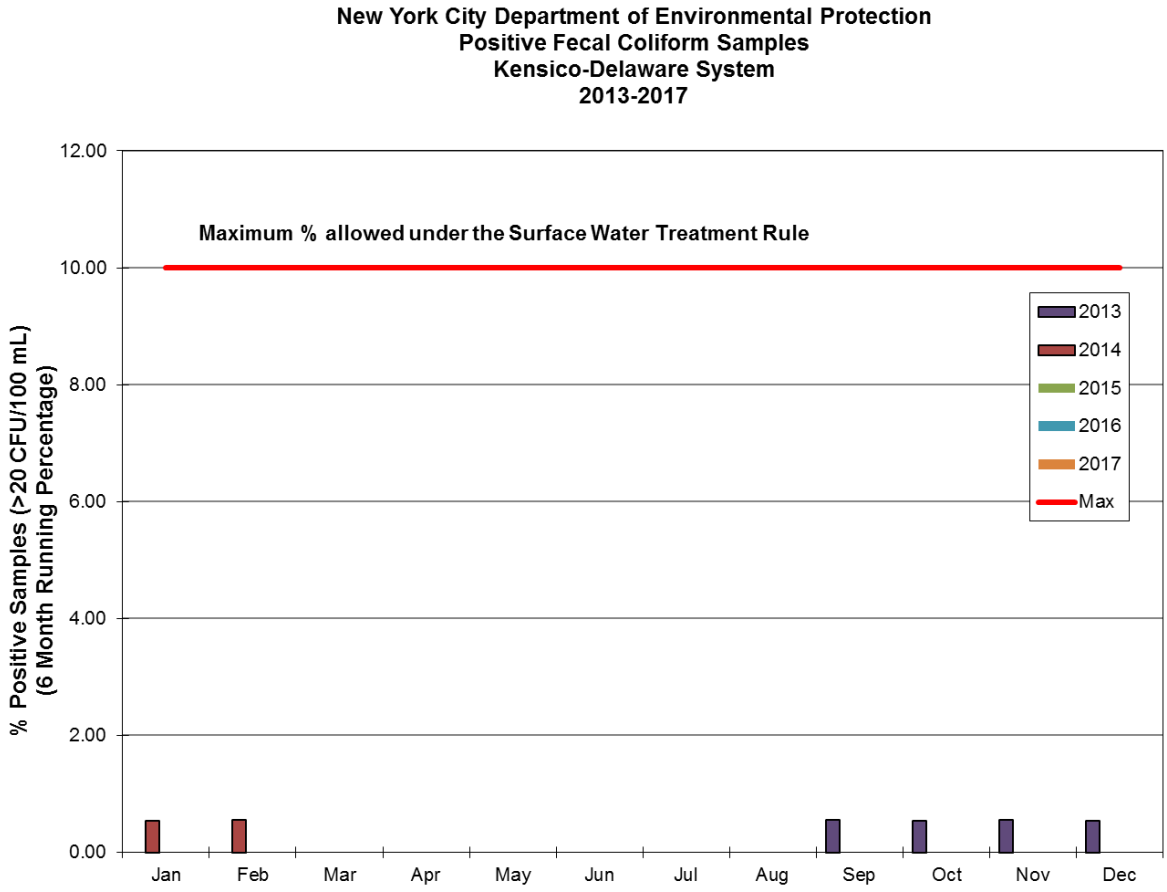

Figure 2.1 Positive fecal coliform samples, Kensico-Delaware System, 2013-2017.

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

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 2017 calendar year (Figure 2.2). No samples were collected from the Catskill Aqueduct in 2017 because the Catskill Aqueduct south of Kensico Reservoir was offline.

2.1.3 Raw Water Disinfection/CT Values (40 CFR Sections 141.71(b)(1)(i) and141.72(a)(1))

CT values recorded each day during the year for the Catskill and Delaware Systems produced net inactivation ratios (IAR) greater than or equal to 1.0. Since the first segment of the Catskill Aqueduct was offline from Kensico to Eastview, the net IAR was measured using the IAR from the first segment of the Delaware Aqueduct from Kensico to Shaft 19 at

Catskill/Delaware UV Treatment Plant (CDUV), and adding the IARs from the CDUV to Hillview Reservoir on each aqueduct (second segments). The actual lowest net IAR in 2017 was 1.9 for the Catskill Aqueduct and 1.7 for the Delaware Aqueduct.

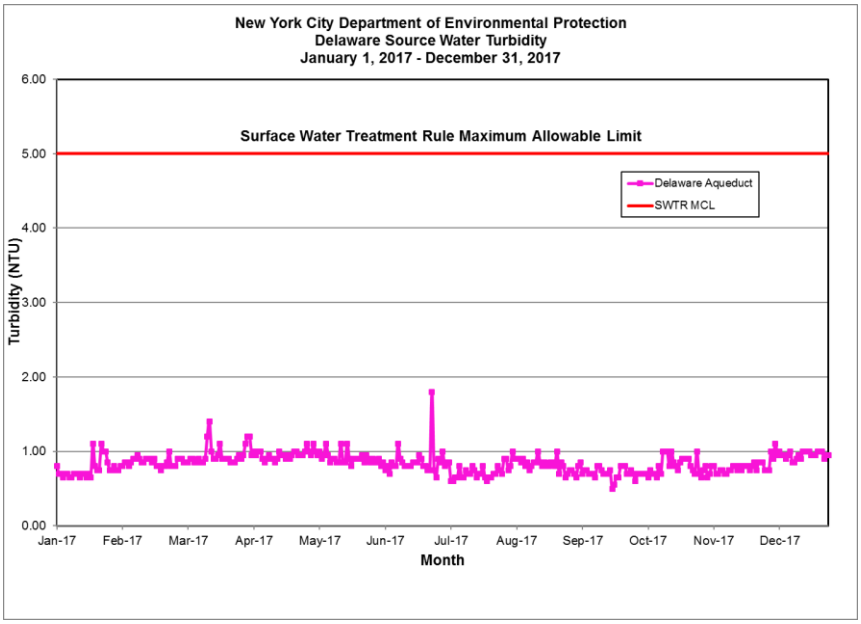

Figure 2.2 Delaware source water turbidity, January 1, 2017-December 31, 2017.

2.1.4 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 2017; chlorine residuals were maintained 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 0.30 mg L^{-1}.

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

Of the 15,994 samples measured for residual chlorine within the distribution system during 2017, all were greater than or equal to 0.01 mg/L, except for nine samples that equaled 0.00 mg/L.

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

The analysis for trihalomethanes in 2017, performed on a quarterly basis, resulted in a maximum total trihalomethane (TTHM) value of 56 μg L^{-1}. The analysis for haloacetic acids, also performed on a quarterly basis, resulted in a maximum haloacetic acid five (HAA5) value of 59 μg L^{-1}.

The highest TTHM quarterly running annual average during 2017, recorded during the first quarter, was 41 μg L^{-1} - a level below the regulated level of 80 μg L^{-1}. The highest HAA5 quarterly running annual average, recorded during the first, third and fourth quarters, was 38 μg L^{-1} - a level below the regulated level of 60 μg L^{-1}.

2.2 Total Coliform Monitoring

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

Within the distribution system, coliform monitoring indicated monthly levels of total coliforms below 0.9% for all of 2017 (Figure 2.3). The number of compliance samples analyzed for total coliforms was 9,759, of which 32 were total coliform positive and two were *E. coli* positive for 2017. The annual percentage of compliance samples that were total coliform positive was 0.3%. Since 1995, DEP has collected more than 239,200 coliform compliance samples, and only 16 of them have tested positive for *E. coli*.

In 2017, heterotrophic plate counts (HPC) were all ≤500 CFU mL^{-1}, equivalent to a measurable free chlorine residual. Zero percent of the samples had an undetectable free chlorine residual or HPC >500 CFU mL^{-1}. This meets the requirements that a free chlorine residual be

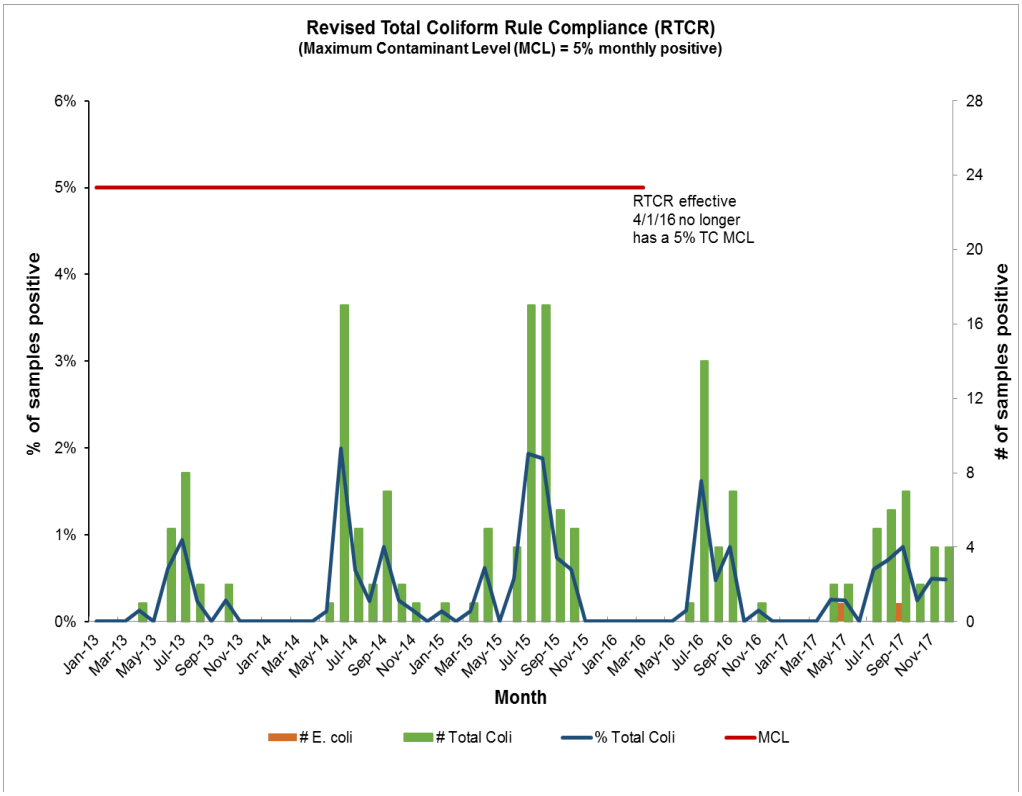

Figure 2.3 Positive total coliform samples, NYC distribution system, 2013-2017.

maintained at representative points in the distribution system, and that no more than 5% of the free chlorine residual samples be undetectable in any two months.

2.2.2 Chlorine Residual Maintenance in the Distribution System

During 2017, DEP continued a number of programs to ensure adequate levels of chlorine throughout the distribution system. They have included maintaining chlorination levels at the distribution system's entry points, conducting localized flushing when necessary, and providing local chlorination booster stations at remote locations. DEP operated two permanent chlorination booster stations during 2017 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, DEP maintained detectable chlorine residuals throughout the distribution system in 2017.

2.3 Expert Panel Review of the Watershed Protection Plan

The 2017 FAD requires DEP to contract with the National Academy of Sciences, Engineering and Medicine (NASEM) to conduct an expert panel review of the City's Long-Term Watershed Protection Plan. The goal is to evaluate the adequacy of the City's Watershed Protection Programs for addressing water quality, water quality trends, and anticipated future activities that might adversely impact the water supply and its ability to comply with 40 CFR §141.71 and §141.171, and 10 NYCRR §5-1.30. The expert panel will provide recommendations, as necessary, for improving programs.

During 2017, the contract with the NASEM was negotiated, drafted and submitted to the City contracting office. The project will commence in early 2018 with the selection and vetting of the expert panel members.

3. Environmental Infrastructure

3.1 Septic Programs

3.1.1 Septic Rehabilitation and Replacement Program

Since 1997, DEP has committed over $100 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 following sub-programs: Priority Area Program (systems located within 700 feet of a watercourse), Hardship Program (systems not located in a priority area where the homeowners meet income eligibility criteria), and Reimbursement Program (systems located outside a priority area and where the homeowner fixed a failing system between July 2, 1999 and December 31, 2017, as funding allows).

In 2017, the Septic System Rehabilitation and Replacement Program funded the repair or replacement of 174 septic systems: 172 systems through the Priority Area Program, one system through the Hardship Program, and one system though the Reimbursement Program. To date, DEP has funded the repair, replacement, or management of over 5,300 septic systems.

3.1.2 Septic Maintenance Program

The intent of the Septic Maintenance Program is to reduce septic system failures by subsidizing regular pump-outs and maintenance. In 2017, the program subsidized 263 septic tank pump-outs, bringing to 1,975 the number of tank pump-outs subsidized since the program's inception.

3.1.3 Other Septic Programs

The Small Business Septic System Rehabilitation and Replacement Program provides funding for the repair or replacement of failed septic systems serving eligible small business owners in the WOH watershed within 700 feet of a watercourse, 500 feet of a reservoir, or within the 60-day travel time area. In 2017, CWC reimbursed two small businesses for the repair or replacement of failing septic systems. To date, the program has funded the repair or replacement of 19 failing systems for small business owners.

During 2017, there was no participation in the Cluster Septic System Program, which funds the planning, design, and construction of cluster systems in 13 WOH watershed communities.

3.2 Community Wastewater Management Program

The Community Wastewater Management Program (CWMP) funds the design and construction of community wastewater management solutions. To date, the CWMP has

completed projects in Bovina, DeLancey, Bloomville, Hamden, Boiceville, Ashland, Trout Creek, Lexington, and South Kortright.

The five remaining CWMP projects include Shandaken, West Conesville, Claryville, Halcottsville, and New Kingston. In 2017, CWC worked with these communities on the study phase of the projects. The draft preliminary engineering reports for these five communities have been completed. Additional project highlights for 2017 are below.

- Shandaken – DEP approved a block grant of $6.77 million in May for a septic maintenance district encompassing 60 systems. Shandaken approved a resolution in September to enter into the pre-construction phase of the project.
- West Conesville – DEP approved a block grant of $8.41 million in July for a community septic system with 54 hook-ups. Conesville approved a resolution in October to enter into the pre-construction phase of the project.
- Claryville – DEP approved a block grant of $8.65 million in April for a septic maintenance district encompassing 130 systems in two towns spanning two counties. The Town of Denning's portion of the project is $3.76 million and the Town of Neversink's portion is $4.89 million. Denning and Neversink approved entering into the pre-construction phase in the summer. Pump-outs and inspections of individual septic system within the hamlet of Claryville began in October.
- Halcottsville – DEP approved a block grant for $8.95 million for a community wastewater project in September that includes a large diameter gravity sewer with pump stations and a force main connection to the City-owned Margaretville Wastewater Treatment Plant (WWTP). The Town of Middletown approved entering into the pre-construction phase of the project in December.
- New Kingston – CWC's consulting engineer prepared a draft preliminary engineers report in December 2016 with a proposed service area that included 28 septic systems. The draft proposed several community septic system sites, each presenting different challenges. Several of the identified sites did not have a willing seller. As of the end of 2017, there was no confirmed site although a potential location is being explored. DEP continues to work with CWC and the town to find a viable site and advance the New Kingston project so that the preliminary engineers report can be finalized and a block grant approved.

3.3 Sewer Extension Program

The Sewer Extension Program funded the design and construction of wastewater sewer extensions connected to City-owned WWTPs in the WOH watershed. In 2017, DEP completed projects in Shandaken (Pine Hill WWTP) and Middletown (Margaretville WWTP). The towns authorized property owners to make connections to the sewer laterals for these projects in the second half of 2017, thereby concluding the program.

3.4 Stormwater Programs

3.4.1 Stormwater Cost-Sharing Programs

DEP pays for incremental costs associated with stormwater measures incurred because of the New York City Watershed Rules and Regulations (WR&R) to the extent they exceed the costs of complying with state and federal requirements. Funding is available to cover the design, construction, and maintenance of stormwater pollution prevention plans and individual residential stormwater plans for new construction after May 1, 1997.

Two separate programs are available - the CWC-administered WOH Future Stormwater Controls Program and the Future Stormwater Controls Paid for by the City Program. Eligible components of future stormwater projects can receive 100% reimbursement. This funding can come completely from the WOH program (municipalities and large businesses) or completely from the Future Stormwater Controls Paid for by the City Program (low-income housing projects and single-family homeowners), or it can come 50% from each program (small businesses).

DEP provided $31.7 million to the CWC to administer the WOH Future Stormwater Controls Program. From this allotment, CWC has reimbursed over $6.6 million to program applicants and transferred over $17 million to other eligible watershed protection programs. The fund balance was approximately $14 million at the end of 2017. Table 3.1 summarizes projects approved for funding under both programs in 2017.

Table 3.1 Future stormwater controls projects in WOH approved for funding in 2017.

Applicant	Project	CWC Funding	Percent Funding CWC/DEP
Community Bank – Fleischmanns Branch	SWPPP for new parking lot	$16,795.00	100% CWC
Delhi Riverwalk Phase 2	Stormwater controls for river walk	$156,141.00	100% CWC
Town of Prattsville Medical Clinic	Stormwater controls for new medical building	$62,444.06	50% CWC
Nick Bove Enterprises, LLC	Additional Funds for new stormwater controls – addition to building	$7,494.50	50% CWC

Applicant	Project	CWC Funding	Percent Funding CWC/DEP
O'Connor Hospital	Stormwater controls for expanded parking lot	$9,540.00	100% CWC
Conestoga Investments, LLC	Design of stormwater controls for building conversion, building expansion, new building	$43,333.90	50% CWC
Long Leasing, LLC	Stormwater controls for removal of building; new building	$16,400.00	50% CWC
Windham Mountain Retreat, LLC	Additional Funds for construction of stormwater controls	$25,795.63	50% CWC
Town of Denning	Additional funds for construction of stormwater controls for Town Hall parking lot	$35,898.00	100% CWC
Frosty Land, LLC	Additional O&M funds	$10,000.00	100% CWC
H.D. Lane Volunteer Fire Company, Inc.	Additional funds for construction of stormwater controls for building addition	$799.70	100% CWC
3115 Route 28,LLC	Additional funds for stormwater controls for new parking lot and building extension	$1,011.82	50% CWC
Community Bank – Fleischmanns Branch	Additional funding for removal of C&D debris in area of new parking lot	$10,981.50	100% CWC
Conestoga Investments, LLC	Additional funds for construction of stormwater measures for building conversion, building expansion, new building	$176,505.13	50% CWC

Applicant	Project	CWC Funding	Percent Funding CWC/DEP
Roxbury Barn, LLC	Additional funds for implementation	$2,205.23	50% CWC
Columbus Midtown Properties, LLC	Design and construction of stormwater measures for new Dollar General store	$89,415.85	100% CWC
Town of Denning	Additional funds for additional engineering services for Town parking lot	$1,185.00	100% CWC
Creative Environments, LLC	Stormwater measures for concrete slab for party tent for weddings	$60,177.50	50% CWC
New York Land & Lakes Development, LLC	Design costs for SWPPP for Maple Ridge Farm subdivision	$5,117.50	50% CWC
Long Leasing, Inc.	Additional funds for stormwater measures for new building	1,250.00	50% CWC

3.4.2 Stormwater Retrofit Program

CWC and DEP jointly administer the Stormwater Retrofit Program, which includes a construction grants component (capital projects), a maintenance component, and a planning and assessment component. The program provides funding for the design, permitting, construction, and maintenance of best management practices to address existing stormwater retrofit runoff in concentrated areas of impervious surfaces.

Through 2017, 82 stormwater retrofit projects have been completed, including 68 construction projects and 14 planning and assessment projects. Five of these construction projects were completed in 2017. Presently, there are eight open construction projects and four open planning and assessment projects. Summaries are presented below in Table 3.2, Table 3.3, and Table 3.4.

Table 3.2 Stormwater retrofit construction projects completed in 2017.

Applicant	Project description	Project cost
Village of Tannersville	Hunter Foundation - Design and installation of stormwater collection, conveyance and treatment structures	$75,780.12
Town of Lexington	Hamlet - design and installation of stormwater collection, conveyance, and treatment structures	$177,719.64
Delaware Valley Hospital	Parking lot - design and installation of stormwater collection, conveyance and treatment structures	$265,949.50
Greene County	Sweeper / Vac Truck	$205,070.00
Town of Shandaken	Town highway garage – design of stormwater collection, conveyance and treatment structures	$17,509.59

Table 3.3 Status of stormwater retrofit construction projects still open in 2017.

Applicant	Project Area	Project description	Status
Village of Delhi	Village of Delhi	Implementation of stormwater mitigation practices to reduce inflow and infiltration into the sanitary sewer system	Open
Town of Roxbury	Lake Street	Stormwater collection, conveyance, and treatment	Construction complete
Town of Shandaken	Hamlet of Pine Hill	Design of stormwater collection, conveyance, and treatment structures	In design
South Kortright Central School	School campus	Design of stormwater collection, conveyance, and treatment structures	Construction
South Kortright Central School	Additional Funds	Stormwater collection, conveyance, and treatment structures	Construction

Applicant	Project Area	Project description	Status
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 area	Design of stormwater collection, conveyance and treatment structures	Design complete
Windham Theatre	Parking lots	Construction of stormwater collection, conveyance and treatment structures	Construction Complete
Village of Delhi	Delhi Riverwalk Phase I	Stormwater collection, conveyance, and treatment structures	Construction Complete
Village of Delhi	Delhi Riverwalk Phase II	Stormwater collection, conveyance, and treatment structures	Construction
Delaware Academy	School campus	Stormwater collection, conveyance, and treatment structures	In Design
Village of Delhi	Delaware County	Street Sweeper	Open

Table 3.4 Summary of planning and assessment projects still open in 2017.

Applicant	Grant amount	Funding Date
Town of Andes	$35,275	2009
Town of Windham	$46,625	2015
Village of Fleischmanns	$46,875	2015
Town of Walton	$50,000	2017

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 October 31, 2018. (http://www.nyc.gov/html/dep/html/watershed_protection/fad.shtml).

4.2 Land Acquisition

Through 2017, the Land Acquisition Program (LAP) has protected nearly 147,000 acres in the Catskill/Delaware watershed, the majority in fee simple but also through conservation easements (CEs) acquired by the City and the Watershed Agricultural Council (WAC). This represents more than a four-fold increase in City-owned land since 1997, all based on voluntary transactions with more than 1,700-signed purchase contracts.

