New York City Department of Environmental Protection

Filtration Avoidance Annual Report

for the period January 1 through December 31, 2019

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List of Acronyms

AWSMP	Ashokan Watershed Stream Management Program
BMP	best management practice
BWS	Bureau of Water Supply
C&D	construction and demolition
CAT/DEL	Catskill/Delaware
CATRR	Catskill Aqueduct Repair and Rehabilitation Program
CATUEC	Catskill Upper Effluent Chamber
CC	compliance conference
CCE	Cornell Cooperative Extension
CDUV	Catskill/Delaware Ultraviolet Disinfection Facility
CE	conservation easement
CIG	New York City Department of Cultural Affairs-Cultural Institutions Group
CMC	Catskill Mountain Club
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
DCSWCD	Delaware County Soil and Water Conservation District
DEIS	Draft Environmental Impact Statement
DEP	New York City Department of Environmental Protection
DCAS	New York City Department of Citywide Administrative Services
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
ED/RR	Early Detection and Rapid Response Plan
EFC	New York State Environmental Facilities Corporation
EIS	environmental impact statement
ELTP	Enhanced Land Trust Program
EOH	East of Hudson
EOHWC	East of Hudson Watershed Corporation
FAD	Filtration Avoidance Determination
FDNY	New York City Fire Department
FEIS	Final Environmental Impact Statement

FEMA	Federal Emergency Management Agency
FFMP	Flexible Flow Management Program
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
GWLF	Generalized Watershed Loading Function
HAA5	haloacetic acid five
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HEFS	Hydrologic Ensemble Forecast Service
HHC	New York City Health and Hospitals Corporation
HPC	Heterotrophic Plate Count
IAR	inactivation ratio
IRSP	individual residential stormwater permit
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
MOA	New York City Memorandum of Agreement
MSM	Men who have sex with men
MST	Microbial Source Tracking
NAS	National Academies of Science
NASEM	National Academy of Sciences, Engineering and Medicine
NEIWPCC	New England Interstate Water Pollution Control Commission
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

NYNHP	New York Natural Heritage Program
NYNJTC	New York-New Jersey Trail Conference
NYS	New York State
NYSCC	New York State Canal Corporation
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
NYSTA	New York State Thruway Authority
O&M	Operation and maintenance
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
RCMP	Riparian Corridor Management Plan
REP	Regulatory and Engineering Programs
RFP	Request for Proposals
RNSP	Rondout/Neversink Stream Program
RWBT	Rondout-West Branch Tunnel
SAP	Streamside Acquisition Program
SCSWCD	Sullivan County Soil and Water Conservation District
SDEIS	Supplemental Draft Environmental Impact Statement
SEIS	Supplemental Environmental Impact Statement
SEQRA	State Environmental Quality Review Act
SFI	Stream Feature Inventory
SMIP	Stream Management Implementation Program
SMP	Stream Management Program
SPDES	State Pollutant Discharge Elimination System
SSTS	subsurface sewage treatment system
SUNY	State University of New York
SWAC	Schoharie Watershed Advisory Committee
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
SWPPP	stormwater pollution prevention plan
SWTR	Surface Water Treatment Rule
TCR	Total Coliform Rule
THM	trihalomethane
TTHM	Total trihalomethane
UCSWCD	Ulster County Soil and Water Conservation District
USACE	United States Army Corps of Engineers
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
WQSP	Water quality stream projects
WRF	Water Research Foundation
WRRF	Water Resource Recovery Facility
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

Starting in the early 1990s, New York City began to develop and implement a multi-faceted program to protect and enhance the quality of the City's drinking water supply. The New York City Department of Environmental Protection (DEP) received the first Filtration Avoidance Determination (FAD) in January 1993. Since that time, DEP has spent or committed more than $2.5 billion to implement programs that are 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 later. 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 of funding and countless staff hours, intended to sustain the pristine quality of the source waters of the Catskill and Delaware watersheds. DEP's programs have become a national and international model. Each year, water and public health professionals come from around the world to study the City's source water protection strategies. Over time, DEP has developed strong relationships with key water supply stakeholders including the 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, and the detailed characterization of land use and land cover in the watershed. As part of DEP's source water monitoring program, tens of thousands of samples are collected annually throughout the watershed. Each year DEP performs hundreds of thousands of laboratory analyses. Based on the information collected through its monitoring and research efforts, DEP has crafted a watershed protection strategy that focuses on implementing initiatives that address current potential pollution sources and prevents the creation of new sources.

DEP's most recent FAD was issued in December 2017 and covers a full 10-year period, including comprehensive program plans through 2027. The latest FAD builds on previous accomplishments and continues many of the programs that have been at the core of the water quality protection effort since the early 1990s. In addition, 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 proactively is addressing current and potential future threats to water quality.