In many reservoir 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 increased the number of protected acres by almost 800%. In

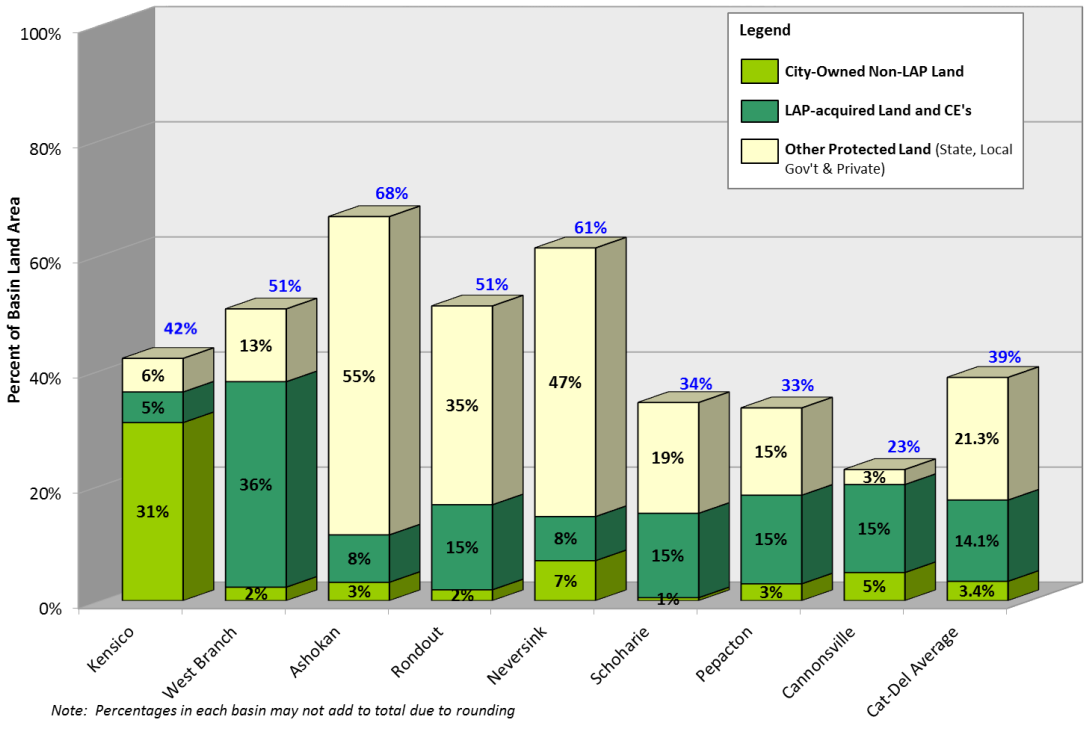

Figure 4.1 Percent of land protected in each Catskill/Delaware basin by real estate type.

the West Branch/Boyd Corners basins, acreage under City control increased by 1,500%, while Schoharie basin acreage jumped by 2,900%. Overall, City-controlled land in the Catskill/Delaware watershed has increased to over 180,000 acres, including CEs secured by DEP and WAC and all deals yet to close. In 1996, the City owned roughly 3.4% of the Catskill/Delaware watershed while New York State and others protected another 21%. Today, roughly 17.5% is City-controlled, representing 45% of all permanently protected land. See Section 4.7.1 for a summary of stream buffers and wetlands protected by real property interests acquired by the City.

4.2.1 Solicitation/Resolicitation

The Revised 2007 Filtration Avoidance Determination (FAD) required a solicitation goal of 300,000 acres over the six-year period, 2012-2017. During 2017, DEP and its program partners solicited 35,933 acres. That brings the total acreage solicited during 2012-2017 to 303,786 acres (Table 4.1). Since 1997, DEP has solicited over 460,000 acres against the overall program-wide requirement of 445,050 acres.

Table 4.1 Solicited acres by calendar year across LAP and six-year FAD period (total solicitation requirement: 300,000 acres)

Calendar Year	LAP CE & Fee (1)	WAC Farm & Forest CE (1)	SAP(1)	NYCFFBO (1)	Solicitation Credit (2) (3)	Total Credit
2012	64,904	2,439	0	0	2,439	67,343
2013	40,702	4,626	0	0	4,626	45,328
2014	38,785	11,202	0	0	10,000	48,785
2015	49,961	46,171	0	0	10,000	59,961
2016	36,436	28,799	620	34	10,000	46,436
2017	25,933	41,625	1,432	17	10,000	35,933
Totals	**256,721**	**134,862**	**2,052**	**51**	**47,065**	**303,786**

Notes:
(1) Actual acres solicited; for WAC, SAP and City FBO, these are raw acres solicited, before application of FAD credit rules as defined in notes (2) and (3).
(2) SAP and NYCFFBO acres credited are equal to solicited acres multiplied by two (i.e. if solicited acres total 60 acres, then 120 acres are credited).
(3) The FAD limits annual solicitation credit for WAC + SAP + City FBO to a maximum of 10,000 acres.

4.2.2 Purchase Contracts in the Catskill/Delaware System

As depicted in Table 4.2, during 2017 DEP and its LAP partners signed (executed) 53 purchase contracts comprising 5,204 acres. These contracts include the first two Watershed Agricultural Council (WAC) forest conservation easements (CE) properties, the first six Streamside Acquisition Program (SAP) properties, and a New York City-Funded Flood Buyout Program (NYCFFBO) property. As depicted in Table 4.3, DEP and its LAP partners closed on 54 purchase contracts comprising 6,371 acres in 2017. These contracts include the first two NYCFFBO acquisition and nine Federal Emergency Management Agency (FEMA) Flood Buyout acquisitions. As of now, 168 CEs totaling 25,700 acres are closed or under contract by DEP.

Table 4.2 Contracts signed in the Catskill/Delaware watershed in 2017 by real estate type.

Type	Contracts	Acres	Av Size	Appraised
City CE	2	285	142	$898,055
NYCFFBO	1	1	1	$86,000
City Fee	40	4,287	107	$15,165,823
SAP	6	41	7	$437,075
WAC Farm CE	2	271	136	$677,750
WAC Forest CE	2	318	393	$401,801
Totals	**53**	**5,204**	**786**	**$17,666,504**

Table 4.3 Contracts closed in the Catskill/Delaware watershed in 2017 by real estate type.

Type	Contracts	Acres	Av. Size	Cost
City CE	3	1,002	334	$2,004,555
NYCFFBO	2	5	3	$253,000
City Fee	31	3,768	122	$11,902,130
FEMA FBO	9	17	2	$60,000
WAC Farm CE	9	1,579	175	$2,782,706
Totals	**54**	**6,371**	**636**	**$17,002,392**

Through 2017, DEP has executed 1,557 purchase contracts comprising 120,418 acres throughout the Catskill/Delaware watershed at a cost of $414.7 million (with additional "soft costs" of about $40 million). Figure 4.2 illustrates acres acquired annually

Of these contracts, DEP has closed deals on 114,540 acres with the remaining projects moving toward closing. In addition, the WAC has closed on 146 farm CEs totaling 26,258 acres, which brings total protected lands in the Catskill/Delaware watershed to 146,676 acres (all executed or closed contracts). Figure 4.3 shows a property DEP acquired in 2017.

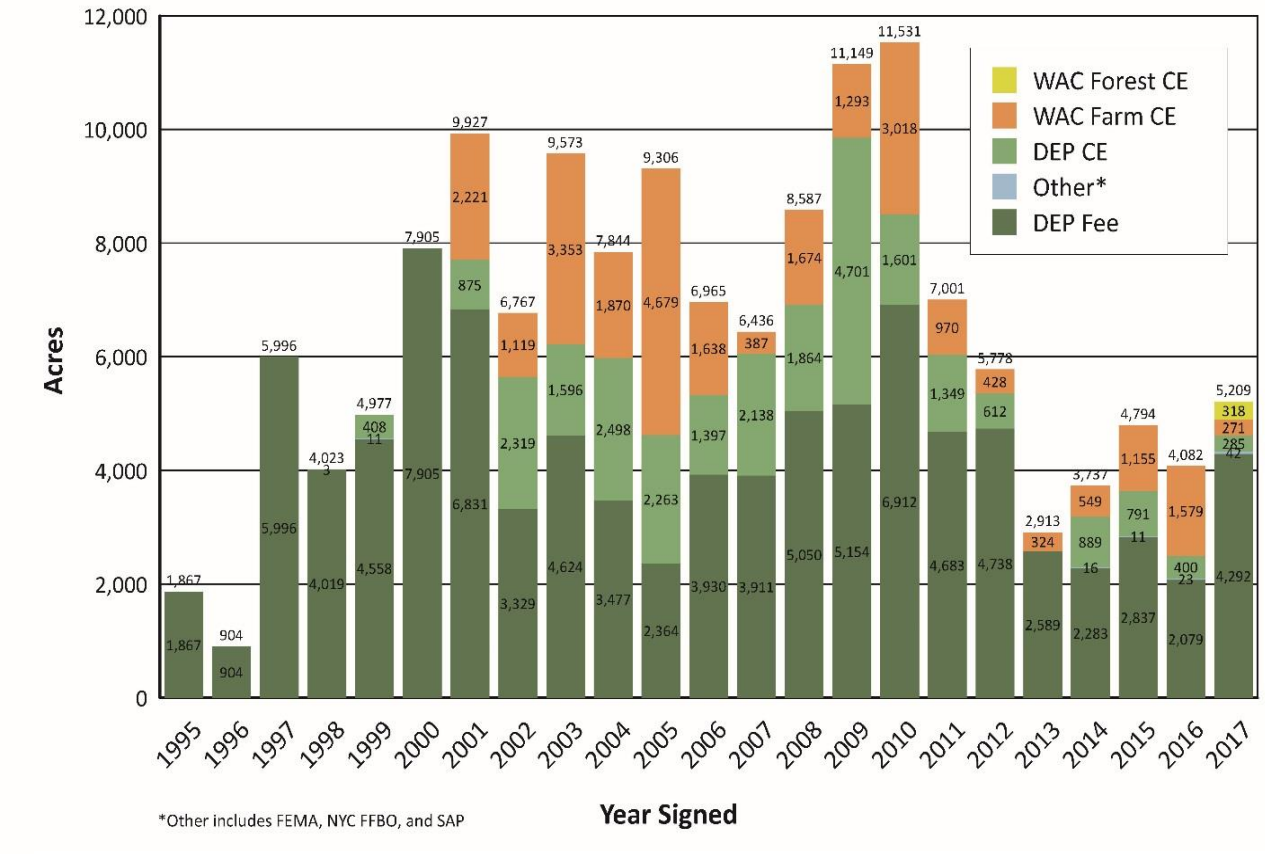

Figure 4.2 Acres in executed contracts by year and real estate type in the Catskill/Delaware watershed.

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

During the reporting period, the New York State Department of Environmental Conservation (NYSDEC) recorded one CE deed conveyed by DEP covering 22 newly acquired parcels totaling 1,326 acres. DEP has also conveyed eight CE deeds covering 102 properties and 8,246 acres, which the state has yet to record. To date, DEP has conveyed to the state 76 CEs on 999 properties comprising 66,372 acres.

4.2.4 New York City-Funded Flood Buyout Program

The NYCFFBO made significant advances in 2017. DEP worked with the Coalition of Watershed Towns to draft an approved model contract for City-owned acquisitions as well as a model conservation easement that would apply to NYCFFBO properties acquired by municipalities. Nineteen appraisals have been ordered to date and the City closed on the first two projects during 2017. Contractors have already removed structures on one of these properties.

At the end of 2017, there were seven pending offers and five accepted offers. Appraised values to date total nearly $3.6 million, with projects falling into the categories of local flood assessment, stream projects, and erosion. All towns with active projects have approved the acquisitions and the CWC is overseeing the demolition of improvements. In 2017, DEP provided NYSDEC with a model CE to cover municipally owned properties acquired through the NYCFFBO; NYSDEC is currently reviewing this model document.

Figure 4.3 The City in 2017 acquired 207 acres in Windham adjacent to the Catskill Forest Preserve and including this large tributary to the Batavia Kill.

4.2.5 Streamside Acquisition Program

DEP funds the pilot Streamside Acquisition Program (SAP) through a contract with the Catskill Center for Conservation and Development. The SAP became fully staffed during late 2016 and hired necessary vendors during 2017. Of the 29 appraisals ordered to date, six are pending receipt (38 acres), six became executed contracts (41 acres) in 2017, and five became accepted offers (34 acres). Two offers are under consideration (15 acres) and 10 offers were refused (71 acres). Of the 75 acres accepted or under contract, roughly 51 acres are within the 300-foot stream buffer and/or the 100-year FEMA floodplain.

4.2.6 Water Supply Permit

DEP's 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, below which it was determined there would be no measurable negative economic impacts to the municipality. The 2010 WSP authorized the LAP

to acquire up to 106,712 acres in the Catskill/Delaware system through 2025, beyond the 102,287 acres acquired as of January 1, 2010.

Between January 1, 2010 and December 31, 2017, DEP signed contracts on 45,034 acres (42% of the total 106,712-acre limit), leaving a balance of 61,678 acres for potential acquisition pursuant to the WSP. Based on negotiations with watershed stakeholders, DEP in 2017 completed a new study assessing the impact of acquisitions on land available for future development. DEP also continued to limit outgoing solicitations in certain WOH towns during most of 2017 while continuing to accept inquiries from interested landowners. Despite these adjustments, DEP still met all FAD-mandated solicitation requirements for 2017.

4.2.7 Federal Emergency Management Agency 2012 Buy Out Program

In 2017, DEP and its county partners completed all acquisitions as part of this FEMA program. Sixteen properties were acquired in six Greene County towns, eight by the City and eight by the local municipality. In Delaware County, 27 properties were identified for acquisition; five properties closed in 2016 (with the City covering the costs for site services and acquisition) and 22 properties are in process of being closed without further City involvement. The City expects to be reimbursed for all of its expenses on these 22 properties and that the properties will be permanently protected. In Ulster County, 16 property owners accepted purchase offers and all have now closed, including 10 that closed in 2017.

4.2.8 Cooperative Activities with Land Trusts

No activity took place in 2017 within the five towns (six eligible properties) that opted in to the Enhanced Land Trust Program (ELTP) in 2011. DEP does not expect this program to result in any projects at least through 2021, when towns will have another opportunity to elect in or out of ELTP. With the exception of the SAP and the WAC CE programs, the City didn't acquire or pay for any properties that involved land trusts or non-governmental organizations during 2017.

4.3 Land Management

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

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

4.3.1 Management of Water Supply Lands and Conservation Easements

Property Management of City Lands

The City now manages 178,280 acres of land and reservoirs it holds in fee simple; this includes reservoir buffer lands (pre-Memorandum of Agreement (MOA)), MOA lands, and land along aqueducts. The average size of parcels acquired under the MOA since 1997 is 67 acres but assembled acquisitions have reached up to 2,838 acres.

DEP inspects all City lands owned in fee simple as per its Fee-land Monitoring Policy (DEP 2010), which outlines procedures for property inspections and boundary maintenance on City lands. Property inspections consist of three types: standard inspections, focused inspections, and aerial inspections. The type of inspection a property receives depends on its priority, which is 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 with minimal trespass or encroachment issues, little road frontage or slight public use. These properties receive a boundary inspection at least once every five years. The most comprehensive type of inspection, five-year boundary inspections 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.

DEP annually performs focused inspections 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 an encroachment) or perform additional site visits as needed. All inspections and site visits — along with 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 used as site-specific conditions dictate.

Encroachments

DEP works diligently to cure encroachments discovered on City lands. DEP Police and Operations staff often identify potential encroachments during routine inspections and property stewardship activities. Once a possible problem is discovered, DEP staff coordinate the response with other entities including DEP Legal Affairs, NYC Law Department and DEP Police.

In 2017, DEP surveyors identified several small encroachments during scheduled re-surveying of DEP's East of Hudson landholdings. The encroachments included sheds, hoop houses, a climbing frame and an above ground pool. DEP notified the encroaching neighbors by mail. Following numerous meetings and site visits by DEP, six of the nine encroachments have been cured. The remaining three are still in the works.

Conservation Easement Stewardship

DEP

At the end of 2017, DEP had 174 closed CE properties totaling just over 26,000 acres in the Catskill, Delaware, Kensico, and Croton watersheds. DEP conducts two annual inspections of all easements in compliance with the terms of the MOA. DEP continues to perform annual aerial inspections for CEs since they provide an efficient alternative for inspecting properties, especially the larger ones. Potential violations that could have serious water quality impacts — such as land clearing, construction, and bridge or road building — are clearly visible using aerial inspections. Combined with an autumn on-the-ground inspection (or a summer ground check if problems are observed), aerial inspections provide a high level of protection for the City's investment.

To improve communication with our CE landowners, DEP sent an e-newsletter in the spring 2017 with information about property management and an invitation to attend a woods walk to discuss forest harvest planning. Landowners who attended represented 1,500 acres of CE properties and learned about forest harvest planning from a highly experienced forester from the Watershed Agricultural Council. Other landowners responded to the e-newsletter with questions about tax payments, sale of their property, and forest harvesting.

Four easement properties were sold to new owners in 2017 and 10 other easement properties are listed for sale. Potential sales to new owners require significant stewardship resources to explain the easement restrictions, answer questions about allowed activities, and share the deed and maps with potential buyers. Once a sale occurs, DEP meets the new owners at the CE property, provides copies of the baseline documentation, and answers questions they have about the easement restrictions and activity approvals. This provides an important opportunity to introduce DEP staff and establish a good landowner relationship. In 2017, one new owner has not responded to letters and phone calls and has never discussed easement restrictions with DEP staff.

In 2017, DEP discovered or confirmed 12 new CE violations. Four violations involved small areas (0.20 acres or less) of wetland disturbance or tree cutting near streams. Three violations involved grading of upland areas to expand roads or farm fields without the necessary prior DEP approval. Two violations are from debris dumping or storage. Two violations involve the installation and use of tent platforms that produce a small amount of prohibited waste; one of these required prior DEP approval for construction near a watercourse. One violation is the result

of herbicide use to control vegetation along a scenic stonewall, rather than for agricultural purposes as required by the easement terms.

Requests to conduct activities that require prior approval included two timber harvests. Three previously approved CE timber harvests took place in the Catskill and Delaware watersheds in 2017. Other activity requests included emergency utility work to expand water main infrastructure outside of a utility easement and a request to replace a one-story cabin with a three-story structure on the existing footprint.

Several landowners have asked DEP to amend their early CE deeds that prohibited farming to add the modest farming allowance contained in CE deeds since 2006. We are discussing this request with 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 2017, WAC had 181 easement properties totaling 27,532 acres in the Catskill, Delaware, and Croton watersheds. WAC performed all required inspections of their easements in 2017, including aerial inspections, as required by the MOA.

DEP continues to play an oversight and advisory role with respect to WAC's farm and forest CE stewardship responsibilities, which continue to increase as its portfolio grows.

The WAC CE deed allows for the granting of a non-material waiver of easement restrictions by WAC. This approach was taken in 2017 to resolve minor violations caused by two rustic but commercial campsites installed on CE properties. The activity is similar in intensity and impacts to allowed family camping activities, but a waiver was required to permit commercial camping and minimal waste storage outside of the development area on the CE property. WAC and DEP in 2017 traded violation guideline drafts and expect formal adoption in 2018.

4.3.2 Beneficial Use

Recreation

DEP provides outstanding public recreational opportunities at 19 reservoirs and two controlled lakes, and on water supply lands throughout the Catskill, Delaware, and Croton watersheds. Through its land protection efforts, DEP has significantly increased the amount of land publicaly available for recreation. This also plays an important role in strengthening local economies and ecotourism-based businesses.

In addition, recreational access expands the stewardship constituency for the water supply system and the lands that protect water quality. With an increasing portfolio of recreational lands, managing the stewardship of these areas becomes an increasingly challenging task that will benefit from assistance provided by the watershed community. Regular recreational

interactions with the natural environment can engender a sense of respect and ownership by the user. This outcome can complement DEP's protection goals and allow for a more engaged recreational user.

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 low-impact activities. DEP's management priority is to allow and enhance those recreational activities that are compatible with water quality protection.

In 2017, 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 4.4 provides a breakdown of the acres of land, by category, opened for recreation since 2003.

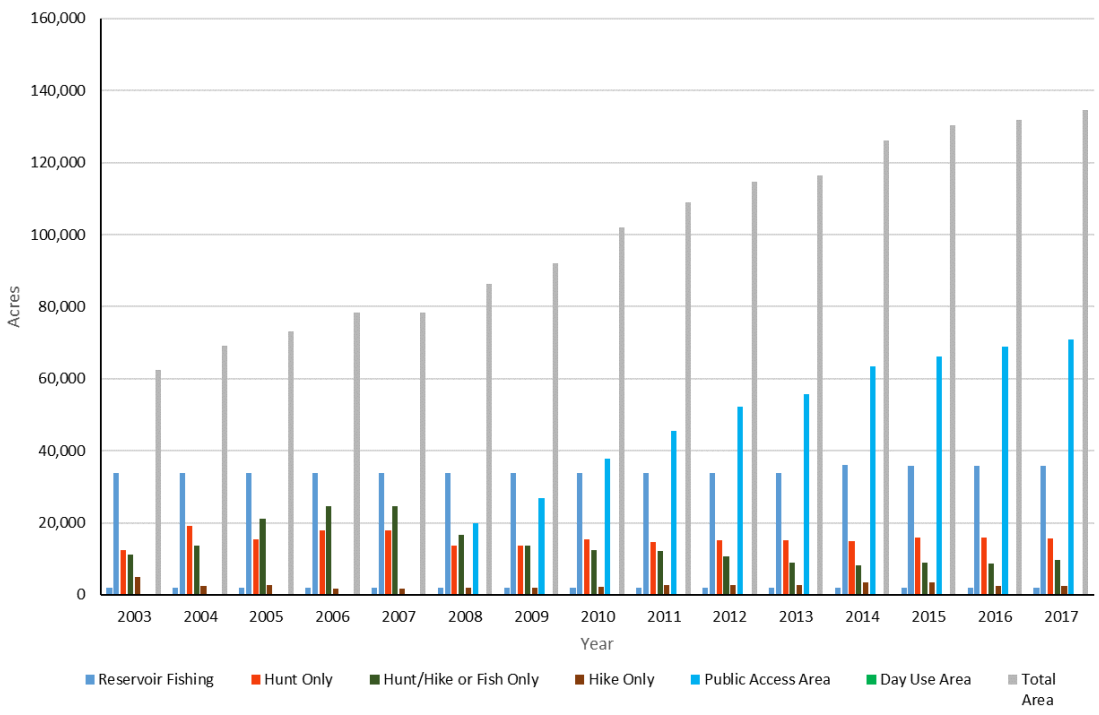

Figure 4.4 Acres of DEP land open for recreation since 2003.

DEP has provided revocable land use permits to several partners for projects on City land. DEP now has eight trails totaling approximately 31 miles with many trail partners, such as the Catskill Mountain Club (CMC), the NY/NJ Trail Conference, and the Finger Lakes Trail

Conference. Planners route hiking trails around sensitive areas like wetlands and to avoid erosion and sedimentation.

Use of these trails provides an opportunity to educate visitors on DEP's watershed protection efforts. In 2017, over 4,500 registered hikers utilized just three of DEP's trail systems maintained by the CMC. DEP plans to increase its trail counting efforts in 2018 by installing trail counters for other hiking areas.

In 2017, DEP worked with Ulster County on advancing the Ashokan Rail Trail, an 11.5-mile-long recreational trail along the Ashokan Reservoir's north shore.

DEP continued to develop its program to allow New York State (NYS) licensed guides to take clients on DEP lands and waters for hunting, fishing, hiking, and other activities allowed by DEP's recreation rules. Permits were issued to an additional two guides in 2017, making the total 34 approved guides. Other activities to enhance recreational opportunities included four public Fishing Days on Ashokan, Gleneida, Pepacton, and Rondout reservoirs. More than 300 people participated in the fishing events. Additionally, DEP held a clean-up day on nine reservoirs with several partner organizations and 418 volunteers, a 60% increase from the previous year. Participants picked up more than 14,858 pieces of trash and recyclables, weighing more than 2 tons.

Fishing Boat Program

DEP has provided for the traditional use of fishing boats on DEP reservoirs. Individuals must register their boats and obtain a DEP permit to store their boat on a reservoir. Prior to storage, all boats must be steam cleaned and then remain on their assigned reservoir. DEP has more than 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. In upcoming years, DEP plans to double the permit period to four years.

DEP closes reservoirs or boat storage areas to new boats when they reach capacity. These limits are based on the DEP Boat Area Rapid Assessment, which relies on several factors to establish healthy limits, including safety, erosion, buffer health, and other natural indicators. The fishing boat program is a very popular resource for the public and provides for a safe and diverse use of DEP reservoirs.

Recreational Boating Program

In 2017, DEP issued 1,646 recreational boat tags (canoes, kayaks, sailboats, sculls) for the four reservoirs covered by the program (Cannonsville, Pepacton, Neversink, Schoharie). Kayaks were by far the most popular vessel followed by canoes.

In addition, canoe and kayak rental vendors rented 968 vessels. The rental program seeks to increase participation in recreational boating on the reservoirs by making vessels easily available to those don't own one or do not want to transport them. The program has seen a steady increase in participation since its start in 2009. Year after year, the rental program grows while

individual boat tags numbers decrease (Figure 4.5). This trend reflects the easy access provided by the rental boat program as well as the program's boost to the regional economy.

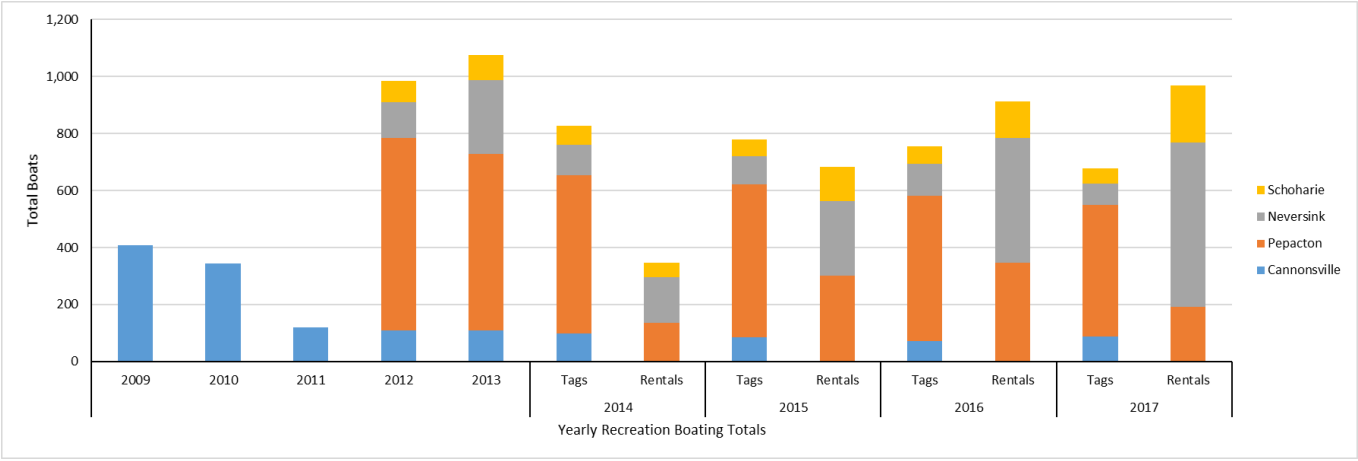

Figure 4.5 Boat tags issued and vendor rentals since program inception.

DEP worked with partners to secure and maintain storage racks at boat launch areas throughout the program area. These racks are available to the public and rental vendors for storing registered and tagged boats. In 2017, DEP expanded the racks at two boat launch sites. DEP staff regularly inspected launch areas and steam-cleaning vendors, removed garbage, and performed routine maintenance.

The recreational boating program caused very little, if any, interference with boaters who keep their rowboats stored on the reservoirs for fishing. There were no serious safety issues encountered and only a few incidents of vessels not properly steam cleaned before being put into reservoirs. Both DEP staff and concerned recreational users approached the violators and informed them of the program requirements. DEP has continued to increase outreach to boaters and updated signage at boat launch sites to prevent impact to the reservoirs. DEP hopes to enhance the program in coming years by extending the recreational boating season.

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, which need to be attached to their vessel to prevent spillage into the water. Motors must be steam cleaned with the propeller removed by a DEP-trained and certified steam cleaning vendor. Permits are issued for single-day use. In 2017, 130 trolling motor tags were issued to 41 unique individuals. While the program is popular with a small group of users, widespread utilization was limited (Figure 4.6). In November 2017, DEP decided to end the pilot program.

DEP's decision stemmed from concerns about the potential transportation of invasive species. While DEP maintains an extensive steam-cleaning program, cleaning trolling motors is more complicated than a regular recreational boat and leaves room for operator error. Increases in invasive species infestations in nearby waterbodies, primarily *Hydrilla*, elevated DEP's worry about the Trolling Motor Program. Due to its relatively low number of participants, DEP believes ending the program will eliminate a threat at a minimal cost to the public.

In 2016, DEP conducted a trolling motor survey of all DEP boaters that focused on the public's perception of the program and whether to expand it. Results suggested there was no strong desire for expansion. While DEP is committed to furthering recreational opportunities to the public, it must first balance doing so with its source water protection goals.

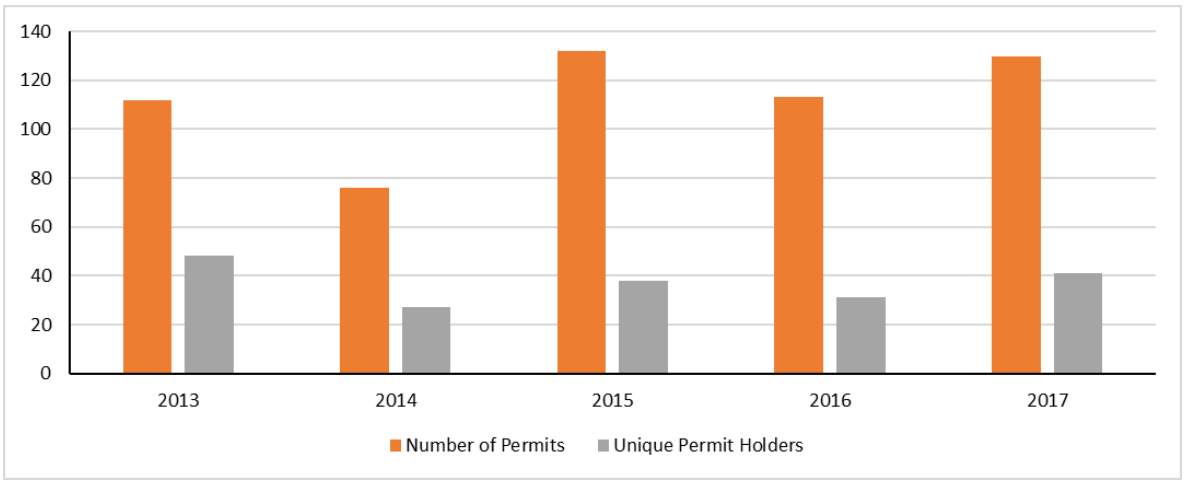

Figure 4.6 DEP trolling motor tags since program inception.

Watershed Stewards

In 2016, DEP launched its Watershed Land Steward Program to engage recreational users as volunteers to assist with the protection and improvement of DEP watershed lands. Volunteers at Kensico and Pepacton reservoirs picked up trash, made sure boats were stored properly, and talked with their fellow anglers and boaters. The participants functioned as ambassadors for their respective reservoirs.

In 2017, this program expanded to cover East of Hudson reservoirs. In partnership with the Croton Chapter of Trout Unlimited, DEP also expanded the program to cover streams flowing into and out of City reservoirs. DEP provides training on important watershed issues including watershed protection, invasive species, and the Recreation Program. Stewards submit monthly reports to DEP, which staff then review and act on. DEP plans to include more volunteers and broaden its reach to address watershed issues through its water supply lands. While focus now is primarily on reservoirs, the potential exists to target land-based recreation on DEP's 130,000+ acres of watershed lands open to the public.

Universal Access

In an effort to reach more recreational users, DEP has increased its focus on universal access. DEP manages most of its recreational properties as open space without improvements but realizes some areas, such as Day Use Areas (DUAs), provide an opportunity for accessibility improvements enabling more users to explore and enjoy DEP lands and waters. DEP has completed several DUA property evaluations and identified possible enhancements to increase universal accessibility. In the short term, DEP is working to ensure all portable restroom facilities meet or exceed ADA accessibility standards, evaluating paved surfaces for ease of access, and improving parking areas with signage. DEP has also completed several designs on future recreational projects that will focus on universal access. At the Ashokan Reservoir, DEP worked with the Conway School to develop a site design that adds ADA-accessible trails and walking paths. On the Rondout Reservoir, DEP completed a preliminary design of an accessible fishing dock. DEP's goal is to incorporate these features into planned facility improvements and upgrades.

Agricultural Use

DEP allows its land to be used for agricultural activities through a 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 farmers using City lands are enrolled in the WAC's Whole Farm Plan Program. Enrollees adopt whole farm plans, which helps ensure they employ good farming practices. These plans are generally developed for private land but can be adapted for use on City lands and include various agricultural Best Management Practice (BMPs), such as soil stabilization techniques. Some of the agricultural lands the City purchases under the Land Acquisition Program (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. In 2017, DEP approved 12 new projects covering 197 acres for a total of 136 projects in 26 different towns covering 3,139 acres. Most project areas were inspected in 2017 and no major issues were observed. On projects where no riparian buffer area existed prior to City purchase, the streamside vegetation is reestablishing itself and in a few years will form an effective buffer area.

4.4 Watershed Agricultural Program

The Watershed Agricultural Council (WAC) administers the Watershed Agricultural Program (WAP) using DEP-provided funds and technical assistance provided by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), Delaware County Soil and Water Conservation District (DCSWCD) and Cornell Cooperative Extension (CCE). The USDA Farm Service Agency provides technical and financial assistance for the federal Conservation Reserve Enhancement Program (CREP).

To date, the WAP has developed 449 Whole Farm Plans (WFPs), including 371 West of Hudson (WOH) farms and 78 East of Hudson (EOH) farms. At the end of 2017, 331 of these WFPs (74%) remained active, including 264 WOH farms (71%) and 67 EOH farms (86%). By comparison, 349 WFPs were active at the end of 2016.

During 2017, the WAP developed one new WFP (EOH farm) while 16 farms became inactive (15 WOH farms and one EOH farm) and three WOH farms withdrew from the program. Eight "large" farms signed up for the WAP do not yet have a WFP. For the 331 active WFPs at the end of 2017, the WAP conducted 312 annual status reviews (94%), which exceeds the 90% FAD metric. The WAP also completed 84 WFP revisions during 2017.

In 2017, the WAP implemented 317 BMPs on all participating farms at a total cost approaching $2.5 million. These figures include 268 BMPs on WOH farms ($2 million) and 40 BMPs on EOH farms ($0.5 million). These figures also include the repair or replacement of 114 BMPs on WOH farms. To date, more than 7,500 BMPs have been implemented on all watershed farms at a cost exceeding $61.2 million; these figures include 6,829 BMPs on WOH farms ($54.7 million) and 734 BMPs on EOH farms ($6.5 million). In 2018, the WAP anticipates implementing approximately 250 BMPs on WOH farms at an estimated cost of $3 million and approximately 30 BMPs on EOH farms at an estimated cost of $408,000. For a detailed description of numbers and types of BMPs implemented, as well as photos, please refer to the WAP Annual Report posted on the WAC website (nycwatershed.org).

Pursuant to the 2017 FAD, the WAP is required to achieve a new BMP implementation metric designed to reduce the backlog of existing BMPs in WFPs and limit future backlogs for new BMPs. This metric covers newly identified or recommended (but not implemented yet) BMPs in WFP pollutant categories I-VI, as well as previously implemented BMPs (regardless of pollutant category) needing repair or replacement.

In 2017, DEP and WAC developed an official BMP backlog list to serve as a baseline for measuring annual backlog reductions. This official BMP backlog list includes 1,754 BMPs at a total estimate cost of $35.8 million, including 1,410 new BMPs (estimated cost of $28.1 million) and 344 repair and replacement BMPs (estimated cost of $7.7 million).

Through its annual BMP implementation accomplishments, the WAP was able to reduce the BMP backlog by 75 new BMPs (5%) and 94 repair or replacement BMPs (27%) during 2017. As a result, the updated BMP backlog list effective January 1, 2018 is now 1,585 total BMPs (1,335 new BMPs and 250 repair or replacement BMPs).

Because the 2017 FAD was being finalized this past year while DEP was negotiating a new contract with WAC to continue the WAP beyond 2018 (including the development of an official BMP backlog list), 2017 should be viewed as a transition year. The WAP has re-prioritized its workload to achieve new BMP implementation metrics by the FAD deadlines established for the end of 2022 and 2024.

During 2017, the WAP completed 69 new or updated nutrient management plans (NMPs) on active WOH and EOH farms. In the WOH watershed, 242 participating farms are following NMPs, of which 91.4% are current (developed within the last three years). In addition, 127 WOH farms participated in the WAP's Nutrient Management Credit Program in 2017, an increase of 10 participants from the previous year. The 2017 FAD requires the WAP to offer the Nutrient Management Credit Program to all eligible farms. The WAP identified 10 eligible farms that were not previously participating and invited eight to participate. Six farms responded affirmatively and two declined. WAP will invite the remaining two eligible farms to participate in 2018.

The WAP implemented its second full year of the Precision Feed Management (PFM) Program, completing 10 new Feed Management Plans in 2017, making 31 participating dairy farms (29 in the Cannonsville basin and two in the Schoharie basin). Two of these farms have since exited the dairy industry, leaving 29 current active plans.

Due to PFM staffing changes in early 2017, the WAP was unable to achieve its internal goal of 40 Feed Management Plans by the end of its second year. To date, only 51 farms have applied to participate in the program, of which five farms have been lost to attrition.

The WAP will continue developing plans for the remaining 15 participants, which includes 13 dairy farms (five in the Cannonsville basin) and two beef farms also in the Cannonsville basin.

PFM staff visited participants an average of once per month to assist with implementing feed management goals and strategies. Initial results show that 38% of the participating herds (51% of cows) are always feeding within benchmark phosphorous guidelines and 45% of the herds (38% of cows) require active diet management. Eight herds (27%) receiving some form of PFM intervention have shown a net reduction of manure-excreted phosphorous of 2,470 kg/year or 23%.

In 2017, 19 CREP contracts were signed covering 170 acres of riparian forest buffers; this includes seven new contracts (29.8 acres) and twelve re-enrolled contracts (140.3 acres). Three CREP contracts expired (16.5 acres) in 2017 and landowners chose not to re-enroll. Two contracts were canceled (6.0 acres). Active CREP contracts (184) with 141 different landowners contain 1,842.8 acres of riparian forest buffers.

The WAP conducted 36 farmer education programs in 2017 attended by 864 participants, of which 39% were watershed farmers, 28% were other farmers, and the rest were students, agribusinesses or agency staff. An estimated 30% of all WAP participants attended at least one farmer education program during 2017, with highlights including the annual Catskill Regional Agricultural Conference, the annual WAP farm tour, and several other tours and workshops covering topics such as livestock production, forage quality, cover crops, and farm succession planning.

Finally, the WAC Economic Viability Program continued to implement the Pure Catskills Campaign, reaching more than 50,000 people through its annual print guide, e-newsletters, and marketing website (purecatskills.com). In 2017, the economic program supported a regional food hub in Hamden (Lucky Dog Farm), coordinated and maintained the Pure Catskills Marketplace online retail store, and attended or sponsored over 15 events promoting the diversity of agricultural and wood products from the region.

4.5 Watershed Forestry Program

The Watershed Forestry Program is a partnership among DEP, WAC, and the U.S. Forest Service (USFS). The partnership supports and promotes well-managed working forests through stewardship planning (forest management plans), the Management Assistance Program (MAP), the implementation of BMPs, professional training for loggers and foresters, and educational programs for watershed landowners and school-based audiences in both the watershed and New York City.

In 2017, WAC funded the development of 64 forest management plans covering 9,767 acres. Seven of these plans resulted in the new enrollment of 425 acres in the NYS Forest Tax Law (480-a tax abatement program), while the remaining 57 plans (9,342 acres) represented re-enrolled properties. The landowner of a property enrolled in the 480-a tax abatement program agrees to restrict development, limit subdivision, and commit to a schedule of forest stewardship activities for a rolling ten-year period. In this capacity, the 480-a program protects water quality by essentially functioning as a term easement preventing conversion of forestland to other less protective uses.

WAC also funded the completion of 33 MAP projects including 11 timber stand improvement projects, 12 wildlife improvement projects, eight invasive species control projects, and two tree planting/deer fencing projects. To date, the program has funded 586 MAP projects on 4,750 acres of forestland, with timber stand improvement and wildlife improvement representing 60% of all completed projects. The number of completed MAP projects declined in 2017 compared to the 52 projects in 2016 and below the annual goal of 45 projects. This decline can be attributed to a significant increase in the size of timber harvest projects that required BMP funding as further described below.

In 2017, WAC funded the completion of 50 road BMP projects and 13 stream crossing projects on active timber harvesting sites. Despite a modest 4% increase in the number of participating timber harvests from 2016 to 2017, the size of these harvests was 28% larger as measured by the total length of roads and trails cost-shared. This resulted in the highest recorded demand for BMP funding in the history of the program. Due to this increase in associated funding needs for road stabilization, WAC approved fewer MAP applications and re-prioritized funding to support BMP implementation. DEP supported this decision, given the importance of protecting water quality from timber harvesting impacts and the unpredictability of timber markets that affect harvest frequency and intensity. In 2017, the program also loaned out 11

portable bridges, distributed 11 free BMP samples, and completed seven Croton Trees for Tribs projects. These latter projects included 464 trees and shrubs planted along 465 linear feet of streams (0.33 acres).

Since 2015, WAC has supported an interactive website called MyWoodlot.com that educates forest landowners through online modules and helps them create customized plans with personalized goals and management activities. Forty-five landowners created MyWoodlot profiles in 2017, for 160 profiles to date; 39 of these profiles (34%) belong to staff, committee members and partners. The website contains 48 goals, 207 activities, 600 pieces of "how-to" information, and 122 blogs and feature stories available as educational content for interested landowners. Website diagnostics suggest over 14,000 unique users visited MyWoodlot.com during 2017, a 100% increase over 2016.

In collaboration with the NYS Trained Logger Certification and Cornell Cooperative Extension, the Watershed Forestry Program sponsored eight professional logger-training workshops during 2017 attended by 70 participants. Approximately 108 loggers working in the Catskill/Lower Hudson region remained "Trained Logger Certified" during 2017.

WAC and its program partners sponsored several forest landowner education programs in 2017, including 62 targeted events reaching more than 2,500 participants. The watershed model forests hosted many of these events, with one highlight being a maple-sugaring event at the Clearpool Model Forest that attracted 250 people. The annual Forest Self Study Course attracted 106 landowners, a 26% increase compared to last year (84 participants). The Cornell Master Forest Owners (MFO) Program conducted 40 landowner visits. In 2017, MFOs served the Catskill region (16 are based in the watershed).

The Watershed Forestry Program in 2017 implemented the following school-based education programs: Green Connections School Partnership Program, Watershed Forestry Institute for Teachers, and Watershed Forestry Bus Tour Grants Program. The 2016-2017 Green Connections Program engaged 175 students in four partner schools, while 24 teachers attended the 2017 Watershed Forestry Institute for Teachers held at the Taconic Outdoor Education Center in Putnam County. WAC sponsored 24 bus tours attended by approximately 200 adults and over 1,200 students (primarily New York City residents), including Trout in the Classroom field trips, Green Connections field trips, Croton Trees for Tribs planting events, and educational visits to a watershed model forest.

Finally, the watershed model forests continued to host diverse educational programs and outreach events that reached thousands of youth, landowners, loggers, and water consumers in 2017. The Lennox Model Forest educated 200 campers with forest-based programs such as wilderness survival and nature hikes, while the Frost Valley Model Forest attracted thousands of campers and visitors. The Siuslaw Model Forest hosted more than two dozen youth and adult programs, covering topics such as beekeeping, invasive species, mushroom cultivation, stream protection, and forest ecology. The Clearpool Model Forest reached hundreds of students from

East of Hudson and New York City schools, in addition to hosting the New York State Outdoor Education Association Annual Conference in October (150 professionals).

4.6 Stream Management Program

Throughout 2017, the Stream Management Program (SMP) continued to work closely with watershed communities to restore and protect stream system stability and ecological integrity by facilitating the long-term stewardship of watershed streams and floodplains. By the end of the year, the program completed Local Flood Analyses (LFAs) in most of the West of Hudson (WOH) population centers, effectively laying the groundwork for the implementation phase of the Flood Hazard Mitigation Program. In addition, the SMP completed several water quality projects using natural channel design principles, conducted stream feature inventories on 51 miles of priority waterways, and continued to deliver stream management educational programming, professional engineering and technical assistance.