This annual report covers the period January 1, 2019, through December 31, 2019, and is compiled to satisfy the requirements of the 2017 FAD. Material in this report is organized to parallel the sections of the FAD. Figure 1.1 and Figure 1.2 depict the impressive level of accomplishment over the past quarter century. The programs, each designed to target potential pollution sources, have touched nearly every corner of the City's vast catchment.

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. 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.

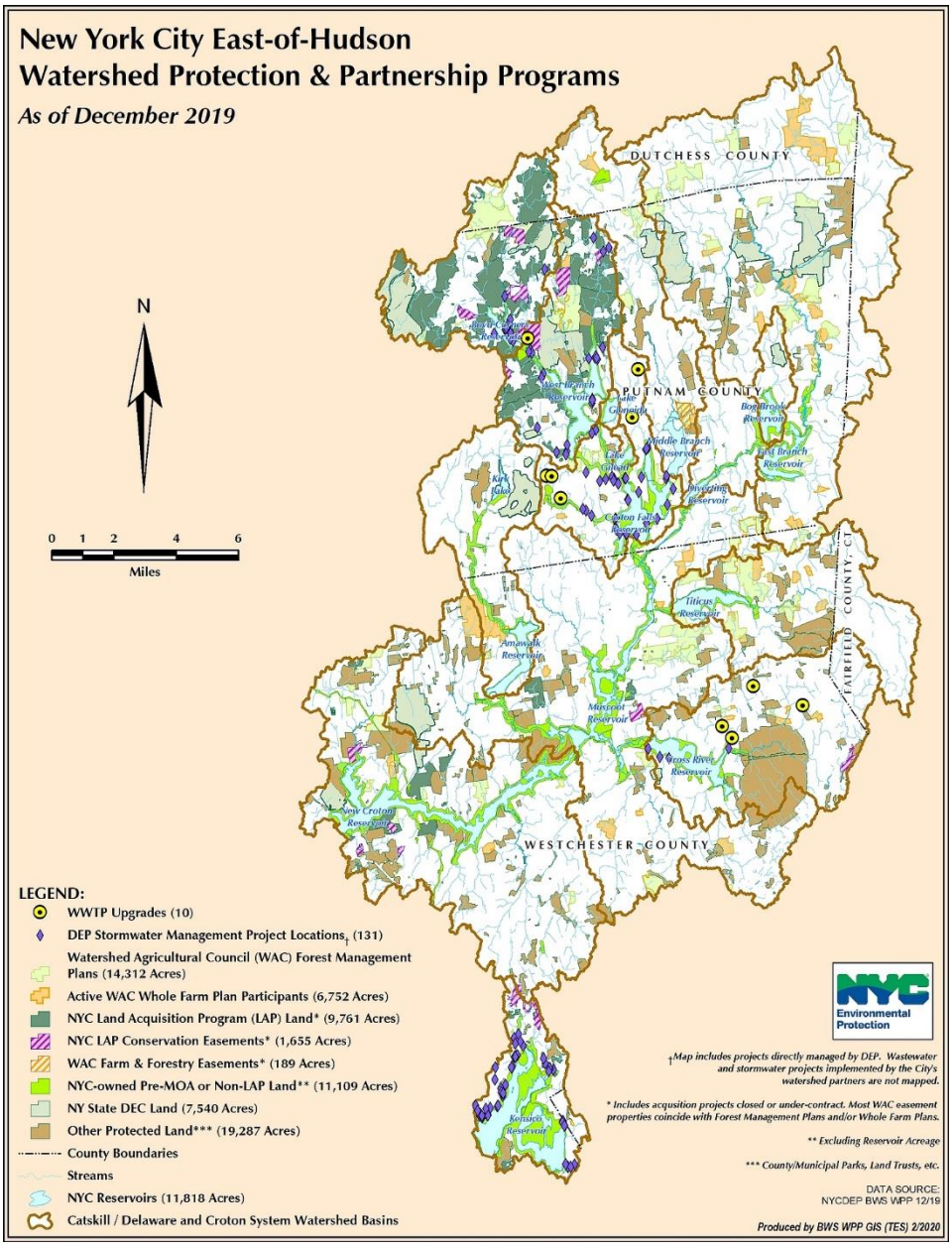

Figure 1.1 New York City East-of-Hudson watershed protection and partnership programs as of December 2019.