4.6.1 Implementing Stream Management Plans

In 2017, DEP and its SMP partners continued to implement recommendations made in stream management plans and tracked in annual action plans. Locally driven projects are funded through the application-based Stream Management Implementation Program (SMIP), the Flood Hazard Mitigation Program (FHMP), and the Catskill Streams Buffer Initiative (CSBI). DEP separately funds water quality-driven projects through SMP partner contracts.

Throughout the year, DEP and its SMP partners continued to meet with advisory councils and working groups to respond to local concerns and prioritize projects for SMIP funding. Table 4.4 summarizes the total number of SMIP awards funded in 2017 and to date. For the 218 SMIP grants awarded to date, 143 have been completed, 47 are in process, and 28 are at the design stage. Basin-specific accomplishments are reported below, and descriptions of all projects can be found at catskillstreams.org. A summary of CSBI projects is reported in Section 4.7.

Table 4.4 Number of SMIP awards by category for 2017 and totals to date (2009-2017).

SMIP Category	2017	Total
Education and Outreach	10	56
Recreation and Habitat Improvements	1	14
Stormwater and Critical Area Seeding	0	7
Highway / Infrastructure	3	43
Landowner Assistance / Streambank Restoration	5	34
Planning and Research	5	37
Flood Hazard Mitigation	2	27
Total	**26**	**218**

Ashokan Basin

Through DEP's partnership with CCE of Ulster County and the Ulster County Soil and Water Conservation District (UCSWCD), the Ashokan Watershed Stream Management Program

(AWSMP) advanced numerous initiatives in 2017, including the monitoring of three stream restoration projects; completion of a stream feature inventory on the Little Beaver Kill and its tributaries; and assessments of stream bank erosion throughout the watershed. UCSWCD substantially completed two FAD water-quality stream restoration projects in the Town of Woodstock (both Van Hoagland Projects). The 2017 Ashokan Watershed Conference attracted 88 people and six new SMIP awards were announced totaling $334,855. Also in 2017, the AWSMP completed the Boiceville and West Shokan LFAs while advancing LFAs for Shandaken and Allaben through participation in the Shandaken Area Flood Assessment and Remediation Initiative (SAFARI), the Olive Flood Advisory Committee and the Flood Hazard Mitigation Working Group. The AWSMP website (ashokanstreams.org) continues to be an excellent resource for news, publications and events.

Delaware Basin

In partnership with DEP and the Delaware County Planning Department, the DCSWCD advanced SMIP, stream restoration, riparian buffer, and flood hazard mitigation efforts in 2017 as recommended in the Action Plan for the East and West Branches of the Delaware River. Priority was placed on SMIP project designs by DCSWCD and its three professional engineering consultants, with four projects substantially advanced. One SMIP grant was awarded to the Watershed Agricultural Council to undertake the CREP-CSBI Pilot Program in Delaware County and three stream restoration projects were completed: Little Delaware River Restoration Project at the Bovina Highway Garage, the East Brook Stream Restoration Project in the Town of Walton, and the Magee Emergency Stream Intervention Project in the Town of Tompkins. In 2017, the respective municipalities all accepted the Arkville LFA, Fleischmanns-Clovesville LFA, Hamden LFA, and draft Walton Tributaries LFA. The Delhi LFA and Andes LFA substantially advanced, while the Town of Roxbury met to consider forming a flood commission.

Rondout and Neversink Basins

The Rondout Neversink Stream Program (RNSP), led by Sullivan County Soil and Water Conservation District, significantly progressed design of two stream restoration projects on the East Branch Neversink River as recommended in the Claryville LFA. The goals of these projects include flood hazard mitigation and water quality improvement. The RNSP approved eight SMIP awards totaling $823,158, including $500,000 for a flood hazard mitigation and floodplain restoration project to repair a chronic washout on Frost Valley Road, a major transportation route in the Neversink basin. The RNSP completed stream feature inventories on Trout Creek and Sugarloaf Brook (both Rondout Reservoir tributaries) and Conklin Brook (a Neversink Reservoir tributary), as well as a reference reach validation survey at the Frost Valley Model Forest. The RNSP also awarded two significant research grants, one to the U. S. Geological Survey (USGS) to update fish population and habitat studies, and a second to Colorado State University to examine the role of large wood accumulations in stream channels. The RNSP coordinated the fourth annual Angler's Symposium and funded education projects with Tri-Valley High School,

Sullivan BOCES, and Time and the Valleys Museum. Additional information about the RNSP can be found online at rondoutneversink.org.

Schoharie Basin

In 2017, the Greene County Soil and Water Conservation District (GCSWCD) and the Schoharie Watershed Advisory Committee progressed several stream management plan recommendations, including funding 11 new SMIP projects costing $634,090; the completion of six CSBI projects and stream feature inventories for 19.3 miles of the Batavia Kill; annual monitoring of nine former stream restoration projects; and the seeding and mulching of 9.8 acres through the roadway seeding program. Three LFAs continued to progress in the towns of Ashland and Hunter, and the Village of Tannersville, and one LFA was completed in the Town of Conesville. GCSWCD completed the Batavia Kill at Kastanis stream restoration project in partial fulfillment of the 2017 FAD and the County Route 2 culvert replacement in Lexington. GCSWCD hosted its 11th Annual Schoharie Watershed Summit (over 90 participants) and a series of educational events through the annual Schoharie Watershed Month in May. The latter included an Arbor Day Volunteer Tree Planting, the annual Student Art Exhibit, student trout releases, a film screening of "Hometown Habitat, Stories of Bringing Nature Home," opening of the expanded Kaaterskill Rail Trail, and a volunteer invasive species removal event at the Mountain Top Arboretum.

4.6.2 Flood Hazard Mitigation Program

In 2017, LFAs were completed in six municipalities, substantially advanced in four municipalities, and initiated in one municipality. LFAs are now complete in 20 population centers and municipalities are implementing the recommended flood-hazard-mitigation projects such as modifying floodplains, treating hydraulic constrictions at bridges, relocating residential, business and critical facilities, eliminating sources of pollution and addressing threats to infrastructure. Figure 4.7 depicts the locations and status of LFAs in the WOH watershed. Copies of completed LFAs and descriptions of LFA recommended projects are available at catskillstreams.org.

Communities with completed LFAs seek funding through the CWC and the SMP to begin recommended projects. In 2017, the CWC received applications for demolition of a decaying, closed bridge in Shandaken; anchoring 11 fuel tanks; and repair of a streambank in Windham. The DCSWCD hired a consultant and substantially advanced the design of the Water Street Floodplain Restoration project in Walton. The AWSMP worked closely with the Town of Shandaken and the New York State Department of Transportation (NYSDOT) to advance a floodplain restoration project associated with the replacement of the Route 28 bridge over the Esopus Creek in Mount Tremper. In the Town of Olive, DEP and the AWSMP worked with

Figure 4.7 Location and status of LFA projects, 2017.

local officials to identify properties for relocating the Boiceville fire station. Under the Revised 2007 FAD, CWC has committed or spent $1.5 million toward 24 LFA recommended projects (15 are complete). Also, the SMP has committed or spent $4.2 million on flood hazard mitigation activities, including seven LFA recommended projects (on which $272,315 has been committed or spent). Four of those seven projects are complete.

During 2017, the SMP continued to provide technical support and coordination for the NYCFFBO. The LFA processes identified 15 of the 19 properties active in the program, which are supported by SMP partners and the CWC.

In 2017, CWC hired consultants to determine if structures owned by NYCFFBO applicants face substantial erosion or inundation threats, and to plan and supervise demolition of such structures. Contractors finished the first demolition of an erosion-hazard property on newly acquired City lands in October.

4.6.3 Stream Studies

The Stream Studies Program continued to provide scientific support to stream management implementation. The primary projects include: (1) the Catskill Mountain Regional Bankfull Discharge and Hydraulic Geometry Regression Relationships ("Catskill Mountain Regional Curves"); (2) the Esopus Creek watershed and Stony Clove Creek watershed

turbidity/suspended sediment monitoring studies ("Turbidity/Suspended Sediment Studies"); and (3) the Geomorphic Reference Reach Study. In March, DEP convened a research coordination meeting with SMP partners to review the projects' status and discuss future research priorities as well as ongoing initiatives.

The data acquisition phase for the Catskill Mountain Regional Curves project was completed in 2017. DEP worked with DCSWCD and UCSWCD to complete surveys at two USGS stream gage study reaches: Town Brook (Hobart) and Bush Kill below Maltby Hollow (West Shokan). Both sites were deemed marginally suitable. Subsequent analysis has indicated these sites are unlikely to yield reliable data.

The 10-year Turbidity/Suspended Sediment Studies project completed its first full year of data acquisition in 2017. USGS collected continuous turbidity data at all primary and secondary monitoring sites: nine in the Esopus Creek watershed (not counting Stony Clove) and 20 in the Stony Clove watershed. USGS also collected continuous discharge data and storm event suspended sediment samples at 14 primary sites. With consultant support, DEP continued geomorphic monitoring at selected suspended sediment source reaches in the Stony Clove watershed. Seven sites have been surveyed and monumented for future monitoring.

In 2017, DEP also initiated two new pilot studies closely connected to the Turbidity/Suspended Sediment Studies: a pilot bedload monitoring study and a pilot suspended sediment source fingerprinting study. Each is in collaboration with USGS and the AWSMP. The bedload monitoring pilot study was initiated by a request from the SMP partners and includes two sampling sites: Stony Clove Creek at Jansen Road in Lanesville and Birch Creek near Big Indian. The study calls for direct measurements of bedload sediment during bankfull discharge events and continuous hydroacoustic sampling at each site. A particle tracer study using radio frequency technology is part of the Stony Clove bedload monitoring reach. The suspended sediment source fingerprinting study is an attempt to determine the geologic sources of suspended sediment (glacial lake sediment, glacial till, stream alluvium and forest soils) using geochemical analytes.

DEP continued to develop a fluvial geomorphic reference reach database for use in applying natural channel design principles to stream restoration projects. DEP completed a GIS-based assessment protocol in 2017 to identify potential Rosgen C-type streams and conducted initial field reconnaissance with SMP partners to screen candidate sites. Based on this field screening, no new Rosgen C-type reference reaches are planned for inclusion in the database. DEP also completed a reference reach validation survey in the West Branch Neversink River.

4.6.4 Stream Projects

In 2017, the SMP completed eight projects treating 1.38 miles of stream length at a total cost exceeding $3.7 million. Table 4.5 depicts the basin, project type and length of each project. To date, the SMP has completed 368 projects treating 43.2 miles of stream length, including

CSBI projects. Figure 4.8 depicts the geographic locations of the 2017 projects.

Table 4.5 Summary of SMP Projects completed in 2017.

Basin	Type of Project	Name of Project	Length (ft)
Delaware	Full Channel Restoration	Little Delaware River at Bovina	800
	Full Channel Restoration	East Brook Stream Restoration	550
	Streambank Stabilization	Magee ESI Phase 1	275
Schoharie	Infrastructure	County Route 2 Culvert Replacement	140
	Full Channel Restoration	Batavia Kill, Kastanis Stream Restoration	3,800
Ashokan	Full Channel Restoration	Beaver Kill at Van Hoagland, Project 1	800
	Full Channel Restoration	Beaver Kill at Van Hoagland, Project 2	850
	Infrastructure	Hillside Drive Culvert Replacement	45

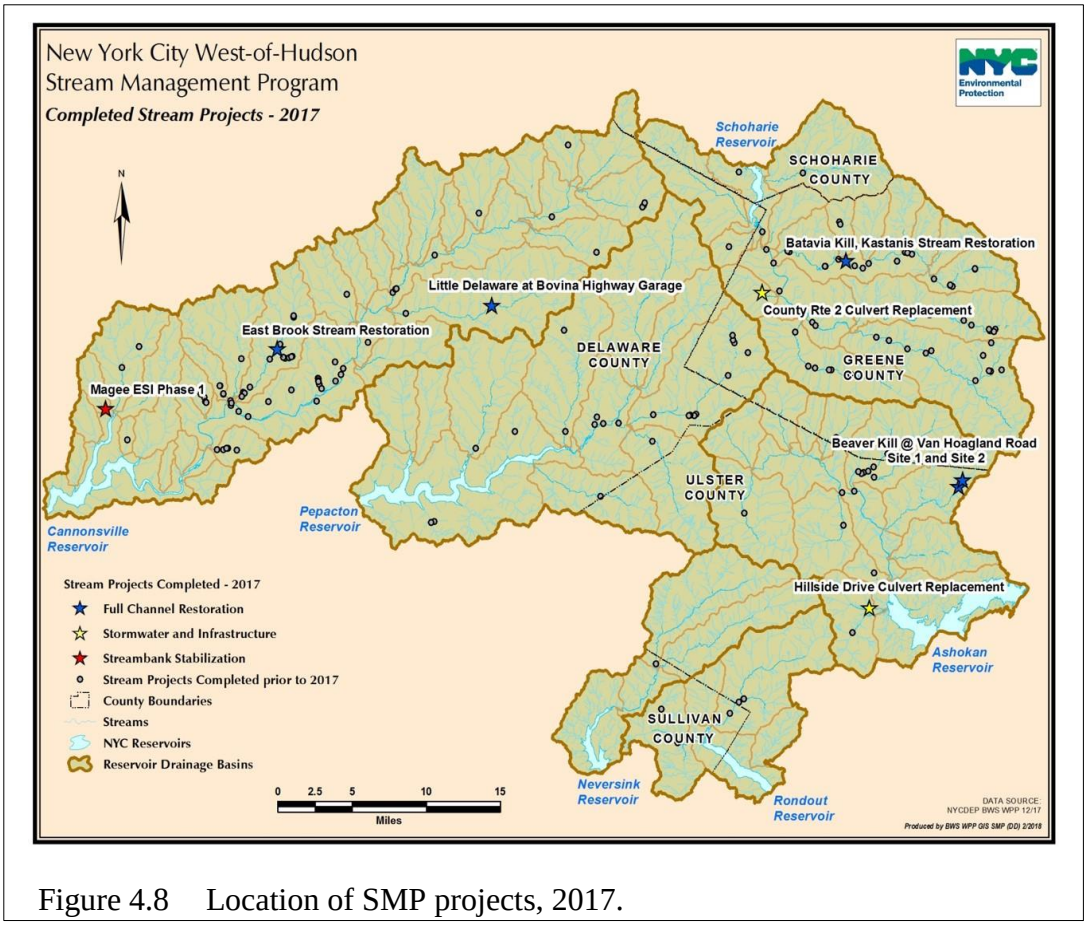

Figure 4.8 Location of SMP projects, 2017.

Little Delaware River Restoration Project at the Bovina Highway Garage

DCSWCD awarded a SMIP grant to the Town of Bovina to address stream bank erosion near the highway garage and the access road to the municipal wastewater treatment facility. The full channel restoration project, designed by DCSWCD, included the installation of a bankfull bench at the upper-reach right stream bank, stream bank rock revetment at the outside of two meander bends, installation of three constructed riffles for streambed grade control, and willow brush layering and live stake plantings (Figure 4.9 and Figure 4.10). In addition to stabilizing the streambanks, the streamside plantings will trap sediment, reduce transport of nutrients, lower stream temperatures, and create habitat for wildlife. Total construction cost was $298,427.

Figure 4.9 Little Delaware River project before construction.

Figure 4.10 Little Delaware River project after construction.

Batavia Kill at Kastanis Stream Restoration Project

GCSWCD and DEP identified the Kastanis reach of the Batavia Kill as experiencing extensive instability, finding that 4,220 feet along both stream banks were eroding. This reach exhibited the third highest erosion rate in the Schoharie watershed. The Red Falls reach, planned for treatment during 2018-2019, exhibits the highest rate and the Big Hollow headwaters reach exhibited the second fastest rate prior to its restoration.

In 2017, GCSWCD restored stability to 3,800 feet of the Kastanis reach by re-aligning the stream channel to create meanders and belt widths for lateral stability and by installing live stone revetment and dense riparian plantings along the restored channel. Plantings included sod mats, live willow stakes, potted trees and shrubs, on site tree transplants, willow fascines and brush mattress, and permanent and temporary seed mixes. Total construction cost was just over $1 million (Figure 4.11 and Figure 4.12).

Figure 4.11 Batavia Kill at the Kastanis reach before construction.

Figure 4.12 Batavia Kill at the Kastanis reach after construction

Beaver Kill at Van Hoagland Road, Project 1 and Project 2

These two projects stabilized failing hillslopes along the Beaver Kill in the Town of Woodstock, directly upstream of the Van Hoagland Road bridge. The AWSMP identified the project sites through stream feature inventories as distinct sources of fine sediment being entrained into the Beaver Kill. Construction of both projects was undertaken simultaneously and included realignment of the stream channel away from the toe of the slope failures; extensive regrading of the slopes and installation of drainage networks to capture and redirect storm water; installation of rock-armored and heavily vegetated benches in front of the slopes; and bioengineering practices to promote long-term stability. Contractors completed the majority of construction work in 2017, with some additional work anticipated in early 2018. Total construction costs for both projects is approximately $1.5 million.

4.7 Riparian Buffer Protection Program

Protecting riparian buffers is a critical component of DEP's Long-Term Watershed Protection Strategy. Privately owned lands contain approximately 65% of the total riparian buffer acreage in the Catskill/Delaware watershed, with many of these buffers protected to some degree by various watershed programs described in Section 4.4 and Section 4.5. This section highlights the protection of riparian buffers on publicly owned or controlled lands and the progress of the Catskill Streams Buffer Initiative (CSBI), including a pilot partnership with the federal Conservation Reserve Enhancement Program (CREP) on fallow agricultural land.

4.7.1 Activities on City-owned or Controlled Land

DEP's LAP includes 300-foot boundaries on either side of a watercourse as a principal eligibility requirement under the "natural features criteria" set forth in the MOA. Through 2017, approximately 40% of the entire Catskill/Delaware 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 35.4% (88,600 acres) of all stream buffers in the Catskill/Delaware watershed. Since 2004, DEP has increased the percentage of protected stream buffers from 7.5% to 17.4%. Through the LAP, DEP also funds the Streamside Acquisition Program, which in 2017 executed six contracts to acquire 41 acres of stream and buffers within the Schoharie basin.

DEP carefully considers the presence or absence of riparian buffers when it reviews requests from outside parties for projects on City-owned lands. For example, when allowing agricultural use of City-owned lands, DEP requires a minimum 25-foot buffer between farming activities and the stream, with proposals maintaining a larger buffer given extra points in their rating. DEP reviews all land use permits and proposed projects, including stream crossings, 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 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 Stream Management Program (SMP) and a cornerstone of the City's efforts to protect and enhance riparian buffers in the WOH watershed. 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 2017 annual meeting of the interagency Riparian Buffer Working Group was an opportunity for component programs to highlight past successes and new ideas for implementing these activities.

Plants are essential to natural stream bank stability, and providing plant materials that are local genotypes of Catskill native species continues to be one of the unique aspects of the CSBI. Through contracts, the Greenbelt Native Plant Nursery and One Nature, LLC, supply the Catskill native plant material. Plant selection, propagation and grow-out techniques are carefully considered. In 2017, DEP and its partners received 5,000 gallon-sized trees and shrubs. To date, over 54,500 gallon-sized trees and shrubs from locally collected seed have supported CSBI planting efforts.

DEP works with five county Soil and Water Conservation District (SWCD) coordinators who help participating landowners develop Riparian Corridor Management Plans (RCMPs). These serve to guide project design and educate landowners about their riparian buffers. Since 2009, 131 RCMPs have been completed, including seven new RCMPs completed in 2017.

In 2017, the CSBI completed 10 riparian buffer restoration projects on 3.8 acres of streamside property and over 0.5 miles of stream length (Table 4.6 and Figure 4.13). These projects installed 2,042 native Catskill plants and over 940 linear feet of bioengineering treatments consisting of native willow species mostly harvested from within the watershed.

To date, the CSBI has completed 197 projects spanning 107.8 acres and over 17 miles of stream length. These projects installed nearly 140,542 plants (51,042 trees and shrubs, 72,000 plugs, and 17,500 tubelings), all native Catskill species. In 2017, riparian planting activities also took place on three non-CSBI stream restoration projects, enhancing buffers with 5,000 trees and shrubs, 9,278 live stakes, and roughly 6,000 feet of bioengineering treatments.

Table 4.6 Summary of CSBI projects completed in 2017.

Project name	County	Basin	Linear feet	Area (acres)
Rikard Planting	Greene	Schoharie	115	0.26
Drake Planting	Greene	Schoharie	362	0.7
Simmons Planting	Greene	Schoharie	176	0.2
Pesciotta Planting	Greene	Schoharie	193	0.3
Freedman Planting	Greene	Schoharie	45	0.03

Project name	County	Basin	Linear feet	Area (acres)
Bilash Planting	Greene	Schoharie	570	1.32
Tew Planting	Sullivan	Neversink	50	0.05
Frost Valley, White Pond Planting	Sullivan	Neversink	250	0.04
Margaretville Pavilion Planting	Delaware	Pepacton	175	0.15
Chambers Hollow, VanAssche Planting	Delaware	Cannonsville	680	0.78
Total			**2,616**	**3.83**

Figure 4.13 Locations of CSBI projects completed in 2017 and in prior years.

In 2017, the Ashokan basin CSBI removed invasive species to both prepare future planting sites and to control invasive species and deer grazing on prior planting sites. Many CSBI projects require such pre- and post-planting maintenance for successful transplant establishment.

Following installation, county CSBI coordinators monitor projects for five years to document plant survival and growth rates, assess the effectiveness of installation techniques, understand the factors affecting project success, and design follow-up maintenance interventions. Coordinators monitored 66 sites in 2017, eight of those for the first time. The five county CSBI coordinators actively monitor 122 sites in total. Summer interns assist the CSBI coordinators through partnerships with Ulster County Community College and the State University of New York.

In 2017, DEP, WAC and DCSWCD established a two-year-long pilot partnership to implement riparian buffers on fallow agricultural lands through the WOH watershed. In Delaware County, the SWCD contracted with WAC to hire a coordinator for the pilot program, and a CSBI-CREP working group was formed. The group has identified initial parcels and is assessing landowner interest. Using GIS, DEP is identifying other potentially eligible parcels. A landowner survey has been prepared to further assess and catalyze interest in the Delaware County pilot program.

4.8 Ecosystem Protection Program

4.8.1 Wetlands Protection Program

Wetland ecosystems provide many far-reaching services that help maintain the high quality of surface waters in the watershed. They detain stormwater and flood flows, prevent erosion, and retain/filter out nutrients and pollutants. Wetlands also provide stream base flow and play a role in the carbon cycle, with some types sequestering significant amounts of carbon. Wetlands support biodiversity by providing important fish and wildlife habitat. They also provide recreational and educational opportunities.

DEP protects these ecosystems through regulatory means, including the Watershed Rules and Regulations, and through its review of federal, state, and municipal wetland applications in the watershed. Initiatives such as the watershed agricultural, forestry, and land acquisition programs can add more layers of protection. DEP also employs conservation practices to ensure management of its own lands is protective of wetlands. Through mapping and monitoring, DEP also collects information on the distribution and characteristics of wetlands to support watershed protection programs.

Permit Review

DEP receives notification of applications filed in the watershed under Article 24 of the NYS Environmental Conservation Law, Section 404 of the Clean Water Act, and CT town wetland regulations (Conn. Gen. Stat. Sec. 22a-42f). A subset of NY towns within the EOH watershed voluntarily forward filed wetland permit applications to DEP for review. DEP reviews all of these submittals and provides comments when alternatives that would avoid, minimize, or mitigate wetland and water quality impacts are identified. DEP's comments often lead to project plan modifications, resulting in less impact and/or improved mitigation than originally proposed.

In 2017, DEP reviewed 38 wetland permit applications, including seven in Catskill/Delaware (CAT/DEL) basins (Schoharie, West Branch, Boyd Corners, and Kensico). Twenty-two of those applications were submitted pursuant to the New York State Freshwater Wetlands Act, four of which were in CAT/DEL basins. DEP also reviewed 11 municipal and five federal wetland applications (Figure 4.14 and Table 4.7).

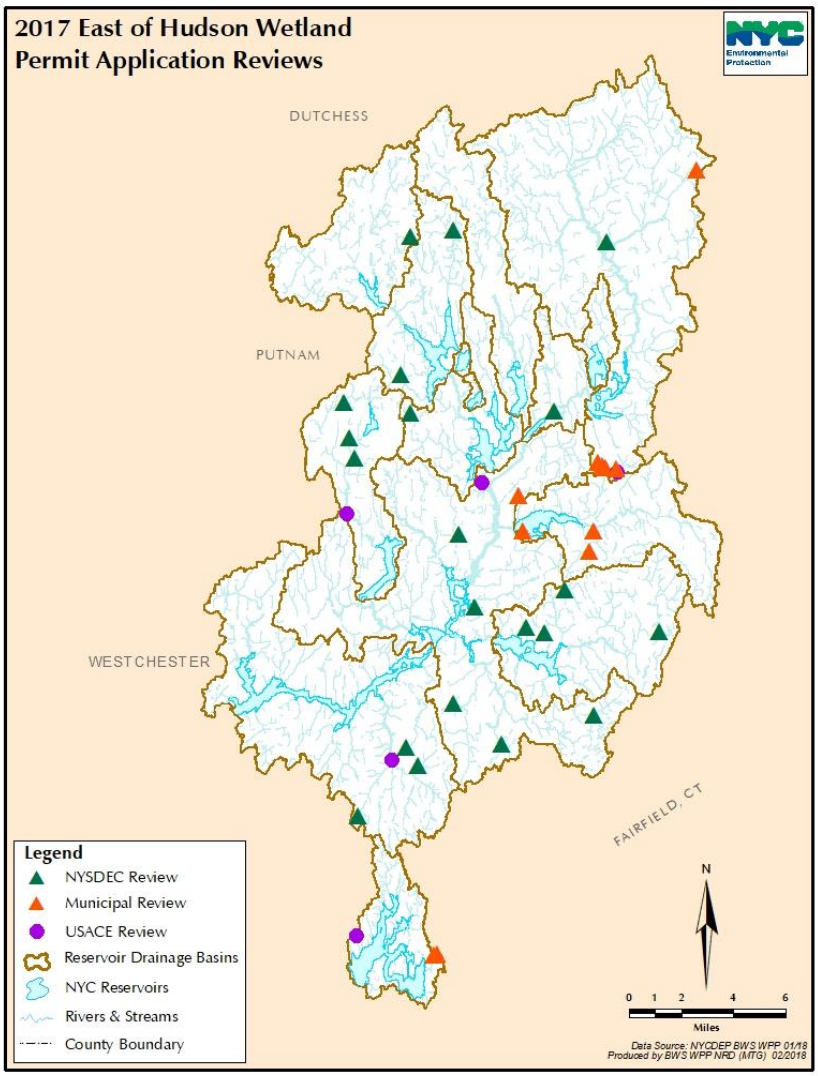

Figure 4.14 Location of wetland permit applications reviewed in EOH in 2017.

Table 4.7 Wetland permits reviewed in 2017.

Property	Basin		
Central Hudson SM Gas Line	Amawalk	NYSDEC	AA disturbance
Mazzola Property	Amawalk	NYSDEC	AA disturbance
Park and Athletic Complex	Amawalk	NYSDEC	AA disturbance
Hidden Meadows Kearny Realty Development	Amawalk	USACE	Wetland (0.04 ac), AA disturbance
Little Buck Mountain Pond	Boyd Corners	NYSDEC	Aquatic nuisance species management
Boutkov Property	Cross River	NYSDEC	AA disturbance
Hellinger Property	Cross River	NYSDEC	AA disturbance
Reinbergen Property	Cross River	NYSDEC	AA disturbance
Thistle Waithe Learning Center	Cross River	NYSDEC	AA disturbance
Lake Plaza Shopping Center	Croton Falls	NYSDEC	AA disturbance
Morningthorpe Pedestrian Bridge	Diverting	NYSDEC	AA disturbance
Carriage House Restaurant	East Branch	NYSDEC	AA disturbance
Cooper Residence	East Branch	Town	AA disturbance
Hamawy Residence	East Branch	Town	AA disturbance
Pietsch Gardens	East Branch	Town	AA disturbance
Shallat Property	East Branch	Town	AA disturbance

Property	Basin		
32 Big Trail Road	East Branch	Town CT	AA disturbance
Gizzi Property	East Branch	USACE	Temporary wetland disturbance for forest management
40 Locust Road	Kensico	Town	AA disturbance
52 Locust Road	Kensico	Town	AA disturbance
Kensico Preserve (Baker Residential)	Kensico	USACE	Wetland (0.06 ac), AA disturbance
Gilligan Property	Muscoot	NYSDEC	AA disturbance
Red Panda Trust	Muscoot	NYSDEC	AA disturbance
Vogel Property	Muscoot	NYSDEC	AA disturbance
Wilder Balter Affordable Housing	Muscoot	NYSDEC	AA disturbance
Somers Crossing	Muscoot	NYSDEC	Wetland (0.01 ac), AA disturbance
Hanney Residence	Muscoot	Town	AA disturbance
Butlerville Road Bridge-WCDPW	Muscoot	USACE	Temporary wetland disturbance for bridge abutment replacement
WIN Development	New Croton	NYSDEC	AA disturbance
WCDEF Sewer System Rehab	New Croton	NYSDEC	AA disturbance
Leonard Park Pond	New Croton	NYSDEC	Aquatic nuisance species management
MTA Commuter Rail new substation	New Croton	USACE	Wetland (0.077ac) permanent and (0.159 ac) temporary disturbance
Klein Property	Schoharie	NYSDEC	AA disturbance
Klemm Property	Titicus	Town	AA disturbance

Property	Basin		
Lisi-Sorokin Property	Titicus	Town	AA disturbance
Love-Isler Residence	Titicus	Town	AA disturbance
Sycamore Park Rec Center	West Branch	NYSDEC	AA disturbance
Garfinkle Property	West Branch	NYSDEC	Aquatic nuisance species management

Twenty-nine (76%) of the activities reviewed were for disturbance only within the adjacent area. Only four of the permit applications (11%) were for permanent encroachments, each less than 0.1 acre. Wetland encroachments were minimal and DEP focused its comments to ensure that best management practices for erosion and sediment control were in place, and that proposed wetland and buffer mitigation was appropriate.

In 2017, the City commented on the U.S. Army Corps of Engineers' proposal concerning the repeal, replacement, or modification of certain regulations in accordance with Executive Order 13777. The City also commented on EPA's proposed rule to rescind the definition of "waters of the United States" set forth in the 2015 Clean Water Rule and to recodify previously existing definitions. In both letters, the City supported broad federal jurisdiction over streams and wetlands to help protect the high quality of its water supply.

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 2,894 acres or 19% of these wetlands through its Land Acquisition Program. (See Section 4.2 for details of the Land Acquisition Program). In the CAT/DEL watershed, pre-MOA DEP lands contain an additional 973 acres (6%) of wetlands, with an additional 1,269 acres (8.3%) of wetlands located on state or other protected lands. This amounts to nearly 34% of wetlands in the CAT/DEL watershed being located on protected lands. Table 4.8 summarizes the number and acreage of wetlands protected through acquisition for both the CAT/DEL and Croton watersheds.

Table 4.8 Wetlands acquired or protected by the NYC Land Acquisition Program in the Catskill/Delaware and Croton systems as of December 31, 2017.

Description	*Acres*	*% of Total Watershed Acreage*	*% of Total Land Acquired*	*% of Total Wetlands or Deepwater Habitats in System*
For Catskill/Delaware (Ashokan, Schoharie, Rondout, Neversink, Pepacton, Cannonsville, West Branch, Boyd Corners, Kensico basins):				
Total Acreage of Entire Watershed	1,048,661			
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 12/31/17†*:	144,445	13.77%		
Within those total lands under contract or closed:				
Total Acreage of Wetlands (both NWI and DEC-regulated, excluding Deepwater Habitats**)	2,894		2.00%	19.05%
Total Acreage of Deepwater Habitats**	188		0.13%	0.66%
Total Acreage of Wetlands and Deepwater Habitats**	3,082		2.13%	7.08%
For Croton:				
Total Acreage of Entire Watershed	212,700			
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 12/31/17†*:	1,984	0.93%		
Within those total lands under contract or closed:				
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, 2017. 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 in 2014.*

*** 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 WAC farm and forest easements. Excludes non-LAP and pre-MOA land.

Wetland Mapping

In 2017, DEP completed a feature accuracy assessment of the Light Detection and Ranging (LiDAR) wetland mapping pilot study (July 2015 FAD Deliverable). Feature accuracy refers to the correct identification of an area as wetland or upland on the map. Feature accuracy was determined to be 93% for the EOH and 87% for the WOH pilot areas, as compared to 77% and 78% for the current NWI, respectively. The pilot therefore demonstrated that incorporation of LiDAR-derived datasets and high resolution aerial photography in object-based image assessment increases the completeness and accuracy of wetland mapping. Further investigation of the pilot accuracy assessment results may inform and improve the watershed-wide expansion of this effort. DEP is working on the scope of services for such an expansion, slated for completion by 2022. DEP also presented the findings of the LiDAR wetland mapping pilot project at the New York State Wetlands Forum annual conference in Suffern, NY.

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 2017, DEP continued to maintain and collect data from automated monitoring wells in these wetlands. The wells measure water level at 6-hour intervals and enable DEP to assess hydrologic functions by observing responses to storms, droughts, and snow melt. They also provide reference baseline hydrographs that can inform wetland establishment and restoration projects.

Figure 4.15 DEP resampled this reference wetland in the Schoharie basin. Note the monitoring well in the far left.

DEP also completed the resampling of the vegetation plots in its reference wetlands originally sampled in 2004 and 2005. The effort took two field seasons, with 50 plots from 10 wetlands resampled in 2016, and 49 plots from eight wetlands in 2017. DEP also collected soil samples during this time (Figure 4.15).

Long-term vegetation, soils, and hydrologic monitoring provides an important baseline for characterizing wetland types in the City's watershed. These data provide standards for conditional and functional assessment, trend analysis, and wetland restoration and establishment efforts. In 2017, for example, DEP gave a presentation at the Watershed Science and Technical Conference in Saugerties, NY on using data collected at DEP's reference wetlands to improve the outcome of wetland establishment and restoration projects.

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 in which no disturbance is permitted under normal circumstances. Moreover, the 100-foot-wide area surrounding wetlands is considered a special management zone, within which tree removal and equipment operation are limited. In 2017, DEP delineated 18 wetlands for three 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.

Education and Outreach

Wetlands program staff conducted numerous educational programs for the public and watershed stakeholders. DEP issued a press release for National Wetlands Month and included two wetland-related articles in its recreation newsletter. DEP hosted a wetlands pop-up educational event at Ashokan Reservoir. Over 50 members of the public stopped by the display to learn about wetlands in the watershed and speak with staff. DEP also led a field ecology class for Ulster County Community College students at two wetlands on DEP property near Ashokan Reservoir and attended the Rockland Sportsman's Expo, where the DEP's educational pamphlet on wetlands in the watershed was distributed.

4.8.2 Forest Management

DEP has an active Forest Management Program staffed by 11 geographically based foresters and one program manager. DEP hired six new watershed foresters during summer 2017. They started working during the last quarter of 2017: two in the Cannonsville and Pepacton basins, one in the Rondout and Neversink basins, one in the Ashokan and Schoharie basins, and two in the East of Hudson watershed. The additional positions support the growing forest management workload resulting from continued land acquisition and the ongoing implementation of the 2011 Watershed Forest Management Plan.

The program is responsible for the scientific assessment and active management of forest resources on City land. Most of these projects are timber harvests, but salvage and restoration projects are involved as well. The overall goal is to promote forest vigor, resistance, and resiliency to protect and enhance water quality.

The Forest Management Program developed and submitted the update to the 2011 Watershed Forest Management Plan (WFMP) as required by the 2010 Water Supply Permit and the 2017 FAD by the due date of December 24, 2017. The update focused on lands acquired since the forest inventory for the WFMP through December 31, 2016, approximately 29,650 acres. The update summarized the results for the forest stand delineation of these lands, with 78% of the lands being forested (23,048 acres). The update also included the 2015 revised Conservation Practices, the WFMP's implementation strategy, a summary of the continuous forest inventory program, staffing improvements, forest stewardship contracting improvements, and an update on future forest management plan recommendations.

Two semiannual Forestry Interdisciplinary Technical Team (FITT) planning meetings were convened in 2017 to address long-range forest planning and project management, bringing together more than 40 DEP resource specialists. FITT field meetings were also held throughout 2017 to develop site-specific management plans on three new forestry projects and to review and approve modifications to active projects. FITT field meetings also took place on two forest management projects about a year after completion to assess the projects' accomplishments. These assessments provide guidance and direction to improve existing and future projects.

Table 4.9 lists the number of forest management projects and acres currently in each phase of the development process as of December 31, 2017, as outlined in the City's Forest Management Plan Conservation Practices.

Table 4.9 Forest management projects by phase.

CP process phase	Number of projects	Acres
Initiation	1	228
Planning	7	747
Implementation	8	882
Completion	6	452
Total	22	2,309

Throughout 2017, DEP implemented and managed three reactive forest management projects across the watershed; all involved salvaging timber damaged and/or blown down by

Figure 4.16 Harvesting spruce blowdown in the Ashokan basin

storms or impacted by emerald ash borer (EAB). Most of this work occurred in the Ashokan and Cannonsville basins where harvesting continues. (Figure 4.16)

A non-native invasive insect, EAB continued to spread westerly through the Ashokan basin and affect all ash trees, which comprise 7% of City-owned forestland. Due to the rate of EAB spread in the Ashokan basin, DEP continues to implement a mitigation strategy as opposed to management. The strategy focuses on identifying dense stands of ash, ash harvesting from forest stands to guide 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 part of the Ashokan basin and similar projects in the Pepacton and Cannonsville basins. As part of the roadside salvage efforts, DEP conducted a community firewood program at Ashokan Reservoir.

4.8.3 Invasive Species

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 four times in 2017 and found it necessary to form a sub-committee to address decontamination methods for boat motors. The ISWG discussed ongoing rapid response efforts for *Hydrilla* in New Croton Reservoir, the release of a biocontrol insect to combat hemlock woolly adelgid, impacts of invasive species introductions from recreation activities, and working with neighboring landowners on control projects through the Land Use Permit Program. This work is in support of the Invasive Species

Management Strategy, which DEP 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.

The ED/RR plan implemented in 2017 includes the following elements:

- Silver vine (*Actinidia polygama*) was reported by a member of 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 continued controlling this population in coordination with the Lower Hudson PRISM. DEP supported the LH PRISM in a successful application for a NYS DEC Eradication Grant to continue this project through 2020, using DEP's ongoing control efforts as a match for the grant.
- DEP collaborated with the Catskill Regional Invasive Species Partnership (CRISP) at the Pakatakan Farmers' Market in July on outreach to landowners and recreation users on early detection of aquatic invasive species.

New York State Invasive Species Advisory Committee

DEP sits on the New York State Invasive Species Advisory Committee (ISAC), which was created through state legislation in 2007 to provide information, advice, and guidance to the New York State Invasive Species Council (ISC) on invasive species impacts, prevention, regulation, detection, and management. In 2017, DEP's representative chaired the committee until October, when her term ended and she took on the role of vice chair. In 2017, the ISAC supported the DEC's Invasive Species Coordination Unit staff in developing a comprehensive Invasive Species Management Plan. Other topics covered included discussion of how the state can identify priority efforts to continue the progress in protecting New York from invasive species. DEP attended five ISAC meetings in 2017 and two ISC meetings to provide the ISAC report.

Invasive Species Management

Hydrilla (New Croton Reservoir)

In 2017, DEP worked with the Water Research Foundation (WRF) to initiate an independent expert review of the control of *Hydrilla* in drinking water supplies and the options available for *Hydrilla* control in New Croton Reservoir (Figure 4.17). WRF awarded a contract to Hazen and Sawyer to facilitate the DEP-hosted workshop in November 2017, with participants from academic institutions, industry and case study experts. Hazen and Sawyer will submit a final report in early 2018 conveying recommendations and conclusions compiled from an extensive literature review, the workshop, and consultation with experts.

Figure 4.17 Scientists visit New Croton Reservoir to view *Hydrilla*.

An invitation for bids went out in late 2017 for a pilot project using the herbicide fluridone to treat *Hydrilla* in New Croton Reservoir to assess the efficacy of treatment and dispersal of fluridone within the reservoir. The pilot is scheduled to begin in early summer 2018.

DEP also participated in a public stakeholder meeting in May 2017 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 approximately 10 acres at the Bushkill Forest Management Project at the Ashokan Reservoir, continuing treatments that began in 2015. This greatly reduced the Japanese barberry at the site and should improve the possible establishment of tree seedlings after the forest management project is complete.

Hemlock Woolly Adelgid (Neversink Reservoir)

Cornell University approached DEP to help with the release of silver flies (*Leucopis* spp.), a newly approved biological control agent for hemlock woolly adelgid, at three sites

around Neversink Reservoir (Figure 4.18). They selected sites based on the amount of adelgid present, ease of access and potential for disturbance. Researchers will return for several years to survey for the silver flies and study their impacts on hemlock woolly adelgid populations.

Figure 4.18 DEP interns and Cornell University researchers release silver flies as a biocontrol on infested hemlocks

Catskill Regional Invasive Species Partnership

DEP continues to work regionally with partners on aquatic and terrestrial invasive species survey, education, and outreach in the Catskill region. In 2017, DEP worked with the Catskill Regional Invasive Species Partnership (CRISP) on a new 5-year strategic plan. DEP hosted a focus group and participated in CRISP quarterly meetings, served on the Steering Committee, and aided in decision making on project funding.

Lower Hudson Partnership for Regional Invasive Species Management (PRISM)

In addition to the response to the early detection of silver vine, DEP participated in a partnership project with the Lower Hudson PRISM and NYSDEC to survey for giant hogweed within the watershed. Researchers found six individual plants on City lands in the Croton Falls

Reservoir basin in the Town of Carmel, which were controlled by the Lower Hudson PRISM field crew. DEP serves on the steering committee for the PRISM as well.

4.9 East of Hudson Non-Point Source Pollution Control Program

The 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 Boyd Corners.

4.9.1 Wastewater Programs

DEP provides support to Westchester and Putnam counties in their efforts to reduce the potential impacts of improperly functioning or maintained septic systems. Westchester County, Putnam County, and their respective municipalities continue to implement the septic requirements of the NYSDEC MS4 General Permit. As required by the permit, programs are in place for inspection, maintenance, and rehabilitation of septic systems.

In 2017, DEP continued implementation of the Septic System Rehabilitation Reimbursement Program in the West Branch, Boyd Corners, Croton Falls, and Cross River

Figure 4.19 Septic tank replacement at a home in Kent in Putnam County.

Reservoir basins in partnership with the New York State Environmental Facilities Corporation (EFC). This program provides funding to homeowners to rehabilitate deficient septic systems or connect their homes to an existing sewage collection system (Figure 4.19). The program provides up to 50% reimbursement for eligible portions of the basins (within 200 feet of a watercourse) not covered by one of the other available septic reimbursement programs.

Residents with a demonstrated financial hardship may have their share of the project cost reduced to 25%.

In April 2017, EFC directly mailed eligible residents a letter describing the program and providing contact information. Seven residents signed into the program during the reporting period. EFC also issued reimbursement in 2017 for two additional sites where construction was completed in prior reporting periods.

4.9.2 Stormwater Retrofit and Remediation

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). DEP has completed designs for both projects and satisfied the respective towns' requirements.

For the Drewville Road project, DEP provided Carmel with the engineering inspection fee of $47,150. DEP completed initial tree cutting activities in the proposed staging area and maintenance road without using heavy machinery, removed downed trees, and installed erosion control measures. The town permit will remain open and the remaining construction work will be completed once the project contract is awarded.

During 2017, DEP advanced the final design specification package for both the Maple Avenue and Drewville Road projects. The project team held a permit audit for the projects in September. The final design specification package was then approved. In November, DEP advertised both projects to contract bidders and held pre-bid meetings for contractors. DEP opened bids in late December. DEP anticipates issuing the Notice to Proceed in the first half of 2018.

4.9.3 Stormwater Facility Inspection and Maintenance

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

4.9.4 Stormwater Retrofit Grant Program

DEP previously 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 to municipalities that participated in a Regional Stormwater Entity in the EOH watershed. DEP issued full payment to the EOH Watershed Corporation (EOHWC) to construct the retrofits needed to satisfy permit obligations of EOH municipalities under Section IX.A.5.b of the NYSDEC MS4 General Permit. All of these funds were expended on stormwater retrofit projects.

The 2017 FAD requires that DEP enter into a contract with EOHWC to provide $22 million for the construction of stormwater retrofits in EOH FAD basins. In 2017, DEP and the EOHWC commenced negotiations on the terms of the forthcoming funding agreement.

4.10 Kensico Water Quality Control Program

4.10.1 Wastewater-Related Nonpoint Source Pollution Management Programs

Septic Reimbursement Program

DEP implements the Kensico Septic System Rehabilitation Reimbursement Program through a contract with EFC. The program reimburses homeowners a portion of the costs to rehabilitate eligible failing septic systems or connect those systems to an existing sewage collection system. In April 2017, EFC mailed the annual reminder letter to eligible residents notifying them of available funding in an attempt to sign interested participants into the program. During the reporting period, one repair was completed and EFC issued a reimbursement for an additional site where the repair was completed in a prior year.

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 located elsewhere in the county. DEP previously funded the installation of a sanitary sewer 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 concerns since the system's installation. WCDEF operates and maintains the units and the units appear to be working well.

DEP also conducts an annual visual inspection of the trunk line to assess the condition of exposed infrastructure. DEP performed the full inspection in May 2017 while also conducting routine partial inspections throughout the year in association with ongoing maintenance of Kensico stormwater BMPs near the line. DEP noted no defects or abnormalities.

4.10.2 Stormwater-Related Nonpoint Source Pollution Management Programs

BMP Construction, Inspection and Maintenance

DEP has constructed 47 stormwater management and erosion abatement facilities throughout the Kensico watershed to reduce pollutant loads to the reservoir. DEP and an outside contractor inspected and maintained these facilities, shown in Figure 4.20, as needed throughout 2017, according to the O&M Guidelines. Maintenance consisted of grass mowing, vegetation removal, tree removal, and sediment and debris removal. All BMPs are performing as designed.

Wildlife Sanitary Surveys

DEP conducts Kensico Reservoir Wildlife Sanitary Surveys to prevent wildlife excrement from washing into the reservoir and potentially elevating levels of fecal coliform

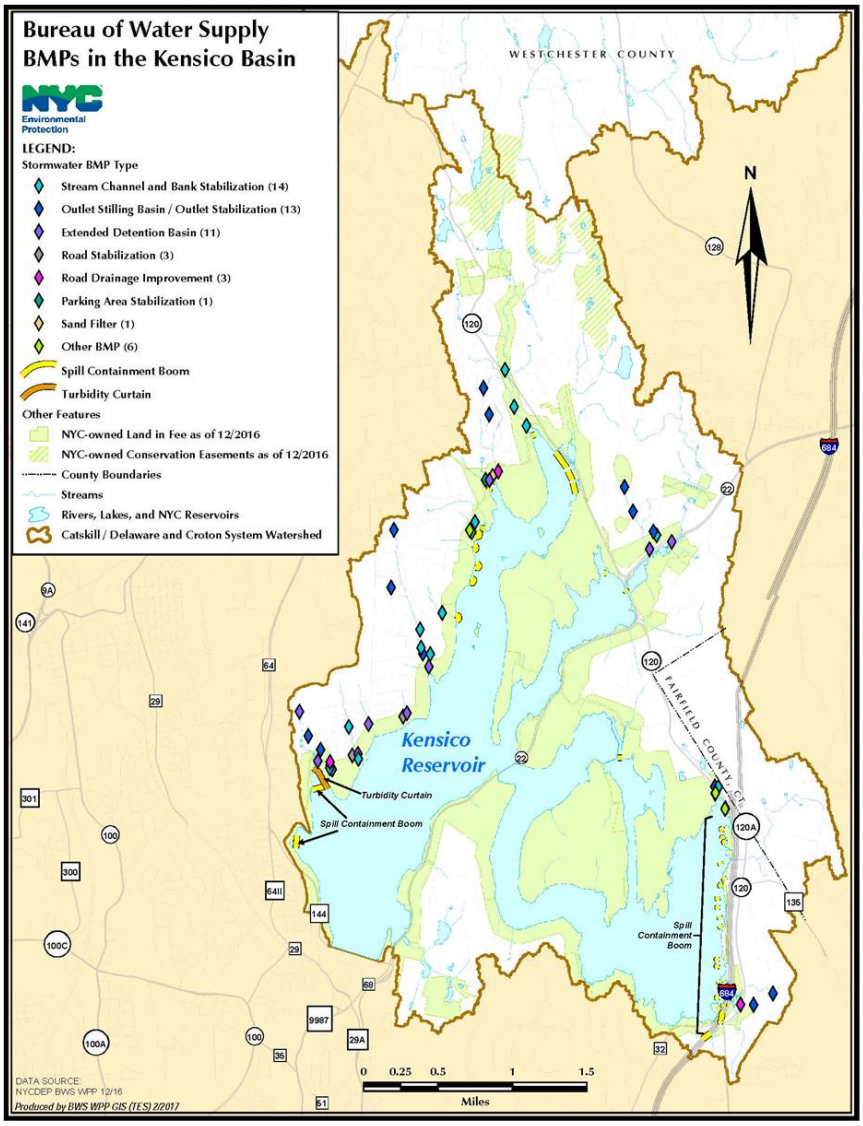

Figure 4.20 BMPs within the Kensico Reservoir Basin.

bacteria. Since intense precipitation events can result in overland flow of water, DEP identified sensitive survey sampling locations based on proximity to the Delaware Aqueduct Shaft 18 water intake location. Figure 4.21 shows a map of the area surveyed approximately 24 to 48 hours prior to significant precipitation events. DEP developed a system of locating, identifying, and removing wildlife excrement, particularly where wildlife latrines had developed, as a proactive effort to reduce fecal coliform bacteria and other pathogens from potentially entering the water supply.

Figure 4.21 Kensico Reservoir wildlife sanitary sampling locations

During 2017, DEP and its contractor conducted three wildlife sanitary surveys in advance of significant precipitation events at Kensico Reservoir (Table 4.10). Trained wildlife biologists and technicians collected, identified, and disposed of wildlife fecal excrement. Of the 171 fecal samples collected, 42% were attributed to white-tailed deer (*Odocoileus virginianus*), 27% were attributed to raccoons (*Procyon lotor*), 25% were attributed to eastern cottontail rabbits (*Sylvilagus floridanus*) and 6% were from all other mammals. There were no avian excrement collections in 2017.

Spill Containment Facilities

DEP maintains spill containment facilities in and around Kensico Reservoir to improve spill response and recovery, and to minimize water quality impacts in case of a spill. In 2017, 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 deployment of booms.

Table 4.10 Kensico Reservoir 2017 wildlife sanitary surveys.

Date of Survey	White-tailed Deer	Raccoon	Eastern Cottontail Rabbit	Opossum	Fox Spp.	Coyote	Mink	Eastern Gray Squirrel	Unknown Mammal	Total
01/23/17	32	22	16	0	1	1	1	0	1	74
10/23/2017	21	18	18	1	0	1	1	1	3	64
10/28/2017	19	6	8	0	0	0	0	0	0	33

Shaft 18 Shoreline Stabilization

Shaft 18 sits along the southwest shore of Kensico Reservoir. Since the Catskill/Delaware UV Disinfection Plant (CDUV) began operating, all water in Kensico flows through the Delaware Effluent Chamber at Shaft 18. Increased reliance on Shaft 18, together with changing

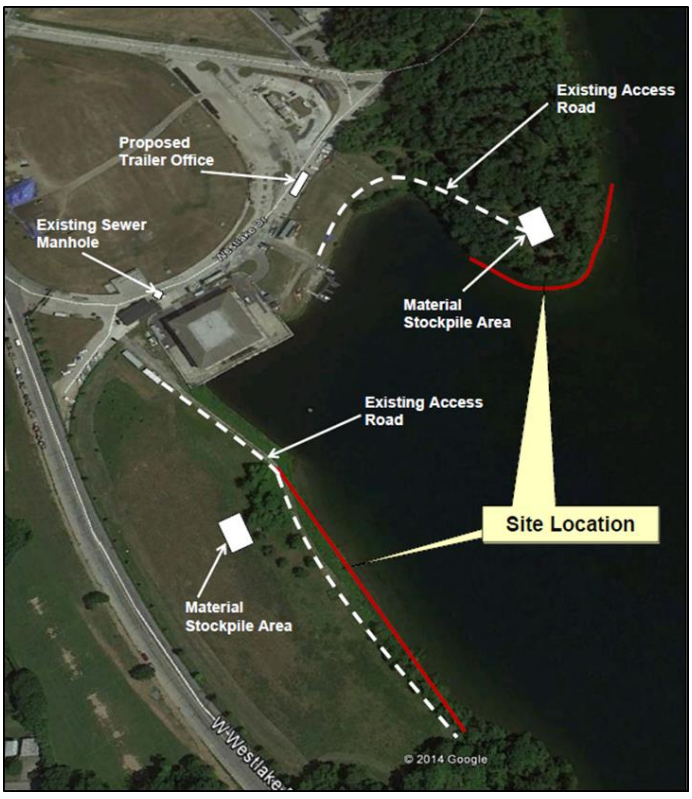

Figure 4.22 Location of the Shaft 18 shoreline stabilization.

weather patterns, necessitates shoreline stabilization measures near the effluent chamber to maintain turbidity levels in compliance 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 4.22). DEP has completed the design and secured approval from the Public Design Commission. The Town of Mount Pleasant issued permit approvals and signed the MS4 and stormwater pollution prevention plan (SWPPP) acceptance. The MS4, Notice of Intent, and SWPPP were submitted to and approved/secured by the NYSDEC and US Army Corps of Engineers.

DEP held the pre-bid meeting for contractors in September 2017. DEP advertised the project to contract bidders in early October and received contractor bids in late October. DEP is currently reviewing the submitted bids and contractor qualifications.

4.10.3 Other Kensico Management Programs

Turbidity Curtain

DEP continues to monitor the extended primary curtain and the back-up turbidity curtain designed to direct flows from Malcolm Brook and Young Brook farther into the body of Kensico Reservoir. DEP inspected both turbidity curtains during 2017 to ensure they are properly functioning. No immediate repair work was required and the curtains appear to be functioning as intended.

Effluent Chamber Dredging

The Kensico Water Quality Control Program has a requirement to reduce turbidity risk. DEP is evaluating the potential need for dredging in relation to the construction of the connection between Kensico Reservoir and the CDUV. DEP anticipates completing this evaluation associated with the connection between the Catskill Upper Effluent Chamber (CATUEC) and the CDUV in 2020. DEP will report on the updated status and the schedule for work after the evaluation is complete.

Westchester County Airport

During 2017, DEP continued to review activities proposed at the Westchester County Airport due to its proximity to Kensico Reservoir. In March, DEP commented on the Draft Final Supplemental Environmental Impact Statement for Park Place at Westchester County Airport, the proposed construction of a 980-space parking garage. In May, DEP commented on the Final Supplemental Environmental Impact Statement.

In July, DEP reviewed and commented on the Westchester County Airport Draft Master Plan initiated by the Westchester County Department of Public Works and Transportation.

Westchester County officials and consultants continue to develop plans to remediate an uncapped landfill at the airport. The plans will include a control measure to prevent accumulated iron flocculent, noted at the base of the landfill within an unnamed stream, from discharging to

Kensico Reservoir. As of December 2017, the NYSDEC, the Office of Watershed Inspector General, and DEP have yet to receive the draft remediation plan.

In November 2017, DEP reviewed plans for maintenance dredging of Detention Basin B, located in the Blind Brook watershed, and confirmed there will be no impacts to the Kensico watershed due to this activity.

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 considers local geology 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. 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 State Pollutant Discharge Elimination System (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 implemented several 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 achieved functional completion in 2016.

Operations Support Tool

The 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. DEP uses OST daily for operational decisions, as well as planning and policy evaluation purposes.

No significant revisions or enhancements were made to OST in 2017. The focus was on using the system to support operational decision-making and planning. Standard modeling practices, such as ongoing evaluation of model performance, forecast verification, and fine-tuning of model code and algorithms, were performed. New software was developed to visualize and export model output, making the use of OST more efficient and providing additional information to support system managers. Over 1,200 model runs were executed in 2017, underscoring the value and purpose of OST for water supply operations.

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 employ 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 apply 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 suggested modification to the Catalum SPDES 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 expert panel met four times in 2017:

- January 5-6, 2017, Kingston, NY
- April 24-25, 2017, Kingston, NY
- September 25-26, 2017, Kingston, NY
- December 7-8, 2017, Washington, D.C.

The first three meetings had sessions open to the public, including opportunity for direct public comment to the panel. Additionally, the public was able to submit comments through the project website (dels.nas.edu/Study-In-Progress/Review-York- City/DELS-WSTB-14-02). The fourth meeting in Washington, D.C. was a working session for the expert panel members and closed to the public. To date, DEP staff have given 13 presentations, participated in several technical conference calls, arranged for two field visits to operational facilities, and supplied

over 200 pieces of information, including operational and water quality data and technical reports. A final meeting is scheduled for April 5-6, 2018, and the report is anticipated in September 2018.

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 the channel's operation.

Consistent with the consent order, DEP in June 2012 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. The Final Scope was issued on March 22, 2017 and it takes into consideration feedback from the public review process and includes responses to the comments received. Work has begun on the draft EIS.

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 plants (WWTP). DEP's monitoring objectives for 2017 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 Filtration Avoidance Determination (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 providing 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), administrative orders, and 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 have continued in the 2017 FAD promulgated in December 2017. These requirements form the basis for the City's ongoing assessment of watershed conditions and 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 2017 activities are summarized in the 2017 Watershed Water Quality Annual Report Annual Status Report. (See Section 5.2 for how to access this 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. DEP collected almost 400 additional watershed samples for special investigations during 2017, including 85 stream samples, 109 reservoir samples, and 60 pathogen samples.

Special investigations in 2017 included several studies focused on the water quality in and around Kensico Reservoir. The first investigation was initiated to locate a suspected input of human fecal contamination to a tributary. This uncovered a break in a local sewer line soon repaired by Westchester County. Follow-up sampling is still ongoing. The other major investigation on Kensico was during the installation of a new boat ramp near the Shaft 18

gatehouse. Staff installed near real-time turbidity monitoring sensors and loggers on buoys in the reservoir, providing water quality data to operators, managers and contractors during the ramp's installation.

Other examples of non-routine monitoring included significant storm events at Kensico Reservoir. In 2017, there were two storm events (in May and October) monitored using auto samplers on streams N5 and Malcolm Brook. When fecal coliform results appeared elevated, DEP sent samples 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 1.2 million measurements in the watershed in 2017.

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 protozoan removal from effluents of the plants. In 2017, DEP collected 39 protozoan samples from 10 wastewater treatment plants throughout the NYC watershed. DEP monitored eight plants in the WOH basins and two plants in the EOH basins (Figure 5.1 and Figure 5.2).

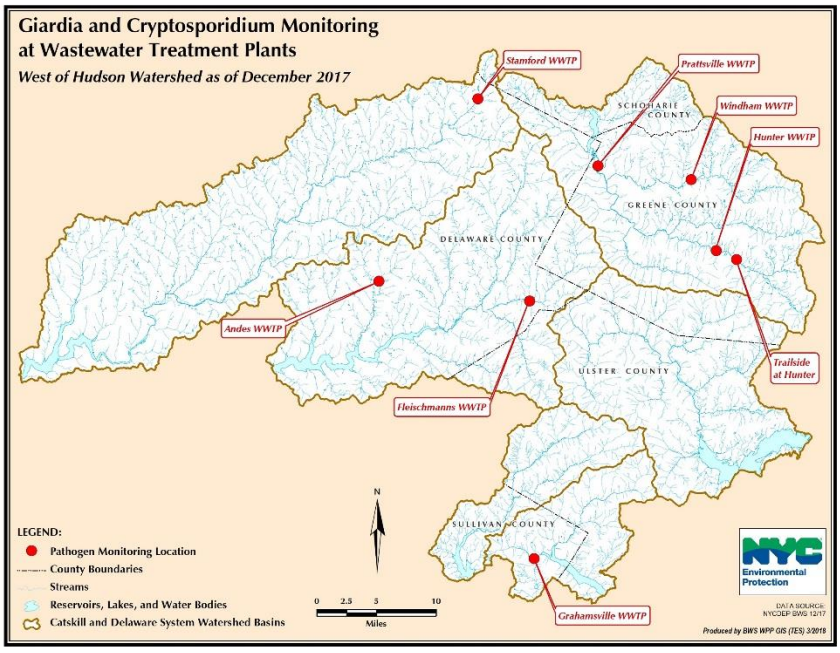

Figure 5.1 Wastewater treatment plants monitored for *Giardia* and *Cryptosporidium* in 2017 in the WOH watersheds.

FAD monitoring is scheduled on a quarterly basis at these ten plants. One exception was the Grahamsville plant, where the sample was collected in January 2018 instead of during the last quarter of 2017.

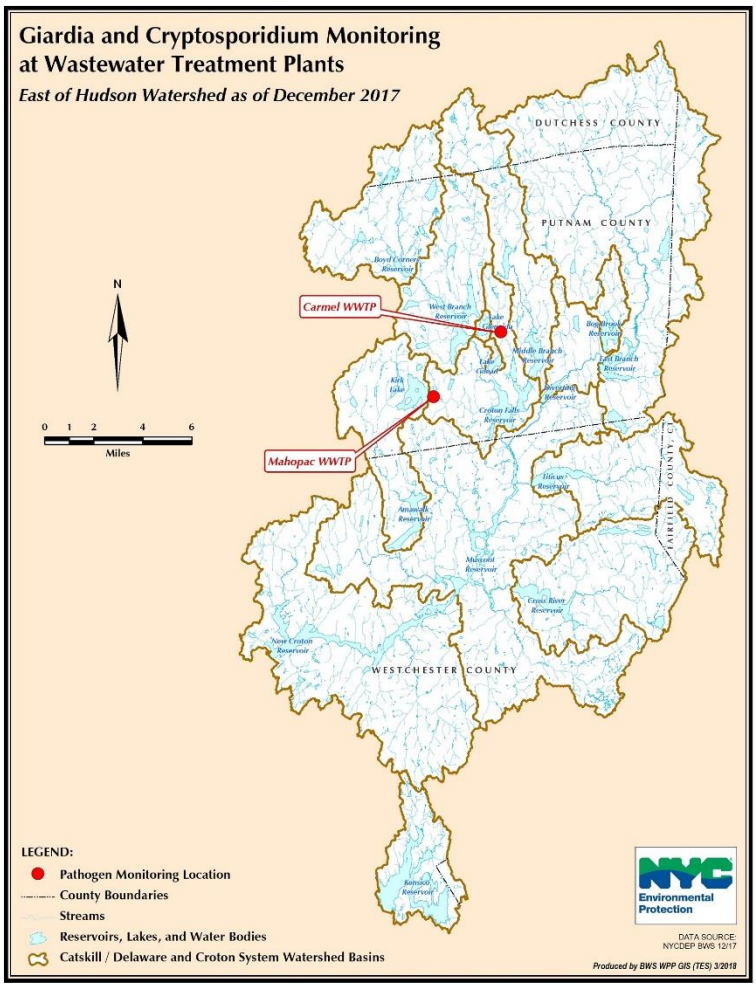

Figure 5.2 Wastewater treatment plants monitored for *Giardia* and *Cryptosporidium* in 2017 in the EOH potential FAD watersheds.

Each sample for *Cryptosporidium* and *Giardia* involved the field filtration of 50 liters of plant effluent water. DEP analyzed the samples according to USEPA Method 1623.1 (USEPA 2012). None of the WWTP samples were positive for *Cryptosporidium* in 2017. However, three samples from two of the WOH plants were positive for *Giardia*. Two of these positives were from Trailside at Hunter, LLC (previously known as Hunter Highlands) and the other was from the Windham treatment plant. Each of the three positive results, and plant conditions at the time of sampling, are discussed below.

The Trailside at Hunter, LLC plant (Hunter Highlands) was sampled on February 21 and had 10 *Giardia* cysts in the 50.4 L sample. DEP contacted the facility operator to investigate any process irregularities that may have led to the elevated *Giardia* count. Operators told DEP that around the sample time a pressure reduction to 60 psi (normal operating pressure ranges from 100-120 psi) was observed in the portable air compressor that drive the air lift pumps within the continuously backwashing upflow dual sand filters. This unit has been active since the beginning of 2017. The sand filters remained operational and turbidity readings for the day ranged from 0.16 – 0.18 NTU. Operators ordered a new compressor and put it in service February 23, 2017. The operator also noted the facility plans to order a permanent, inline compressor. Operators didn't note any other mechanical or process abnormalities that could have led to the positive detection. The following two quarterly samples were negative for *Giardia* cysts; however, 2017's fourth sample was positive. This sample was collected on November 29 and there were seven *Giardia* cysts detected in the 50.7 L sample. DEP again contacted the facility operator to identify any potential process irregularities. However, no mechanical or process abnormalities were noted at the treatment plant around the time of sampling.

The other plant which had a *Giardia* detection in 2017 was the Windham plant. Three *Giardia* cysts were found in the 50.7 L sample taken on November 28. DEP contacted the plant operators to investigate any potential issues; however, no abnormal conditions were noted at the Windham plant around the time of sampling. The first three quarterly samples for 2017 were negative for *Giardia*, and this is consistent with the past three years, when one out of the four samples each year was positive for *Giardia*.

All EOH FAD quarterly samples were collected at the Carmel and Mahopac sewage treatment plants in 2017 and none of the samples were positive for *Giardia* or *Cryptosporidium*.

5.1.4 Water Quality Reports

Pursuant to the City's Long-Term Watershed Protection Plan (DEP 2017b) and as a FAD requirement (Section 5.1), DEP produces and submits a Watershed Water Quality Annual Report to NYSDOH and USEPA in July of each year (e.g., DEP 2017d). 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 2017 report (due July 2018), 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 4,500 samples and over 50,000 analyses. Limnological profiles conducted during the sampling surveys added almost 65,000 additional analyses. For the pathogen component, 491 routine samples were collected at 46 sampling sites (including keypoints) and analyzed for *Giardia* and *Cryptosporidium*, along with turbidity, pH, and temperature, for almost 2,000 analyses. In addition, DEP collected 40 samples at five 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 Open Data website (https://data.cityofnewyork.us/Environment/DEP-Cryptosporidium-And-Giardia-Data-Set/x2s6-6d2j).
- Results from *Cryptosporidium* and *Giardia* weekly sampling at the Kensico influents (DEL17 and CATALUM) and effluent (DEL18DT) are sent directly to regulators by email.
- 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.
- Watershed Water Quality Annual Report (e.g., DEP 2017d)
- Drinking Water Supply and Quality Annual Report (e.g., DEP 2017e)
- Filtration Avoidance Annual Report (e.g., DEP 2015), or, every fifth year, the Watershed Protection Program Summary and Assessment (DEP 2017c)

5.2 Multi-Tiered Water Quality Modeling Program

DEP's Water Quality Modeling Program uses computer simulations to quantify the impact of climate, land use, watershed protection programs, the operation of reservoirs and the water supply system, and water demand on the quantity and quality of water delivered to the City. For a detailed description of water quality modeling activities in 2017, please refer to the Watershed Water Quality Annual Report, which will be available on the DEP website following its submittal on July 31, 2018 (http://www.nyc.gov/html/dep/html/watershed_protection/fad_2017.shtml). A brief summary is below.

In DEP's multi-tiered approach, climate models provide the inputs to watershed and reservoir models. DEP uses climate models to understand and predict the occurrence of extreme events under current and future climate conditions.

With regard to current climate conditions, DEP has developed a stochastic weather generator to predict synthetic time series of precipitation and air temperature. In 2017, climate conditions for WOH watersheds were entered into the Generalized Watershed Loading Function model to predict streamflow. Work continues to produce predictions of future climate by combining global climate model predictions with time series from the weather generator.

In 2017, progress continued on the application and testing of the Soil Water Assessment Tool model in Cannonsville Reservoir watersheds. In 2017, DEP began applying that tool to the entire Cannonsville Reservoir watershed, for both runoff quantity and nutrient concentrations. In addition, application and testing of the Regional HydroEcologic Simulation System model for the Biscuit Brook and Shelter Creek watersheds draining to Neversink Reservoir continued in 2017.

Also in 2017, DEP completed the application, testing, and validation of the two-dimensional reservoir turbidity model for Neversink Reservoir. DEP previously completed similar work for Schoharie, Ashokan, Rondout, and Kensico reservoirs. The water quality modeling section provides routine weekly forecasts of water supply system operation and associated water quality using DEP's Operations Support Tool (OST), and provides OST simulations for periods when elevated turbidity is of concern.

Considerable progress was also made in the application and testing of GLM/AED, a one-dimensional hydrothermal and water quality model, for Cannonsville and Neversink reservoirs. This application focused on simulations of thermal stratification and temperature, nitrogen, phosphorus and carbon species, and chlorophyll. This is the first step in using this model to imitate disinfection byproduct precursors in these reservoirs.

The 2017 FAD requires a yearly progress meeting with regulators to present and discuss water quality modeling results. The first of these annual meetings took place November 8, 2017, at DEP's Kingston office. Representatives of the New York State Department of Health and the USEPA attended. DEP staff provided an overview of modeling activities and the regulators asked questions.

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 efficacy of watershed protection through maps, queries, and analyses; and to support watershed, reservoir, and operational modeling efforts. Primary GIS resources include a centralized geodatabase (the GIS library), the Watershed Lands Information System (WaLIS), and Global Positioning System (GPS) technology. This report summarizes GIS technical support for programs and modeling applications; the completion or acquisition of new GIS data layers; improvements to GIS infrastructure; and dissemination of GIS data.

5.3.1 GIS Technical Support

In 2017, DEP continued to use its GIS to perform technical support and data development for various watershed protection programs and modeling applications. For example, DEP created customized statistical reports and maps depicting land ownership, land cover extent, hydrographic and topographic features, riparian and flood zones, water supply facilities, or program implementation status over particular basins or political boundaries. These analyses

were developed for program design and planning, engineering screening, regulatory jurisdiction determination, emergency response, water supply operations, and recreational outreach.

DEP also generated custom sub-basin boundaries for specific water quality sampling locations using digital elevation models (DEMs). DEMs were also incorporated into global climate models to generate local predictions of future climate conditions. DEP relies on data sets such as reservoir bathymetry, county soil surveys, land cover, and land use to drive model analyses.

In 2017, DEP used new higher-resolution GIS data layers for slopes, hydrography, land cover, and other features to update a WOH watershed town-level assessment of developable land as part of FAD discussions with watershed stakeholders. This analysis updated a similar analysis

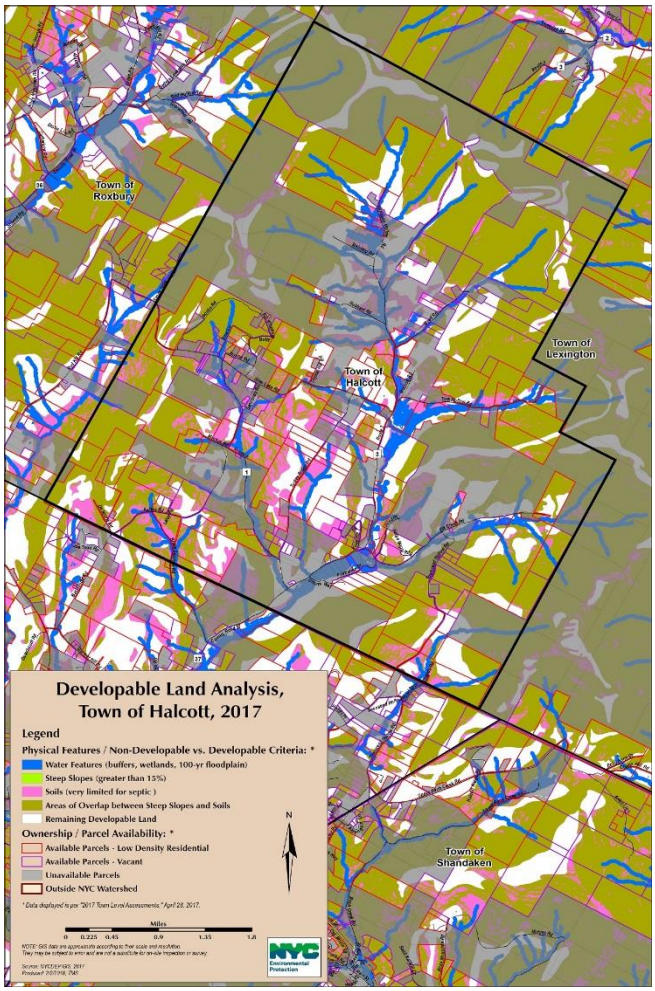

Figure 5.3 Results of an analysis using higher resolution GIS layers to depict the developable vs non-developable land in the Town of Halcott.

performed in 2009 using older lower-resolution data (Figure 5.3). DEP also employed GIS to determine vulnerability within a 1-hour river travel time downstream of all reservoirs in the event of a dam failure, including depictions of inundation areas, vulnerable populations, critical facilities, and the positioning of potential siren systems for emergency notification.

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

Under contract with DEP, USGS is using boat-based sonar to survey all 13 reservoirs and three controlled lakes in the EOH watershed as it did previously for WOH reservoir bathymetry mapping. The USGS delivered final data to DEP for WOH reservoirs in 2017 (The final report is here: https://pubs.er.usgs.gov/publication/sir20175064). During 2017, USGS collected EOH reservoir bathymetry data for eight reservoirs and all three controlled lakes, with the remainder to be collected in 2018. All EOH reservoir boundaries and their dependent data in DEP's version of the National Hydrography Dataset (NHD) have been revised from existing 1-meter topography according to recently corrected spillway elevations referenced to the North American Vertical Datum of 1988 (NAVD88).

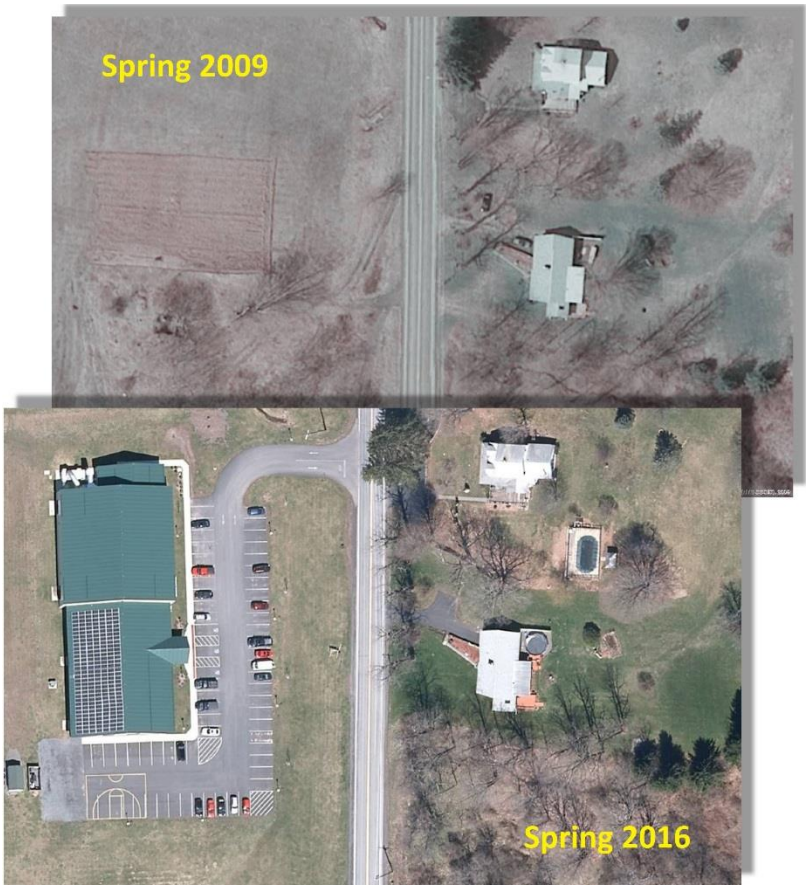

Figure 5.4 Aerial imagery from Arkville showing difference in resolution, 2009 versus 2016. DEP officially released the higher-resolution imagery in 2017.

In 2017, DEP officially released into the GIS library and WaLIS new 0.5-foot-resolution ortho-imagery data collected in partnership with the NYS Digital Orthoimagery Program. This imagery is also available on the NYS GIS Clearinghouse (https://gis.ny.gov/gateway/mg/) since it was collected wall-to-wall for all counties containing any portion of the watershed or aqueducts. User feedback has been extremely positive, given the large area covered and the level of fine detail observable in land cover features (Figure 5.4).

Also in 2017, DEP developed several new GIS data layers related to the Kensico-Eastview Tunnel Project. DEP obtained updated county soil surveys from the USDA along with new data sets from the NYS GIS Clearinghouse, such as NYSDEC snowmobile trails, and updated Accident Location Information System roads. DEP edited and updated several existing feature classes and mission-critical data sets, such as countywide tax parcels, City-owned lands or interests, state-owned lands, water supply facilities, stream restoration projects, septic repairs, and engineering project locations. Based on DEP field verification, DEP made corrections and additions to National Hydrography Dataset (NHD) mapped water features, including all associated GIS layers dependent on hydrography data. DEP also received updated locations of sensitive, threatened, or endangered species on City-owned lands from the New York Natural Heritage Program to supplement data collected by the DEP Wildlife Studies Program.

5.3.3 GIS Infrastructure Improvement

During the reporting period, DEP continued to maintain several components of its GIS infrastructure, including upgrading ArcGIS Desktop to version 10.5; 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. DEP installed and configured an ArcGIS Portal to support web-mapping capability. DEP also monitored and analyzed the performance of GIS and WaLIS software while providing any needed guidance or training to WaLIS users to improve database performance and network connectivity. In addition, DEP performed routine maintenance on numerous GPS units, including updating data dictionaries and software, and replacing or upgrading GPS hardware.

DEP also continued to upgrade and maintain WaLIS, which currently operates on 270 DEP user workstations. During the reporting period, DEP conducted WaLIS training sessions for 33 DEP police officers and customized the DEP Access Permit application. DEP released new versions of WaLIS to address certain issues and provide additional functionality. DEP updated WaLIS source code from Visual Basic to improved Python code and made various enhancements and error fixes. This included the development of a WaLIS tool that adds photo points directly from GPS-capable cameras to a GIS layer.

To assist the Regulatory and Engineering Program, DEP added over 1,300 spatial links between sewer inspection videos and GIS trunk line data displayed in WaLIS, making the videos more accessible and searchable using mapped locations. DEP's WaLIS developers also began

reworking how forestry projects are managed within WaLIS by improving the user interface, changing how bidder lists are maintained, and consolidating all forestry data within the database.

5.3.4 Data Dissemination to Stakeholders

Using established in-house data sharing policies, DEP continued to review all outside requests for GIS data and provide these data to watershed partners and interested parties as required. Over 50 stakeholders and communities are currently on a schedule to receive semiannual data updates for newly acquired and existing City-owned lands, and these parties received data in January and July 2017. DEP also shared its semiannual update of watershed recreation data with Ulster County and provided a copy of high-resolution 2009 land cover and land use GIS data to the New Jersey Department of Environmental Protection. Throughout 2017, DEP responded to data sharing requests from the U.S. Army Corps of Engineers, NYSDOH, NYSDEC, NYS Office of the Attorney General, WAC, CWC, EOH Watershed Corporation, The Catskill Center, Central Hudson, NY Power Authority, and various watershed counties, towns, and consultants working on DEP-related projects.

6. Regulatory Programs

A fundamental component of DEP's overall watershed protection strategy is the enforcement of applicable environmental regulations, which include the New York City Watershed Rules and Regulations (WR&R), the NYSDOH Appendix 75-A Wastewater Treatment Standards, the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity, the state Quality Review Act (SEQRA) and others. The primary mechanism for protection of the water supply is via administration of the WR&R.

DEP's regulatory efforts focus on three principal functions: review and approval of land use activities and land development projects; inspection of wastewater treatment plants, subsurface sewage treatment systems, sewer systems, and active construction sites; and pursuit and resolution of violations of the WR&R.

6.1 Project Review

Land use activities in the City's watershed, including those sponsored by DEP, are reviewed to ensure compliance with the WR&R. Activities that typically require DEP review and approval include WWTPs, sewer collection systems, subsurface sewage treatment systems (SSTS), projects requiring stormwater pollution prevention plans (SWPPP); and the construction of certain impervious surfaces. In addition, DEP issues individual residential stormwater permits (IRSP) and stream crossing/piping/diversion permits for other stormwater-related activities and may grant variances from the requirements of the WR&R.

DEP offers technical comments on permit applications submitted to NYSDEC involving mining operations, timber harvesting, industrial facilities, landfill closures, stream disturbance, wetland incursions, and sanitary SPDES permits within the watershed. DEP also reviews and monitors all New York State Department of Transportation activities undertaken in the watershed, such as road resurfacing, turning lane improvements and bridge replacement. In both cases, DEP's involvement stems from memorandums of understanding with each agency.

The project lists represent all stormwater, wastewater and variance applications. The project activities report also includes detailed summaries and maps reflecting project locations.

6.1.1 SEQRA Coordination

DEP reviews and provides detailed comments on all SEQRA notices received for land use activities in the City's watershed. DEP's SEQRA Coordination Group tracks all applications, maintains a database of new and amended notices, monitors development trends, and coordinates with other governmental entities that regularly act as lead agency pursuant to SEQRA.

The Semi-Annual FAD report includes a summary and mapping of all SEQRA actions reviewed or initiated by DEP during the previous calendar year.

6.1.2 Delegation Agreements

The Westchester and Putnam county health departments review new, modified, and repaired SSTSs in accordance with their respective delegation agreements with DEP. The Ulster County Health Department performs reviews of new SSTSs in accordance with its agreement with DEP.

During 2017, DEP received documentation for 60 delegated SSTSs; 47 of these were subsurface sewage treatment systems in the EOH FAD reservoir basins, the remaining 13 were SSTSs located in the WOH watershed.

6.2 Enforcement Activities

DEP investigates, documents and issues Notices of Violation (NOV) for a wide variety of errant activities including failing SSTSs, non-compliant SWPPPs, projects that commence construction without prior DEP approval, and pollutant-laden discharges to surface water resources. Enforcement actions are prepared with input from both DEP's Bureau of Legal Affairs and the New York City Law Department. DEP coordinates with NYSDEC, county health departments, municipal code enforcement officers, and the Catskill Watershed Corporation on these activities. DEP also routinely refers water quality violations to partner agencies where DEP's authority under the WR&R is limited or non-existent. Improper discharges from sites covered by industrial SPDES permits, such as concrete or asphalt manufacturing facilities, are an example of a violation that DEP fully documents and refers to NYSDEC for further action.

DEP Police patrol the watershed daily documenting a wide range of potential water quality incursions. Officers receive over 300 hours of training in environmental law and regulations, provided in part by DEP watershed protection staff, as well as 170 hours of practical field training in water supply infrastructure protection. DEP police can issue warnings, summonses and NOVs relative to state Environmental Conservation Law and the WR&R, as well as other municipal codes. DEP Police work with DEP regulatory staff to ensure that complaints of possible illicit environmental activity are investigated and addressed in a timely manner.

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. At least two compliance inspections per year take place during the operating season at seasonal surface-discharging facilities. Similarly, at least two compliance inspections occur annually 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 periodically 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 internal agency 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.

6.3.1 Facility Compliance in the Catskill/Delaware Watershed

DEP inspected 31 WOH WWTPs on a regular schedule in 2017; 26 are permitted for year-round discharge and five for seasonal discharge. Three of the 31 are wastewater treatment facilities permitted to discharge to groundwater: the hamlet of Chichester, Mountainside Farms, and Hanah Country Club. Three other facilities are classified as industrial non-contact cooling water discharges. These are Friesland Campina- DOMO, Kraft Dairy and Saputo Foods. Altogether, DEP conducted 145 scheduled compliance and emergency response inspections in 2017.

Compliance with State Pollution Discharge Elimination System (SPDES) permits continued to improve among WWTPs in the Catskill/Delaware watersheds in 2017 due in large part to the WWTCPI Program. On December 21, 2017, staff received notice of an overflow from the pump station serving the Mountainside Farms WWTP. A hydraulic overload from the dairy processing facility along with accumulation of fat, oil and grease within the force main caused the spill. An estimated 100 gallons of process waste spilled. Mountainside Farms contracted a septic hauler to vacuum the line, remove the material, and pump down the station wet well until normal flow was restored. The operator notified the NYSDEC and DEP by phone; a report of non-compliance event was filed with the discharge monitoring report.

DEP participates in Compliance Conferences (CC) with facilities continuing 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 an NOV letter prior to calling for a CC. DEP did not conduct any CCs in 2017. Many problematic and outdated facilities, which exceeded their permits on a regular basis, have connected to another upgraded facility, upgraded as a standalone facility, converted to subsurface discharge, or been totally abandoned. Thus, the number of failed WWTPs has greatly decreased.

6.3.2 Facility Compliance in the East of Hudson Watershed

The West Branch, Boyd Corners, Croton Falls, Cross River, and Kensico reservoir basins are of special interest because they contribute to waters of the Delaware System. The following

is a summary of the WWTPs and collection systems inspected within the West Branch, Croton Falls, and Cross River basins. There are no WWTPs in the Kensico and Boyd Corners basins, but DEP does inspect the collection system/pump stations maintained by Westchester County and the towns of North Castle and Harrison within the Kensico basin. In 2017, 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 2017. Carmel Sewer District #2 WWTP did experience a sewage overflow from its collection on February 19, 2017, that was not entirely contained. Water quality, however, was not impacted. The operator responded to a spill caused by a cracked force main at 1936 US 6 in Carmel near Putnam Plaza; the spill was estimated at 150 gallons and did not make it to a watercourse. The lift station was shut down, wet well was pumped, and an excavator was called in to repair the line.

For monitoring of the Westlake Sewer Trunk Line, see Section 4.10.3.

DEP performed compliance inspections of the North Castle (Old Route 22, Cooney Hill Road, Route 120/Louden Cove, New King Street, Old Orchard Street) and the Harrison (Park Lane) pump stations and collection system throughout the 2017 monitoring period. The inspections revealed no abnormal conditions.

6.3.3 Sampling of WWTP Effluents

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

Grab samples were collected monthly in 2017. 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. These plants are listed in DEP's Watershed Water Quality Monitoring Plan (DEP 2017).

City-owned WWTPs were also sampled in accordance with SPDES permit monitoring 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. DEP laboratories analyzed the samples and reported the results to NYSDEC in SPDES Discharge Monitoring Reports. Monitoring of non-contact cooling water discharges was discontinued in 2015.

In the Catskill System, there are 17 WWTPs with active SPDES permits but only 16 plants with effluents were sampled in 2017. (Four City owned and 12 non-City owned). One has no discharge. Composite samples were collected from nine plants with the composite sampling requirement (four City owned and five non-City owned).

In 2017, 1,782 analyses were performed on 310 effluent samples and influent samples (as required) from WWTPs in the Catskill System (City = 194; non-City = 116).

In the Delaware System there were 13 WWTPs with active SPDES permits sampled in 2017 (two City owned and 11 non-City owned). Composite samples were collected at 11 of the Delaware WWTPs (two City owned and nine non-City owned). For the Delaware System, 1,639 analyses were performed for WWTPs on 321 effluent samples (City = 192; non-City = 129).

In the EOH System, there are 61 WWTPs with active SPDES permits. One WWTP is in a FAD basin. In this system, 2,555 analyses were performed on 369 WWTP effluent samples.

Six non-City-owned WWTPs located within the Croton Falls and Cross River basins and one City-owned plant (Mahopac) are sampled. One facility didn't have any flow.

In 2017, the sampling frequency of non-FAD basin plants was reduced from monthly to quarterly, with the understanding that WWTPs within the Croton Falls and Cross River basins would be sampled monthly if the Croton Falls Pump Station or the Cross River Pump Station were activated.

Wastewater treatment plant effluent results are reported to NYSDOH and USEPA semi-annually in the WWTPCI report required by the 2017 FAD. Sampling data are also shared regularly with DEP's WWTPCI program staff for tracking compliance with SPDES-permitted effluent limits.

6.4 Capital Replacement Program

The City is obligated to pay for capital replacement of watershed equipment and methods ("Capital Replacement Program") at eligible WWTPs that are required by the WR&Rs and not otherwise required by federal or state law. In 2017, DEP continued implementation of the Capital Replacement Program in partnership with the New York State Environmental Facilities Corporation (EFC) under a contract in place since 2015. EFC has indicated to DEP that it is not interested in administering the Capital Replacement Program over the long term. As such, DEP is currently exploring contracting options with another organization for program administration.

During the reporting period, EFC made no payments to WWTPs for capital replacement of watershed equipment and methods. DEP can pay for the replacement of minor equipment directly to each WWTP under the O&M agreements that DEP has with each WWTP owner.

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. Originally established in 1993, DEP and DOHMH updated and signed an agreement in 2017 for WDRAP's continuation until 2022.

WDRAP has two major functions:

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

Active laboratory surveillance, which involved regular visits or telephone calls to parasitology laboratories by WDRAP staff members, began in the City in 1993 for giardiasis and in 1994 for cryptosporidiosis and continued through 2010. In January 2011, an electronic reporting system replaced active laboratory surveillance. Electronic reporting of cases and follow-up by DOHMH continued through 2017.

Public health epidemiologists handle all confirmed cryptosporidiosis cases reported to DOHMH. They verify the data provided in the case reports, collect additional demographic and clinical information, and identify possible sources of exposure. Giardiasis cases receive similar attention if the patient works in a high risk setting (e.g. food handler) or attends, or is thought to attend, daycare.

In 2017, there were 975 cases of giardiasis and 163 cases of cryptosporidiosis reported to DOHMH. These totals are accurate as of February 2018 but are preliminary and subject to change. Of these cases, epidemiologists completed 48 giardiasis case interviews and 133 cryptosporidiosis patient interviews.

An increase in cryptosporidiosis cases first noted in late 2015 continued through 2016 and 2017. The increase was observed especially in the area of one of the university hospitals. Further investigation linked many of the early cases to a diagnostic test called BioFire, which is a polymerase chain reaction (PCR) test for multiple enteric organisms made newly available in the hospital. Seven more laboratories in the City are now using this test.

Of all PCR specimens from NYC residents sent to the NYSDOH Wadsworth Laboratory for confirmation, 84% were confirmed as *Cryptosporidium* positive in 2015, 75.3% were confirmed in 2016 and 85.7% were confirmed in 2017. PCR positive cases reported to DOHMH that do not test positive at Wadsworth Laboratory are not considered confirmed cases of cryptosporidiosis.

The high confirmation rate of PCR positive specimens at Wadsworth Laboratory indicates the new diagnostic assay has a high positive predictive value.

Epidemiologists attempted to interview all confirmed cases of cryptosporidiosis regardless of original diagnosis method. DOHMH believes the increase in cryptosporidiosis cases since 2015 is the result of an increase in testing rather than an increase in cases. The new PCR-based diagnostic is often ordered for patients who would not ordinarily get a test for *Cryptosporidium*. DOHMH based their conclusion upon a review of cryptosporidiosis case data presented at the Pathogen Technical Working Group Meetings convened by DEP in 2016 and 2017.

New York City currently has four systems in place to detect diarrheal disease outbreaks:

- Daily tracking of chief complaint data (including gastrointestinal illness symptoms) from hospital emergency department logs.
- Monitoring of gastrointestinal disease outbreaks in eight sentinel nursing homes across the City.
- Tracking of the number of stool specimens submitted to a large clinical laboratory for microbiological testing.
- Monitoring of sales of over-the-counter or non-prescription anti-diarrheal (ADM) medications at major pharmacies.

These systems are not specifically designed to detect outbreaks of giardiasis, cryptosporidiosis or waterborne disease but to more generally detect an increase in gastrointestinal illness regardless of the cause. These systems are useful for rapid and sensitive detection of gastrointestinal illness outbreaks and alerts from these systems could trigger rapid investigation of source water quality, watershed conditions, and/or other water system parameters. All four systems continued to be operational in 2017. DOHMH during 2017 implemented a new visualization dashboard for the daily anti-diarrheal medication data, which displays both temporal and spatial signals.

There was no evidence of a drinking water-related outbreak in New York City in 2017, consistent with WDRAP findings of prior years.

Each year a WDRAP Annual Report is prepared which provides much more detail than provided here. The annual reports include more complete findings from disease surveillance and case follow-up (including demographic data and case 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.

8. Education and Outreach

DEP collaborates with the Catskill Watershed Corporation (CWC), Watershed Agricultural Council (WAC), Cornell Cooperative Extension, Soil and Water Conservation Districts, Catskill Center for Conservation and Development, the Catskill Regional Invasive Species Partnership, the Lower Hudson Partnership for Invasive Species Management, Trout Unlimited, and other partners to advance a comprehensive watershed education and outreach program. These shared efforts strive to increase knowledge and awareness among key audiences about source water protection, land use planning and stewardship, stream corridor protection, stormwater and wastewater management, flood response and preparedness, invasive species, watershed recreation, land conservation, riparian buffers, and other topics.

One way DEP directly disseminates information to a broad audience is through its website (nyc.gov/dep), social media platforms and press releases. During 2017, DEP had 9,742 followers on "NYC Water" Facebook, 2,333 followers on "NYC Watershed" Facebook, 16,207 followers on "NYC Water" Twitter, and 1,330 followers on "NYC Water" Instagram. On DEP's website, the "Drinking Water" section received 69,365 page views, the "Watershed Protection" section received 13,772 page views, the "Watershed Recreation" section received 26,455 page views, and the "Environmental Education" section received 8,904 page views. DEP issued over 110 press releases during 2017, many of which focused on water supply topics and publicity for DEP-sponsored educational programs and watershed recreation events.

Recreational events and stewardship activities on City-owned lands are an increasingly popular way DEP engages various audiences throughout the watershed. In 2017, DEP organized family fishing events at four reservoirs that attracted over 320 participants and eight reservoir clean-up events that engaged 418 volunteers (a nearly 60% increase from 2016). DEP also organized several boater safety events, a land management workshop for conservation easement landowners, a deer biology workshop for 70 watershed residents, a wetlands interpretive program for 50 participants, a recreational presentation to 30 outdoor guide businesses, and numerous activities and pop-up events associated with New York State Invasive Species Awareness Week (including school-based presentations). DEP's Watershed Recreation e-newsletter reached an average of 100,000 subscribers throughout 2017.

Every year, DEP's Education Office conducts over 300 environmental education programs that reach nearly 18,000 students (pre-elementary through college), teachers, non-formal educators and adult audiences (primarily water consumers) through classroom visits, guided tours, professional development workshops, and events at the Newtown Creek Visitor Center in Brooklyn. DEP's Annual Water Resources Art & Poetry Contest in 2017 engaged more than 1,800 students from over 100 schools in the watershed and New York City, while four DEP-sponsored performances of "City That Drinks the Mountain Sky" held in Queens and Manhattan attracted 2,400 participants. DEP also created an educational map and study guide,

"New York City's Water Story: From Mountain Top to Tap," to help students explore the water supply system and discover how the water cycle affects their everyday lives (www.nyc.gov/html/dep/html/environmental_education/new-york-citys-water-story.shtml).

Another primary way DEP and its partners directly educate specific audiences is through targeted watershed protection programs. Accomplishments for 2017 include -

- The CWC Public Education Program awarded 30 education grants totaling $168,000 to schools and organizations in the watershed and New York City; the estimated audience for all of these programs is approximately 12,000 people, primarily students. The CWC promotes its grants program through its watersheducators.org website, which was upgraded this past year along with the main CWC website (cwconline.org).
- The CWC, in support of its septic system repair programs for homeowners, sponsored two septic system design workshop for engineers and professionals.
- The Watershed Agricultural Program conducted more than 36 farmer education programs attended by 864 participants. Highlights include the annual Catskill Regional Agricultural Conference (144 participants), the annual WAC Farm Tour (65 participants), and dozens of workshops, tours, pasture walks and seminars.
- The WAC continued to promote all of its programs and the importance of working landscapes through its main website (nycwatershed.org), in addition to promoting local farm and forestry products through the Pure Catskills Campaign (purecatskills.com). The annual Taste of the Catskills Local Food Event attracted over 5,000 attendees.
- The Watershed Forestry Program continued to support and expand the MyWoodlot.com interactive website for forest landowners while the watershed model forests continued to host dozens of educational events for all audiences. In 2017, the forestry program sponsored eight logger-training workshops for 70 participants and 24 bus tours for 200 adults and over 1,200 students, primarily from New York City. Twenty-four teachers attended the annual Watershed Forestry Institute in July and 175 students participated in the annual Green Connections School Partnership Program.
- The Stream Management Program continued to sponsor specialized education and training programs for landowners, municipal officials, watershed professionals, and school-based audiences via workshops, interpretive hikes, volunteer planting events, presentations to local flood commissions, and participation in basin-specific stakeholder meetings. Highlights include the annual Schoharie Watershed Summit (90 participants), Ashokan Watershed Conference (90 participants), Anglers Symposium (45 participants), Phoenicia Elementary Earth Day (75 participants), Woodstock Elementary Earth Day (120 participants), Bennett Elementary Earth Day (130 participants), Greene County Youth Fair (300 participants), a Climate Change Youth Leadership Summit (50 participants), a Watershed Scientist in Residence Program (over 130 participants), a two-day Stream Function Pyramid Training

Workshop for approximately 30 local partners, two Erosion and Sediment Control Training Workshops for contractors, more than a half dozen Highway Superintendent meetings, and nearly a dozen Certified Floodplain Manager exam preparation classes. The catskillstreams.com website continued to highlight program accomplishments while serving as a repository for all Local Flood Analyses completed in watershed communities.

- The Trout in the Classroom Program engaged over 10,000 students and teachers from more than 150 schools in the watershed and New York City; the annual Trout in the Classroom Fall Teacher Conference attracted 165 participants.

Finally, DEP and its partners attended numerous community outreach events and speaking engagements throughout the year, primarily in the watershed but also New York City and elsewhere. These opportunities allowed DEP and its partners to give out informational publications, answer questions from the public, share scientific knowledge, and communicate key messages to a broad audience. Highlights for 2017 include the American Planning Association Conference, Annual Shandaken SPDES Permit Outreach Meeting, Ashland Farm and Machinery Show, Catskill Forest Festival, Cleveland Water Alliance Annual Conference, Delaware County Fair, Grahamsville Little World's Fair, International Restaurant and Food Show, Lower Hudson Valley Engineering Expo, Margaretville Cauliflower Festival, New York City Outdoor Expo, New York City Watershed Science and Technical Conference, New York State Floodplain Managers Annual Conference, New York State Outdoor Guides Association Winter Rendezvous, New York State Wetlands Forum, Olive Day, New York State Woodsmen's Field Days, Pound Ridge Arbor Day Celebration, Rockland Community College World Fishing and Outdoor Expo, Shandaken Day, Teatown Hudson River Eagle Fest, and Ulster County Fair.

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 — predictions 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.

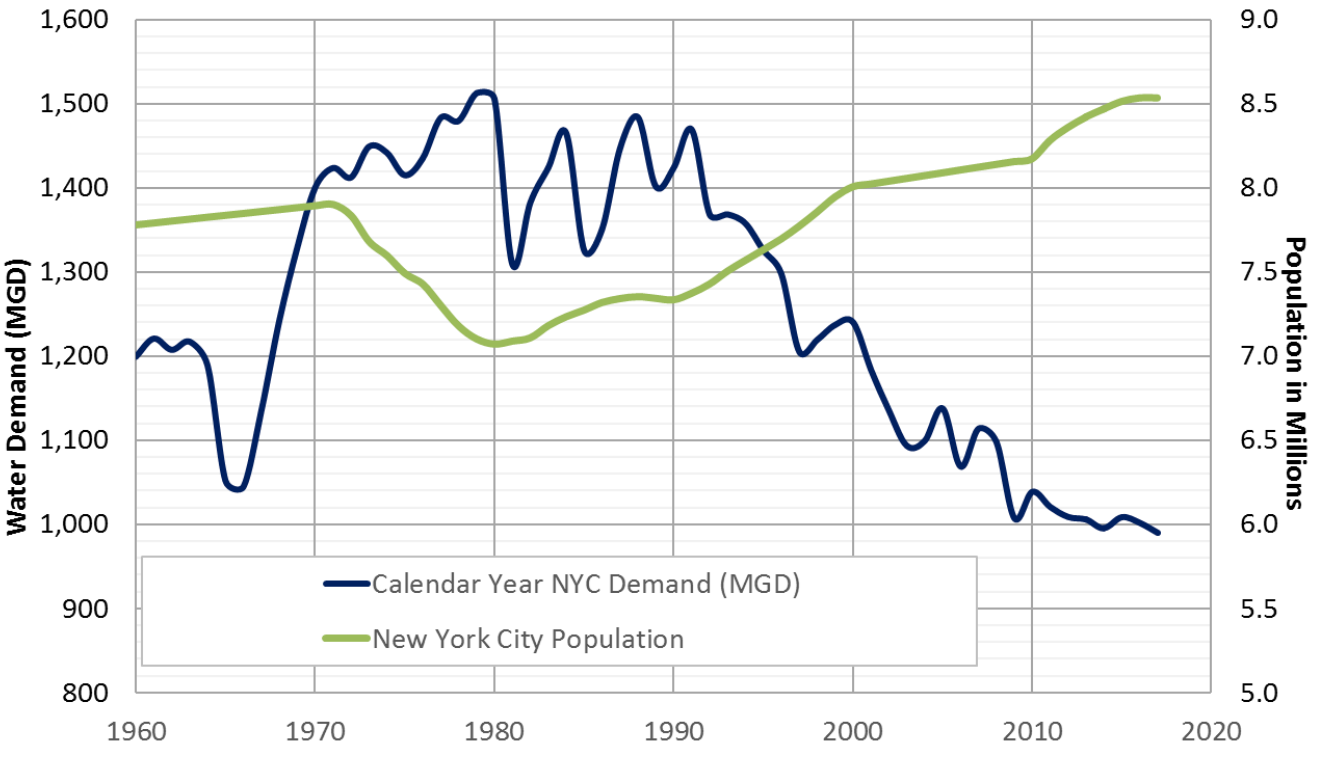

Figure 9.1 New York City water demand and population.

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 20 million gallons per day by 2022. This reflects a revised goal from the 2013 Water Demand Management Plan that will be detailed in the 2018 Water Demand Management

Plan (to be released on June 1, 2018). The 2013 Water Demand Management Plan, (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. DEP added an additional strategy in 2014. Below are the plan's six strategies:

- Municipal Water Efficiency Program: Involves retrofits of city-owned properties.
- Residential Water Efficiency Program: Focuses primarily on the Toilet Replacement Program for multi-family buildings.
- Non-Residential Water Efficiency Program: Collaboration with private sector organizations including restaurants, hotels, and hospitals.
- Water Distribution System Optimization: Entails system repairs and upgrades, managing water pressure, and refining water meter accuracy and leak detection.
- Water Supply Shortage Management: Encompasses the review and revision of plans to prepare for a drought and other water shortages.
- Upstate Wholesale Customers Demand Management Program: Targets demand management planning and implementation for wholesale customers north of the City.

The following is a summary of DEP's 2017 progress in implementing the above listed strategies.

Municipal Water Efficiency Program

DEP has 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), the New York City Fire Department (FDNY), and the City University of New York (CUNY).

In 2017, DEP completed a retrofit project with DPR. DEP funded 400 individual retrofit projects between 2013 and 2017 to replace continuously running spray showers with push button activated models. Through the partnership, bathroom fixtures and plumbing were updated in two recreation centers in 2017 to further reduce water consumption. DEP funded retrofits in nine recreation centers between 2014 and 2017. Overall, this partnership with DPR has resulted in a savings of 1.1 million gallons of water per day.

DEP also completed a retrofit project with CUNY in 2017. DEP funded the replacement of nearly 800 fixtures in 10 City College of New York campus buildings, saving an estimated 11 million gallons of water annually.

Through its partnership with DOE, DEP also funded the replacement of over 31,100 toilets and urinals with high-efficiency models in 348 schools across all five boroughs through 2017. DEP anticipates 500 schools will be retrofitted by 2020 for approximately 40,000 total fixture replacements.

DEP co-funded a water recycling and reuse project with FDNY at the Chauffeur School on Randall's Island that was completed in 2017. The underground reuse tank allows FDNY to recycle potable water utilized for testing and calibrating fire engine hoses and pumps that was previously discharged directly to the East River. The project saves an estimated 30,000 gallons of water per day.

In July 2017, DEP launched its fourth Water Challenge at WWTPs to encourage water reduction in DEP's own facilities. Of the 10 WWTPs that have participated in these challenges, five achieved a 10% reduction over the previous year's baseline average. DEP will start a fifth challenge in 2019, encouraging all 14 WWTPs to reduce demand by 5%. DEP also expanded its water hose replacement program by doubling the number of high-efficiency hoses used to clean equipment at each WWTP. DEP is currently working to replace inefficient water pumps and other equipment 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 2017, the program has replaced over 12,000 toilets.

In addition to establishing the Toilet Replacement Program, DEP directed its contractor, Honeywell, to provide building owners with complimentary household water conservation surveys. The surveys assist building owners with identifying opportunities for water savings and detecting leaks. In 2017, Honeywell conducted surveys in 6,427 individual apartments in 3,133 single-family apartment buildings. Honeywell also surveyed 1,057 multi-family buildings, and 18,981 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 participants. DEP also hosts quarterly workshops to help participants learn how to make their facilities more water efficient.

Previously, DEP launched two Water Challenges to different commercial sectors: restaurants and hotels. DEP hosted workshops to explain how to perform water audits and create water demand management plans for their properties. The Water Challenge to Hospitals — involving Memorial Sloan Kettering, Queens Presbyterian and Harlem Hospital — finished in

January 2018. All three hospitals completed the challenge, and Harlem Hospital achieved the 5% reduction goal, approximately 35,000 gallons per day.

Water Distribution System Optimization

Water distribution system optimization includes system repairs and upgrades, water pressure management, refining water meter accuracy, and leak detection. In 2017, DEP surveyed 4,720 miles of water mains for leaks. By proactively finding and repairing leaks, DEP estimates a savings of 2 million gallons of water per day.

DEP recently implemented a strategic approach to leak detection. Borough-based teams properly trained in leak detection target specific areas served by older network mains more likely to need preventive and corrective maintenance. These teams can respond rapidly to problems compared to the slower response times 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 2017, DEP repaired 7,377 hydrants, replaced 1,452, and provided other maintenance services to 8,886 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 consumption information. 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 target consumer groups have achieved projected consumption reductions or how demand management strategies may be adapted to improve their effectiveness. DEP replaced 2,832 large meters in 2017 (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 the 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 adoption of the revised rules prior to the 2022 shutdown.

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 2017, DEP offers assistance and is working with 10 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 one is pending participation.

Once participating utilities complete their demand management plans, each will work to implement conservation measures identified in their plan. DEP is working to draft individual intergovernmental agreements (IGA). Each IGA represents a contractual funding obligation from DEP and commitment from the utility partner to implement their demand management plan.

The demand management plan for the Village of Ossining was finalized in May 2016, the IGA was finalized in May 2017, and the contract was registered in December 2017. Implementation of Ossining's Demand Management Plan will begin in 2018. Eight other demand management plans are in draft form. DEP anticipates finalizing these in 2018.

9.2 Updates to Drought Management Plan

In 2017, monthly average precipitation and runoff were at or above normal (historical average for the period 1985-2015) for more than 50% of the year. The NYC Delaware Basin Reservoir System storage stayed in the "Normal" storage zone (above drought watch) for the entire year. 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.

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 identify when to declare a Drought Watch, Warning, or Emergency 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 - Declared when there is less than a 50% probability 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 - Declared when there is less than a 33% probability reservoirs in either the Catskill or Delaware System will fill by June 1.
- Drought Emergency - 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. DEP estimates this probability 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. 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 2017, including the flowing major activities:

- Commencement of the bypass tunnel construction
- Catskill Aqueduct repair and rehabilitation: Completed design and advertised construction contract. Bids due in March 2018.

Tunnel Dewatering Preparation

The 80 million gallons per day pumping station, which is capable of dewatering the Rondout-West Branch Tunnel (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 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 commence. During the execution of the tie-in, workers will grout the leaks in the Wawarsing area of the tunnel from within the dewatered tunnel. DEP expects the bypass project to be completed in 2023.

Hydraulic Investigations of the RWBT

Investigations of the RWBT helped DEP assess the nature and degree of leakage stemming from the aqueduct. Efforts 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. DEP routinely 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 2017.
- Surface investigations continued in areas of Roseton and Wawarsing, where water is leaking from the tunnel. A minor change in the location of a surface expression occurred in 2017.
- 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 focuses 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 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. Construction is expected to start this year on all three projects.

9.4 Catskill/Delaware Filtration Plant

History

The 1997 Filtration Avoidance Determination first required the City to produce a preliminary design for filtration facilities for the Catskill/Delaware water supply. The 2002 FAD required the City to provide biennial updates to the preliminary plant design for the Catskill/Delaware (CAT/DEL) system (in addition to constructing an ultraviolet light disinfection facility, which was placed into full service in October 2012). The 2007 FAD continued to require the City to provide a biennial report updating the preliminary design for filtration facilities. In 2013 and 2015, the City and NYSDOH agreed no design changes to the 2009 preliminary plans for the CAT/DEL Filtration Facilities were necessary.

Next Steps

Because the work supporting the preliminary plans is more than 25 years old, the 2017 FAD requires the City to contract for a comprehensive review of filtration methods and technologies and develop a new conceptual design for a filtration facility or facilities. This will minimize the overall time to commence filtration, in the event the City or NYSDOH determines filtration is necessary.

The design review process will include -

- Bench studies and modeling
- Large scale pilot studies
- Independent review from water treatment experts
- Conceptual design incorporating the latest filtration methods and technologies

In 2017, the City met the milestones specified in the 2017 FAD implemented for the CAT/DEL Filtration Plant Design. DEP advertised the new contract on January 31, 2017, and

issued Notice to Proceed as of January 24, 2018, to a consulting engineering firm specializing in water-treatment plant design.

During 2018, DEP staff will work with the selected consultant and start to review potential treatment technologies and prepare for benchtop scale testing.

9.5 Arkville office

In 2017, DEP began working with CWC to establish a new, shared office in the WOH watershed, with the goal of improving the City's source water protection programs. By sharing a work location centrally located in the watershed, the City and CWC can further improve coordination and responsiveness to watershed communities.

In January 2017, CWC hired Keystone Associates of Binghamton to develop a conceptual design and study for a new facility in Arkville, NY. That effort continued for most of 2017 and in December, CWC signed a contract with Keystone for full design and construction administration services.

The expectation is that CWC will construct and own the facility, and DEP will lease space for its staff. DEP has begun working with City oversights to complete the administrative process necessary to lease the space from CWC. In addition, DEP and CWC have held numerous discussions regarding the configuration of the City's portion of the building to ensure it meets all operational and administrative needs.

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