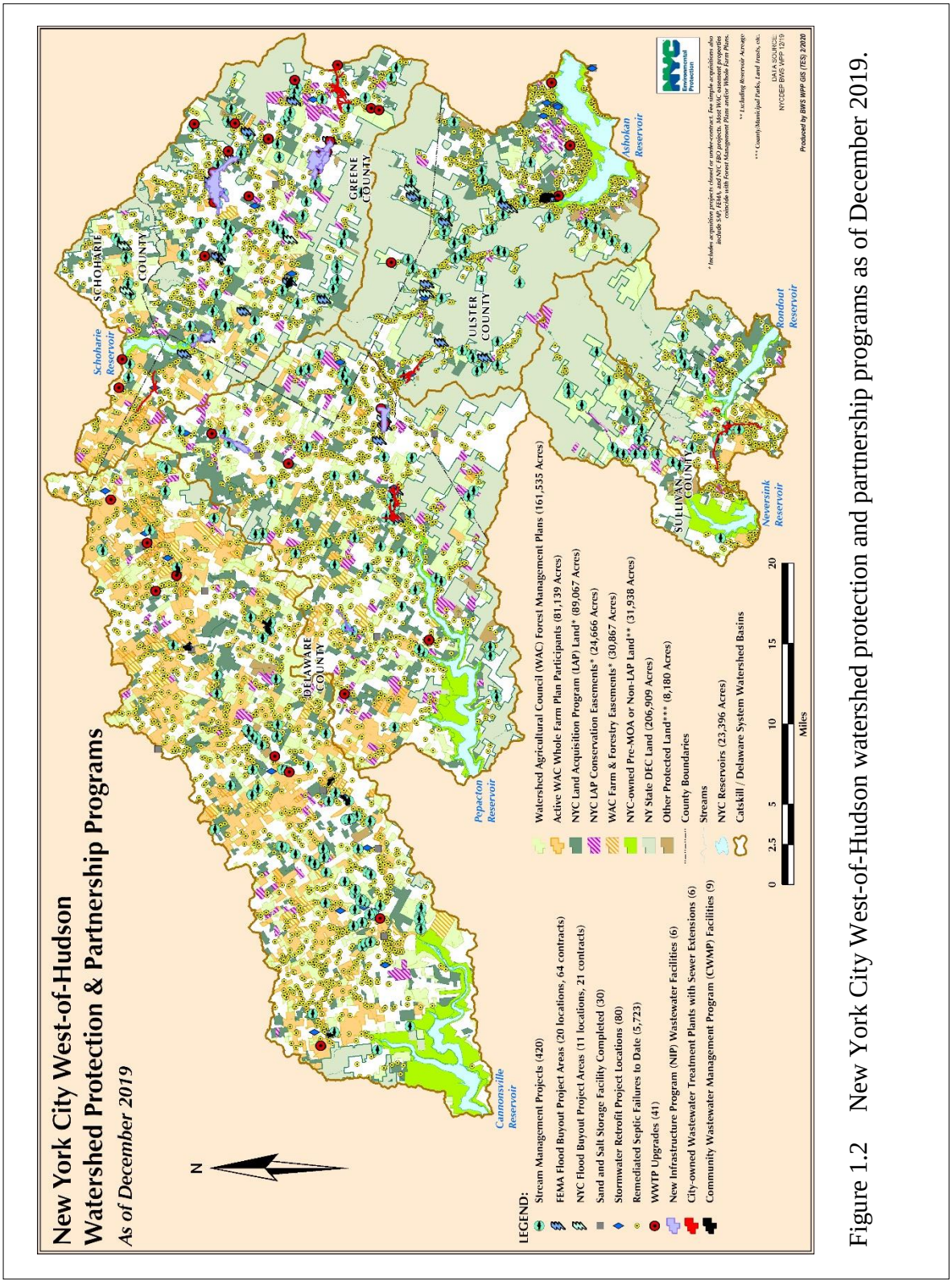

Figure 1.2 New York City West-of-Hudson watershed protection and partnership programs as of December 2019.

2. Federal and State Objective Water Quality Compliance

During 2019, 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 2019, DEP collected 51,244 samples and conducted 719,013 analyses. Of these, 36,271 samples were collected and 456,476 analyses were completed 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, which 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 and demonstrate this in the monthly Water Quality Report. The information provided below summarizes compliance monitoring conducted during 2019.

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 2019, all monitoring samples complied with thresholds defined by the SWTR.

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

In 2019, the Catskill Aqueduct between Kensico Reservoir and the Catskill/Delaware Ultraviolet Light Disinfection Facility (CDUV) was offline. Therefore, no Catskill Aqueduct effluent fecal coliform samples were collected for the year. The Delaware Aqueduct effluent from Kensico Reservoir exhibited fecal coliform concentrations in water prior to disinfection at levels less than or equal to 20 fecal coliforms $100ml^{-1}$ in at least 90% of the samples collected during the year, as calculated by six-month running percentages. In fact, the running percentage of samples for the Catskill/Delaware System never fell below 97.8%.

As shown in Figure 2.1, in 2019 the highest six-month running percentage of positive raw water fecal coliform samples at the Delaware Aqueduct effluent from Kensico Reservoir was 2.2%, well below the maximum percentage of positive samples allowed under the SWTR.

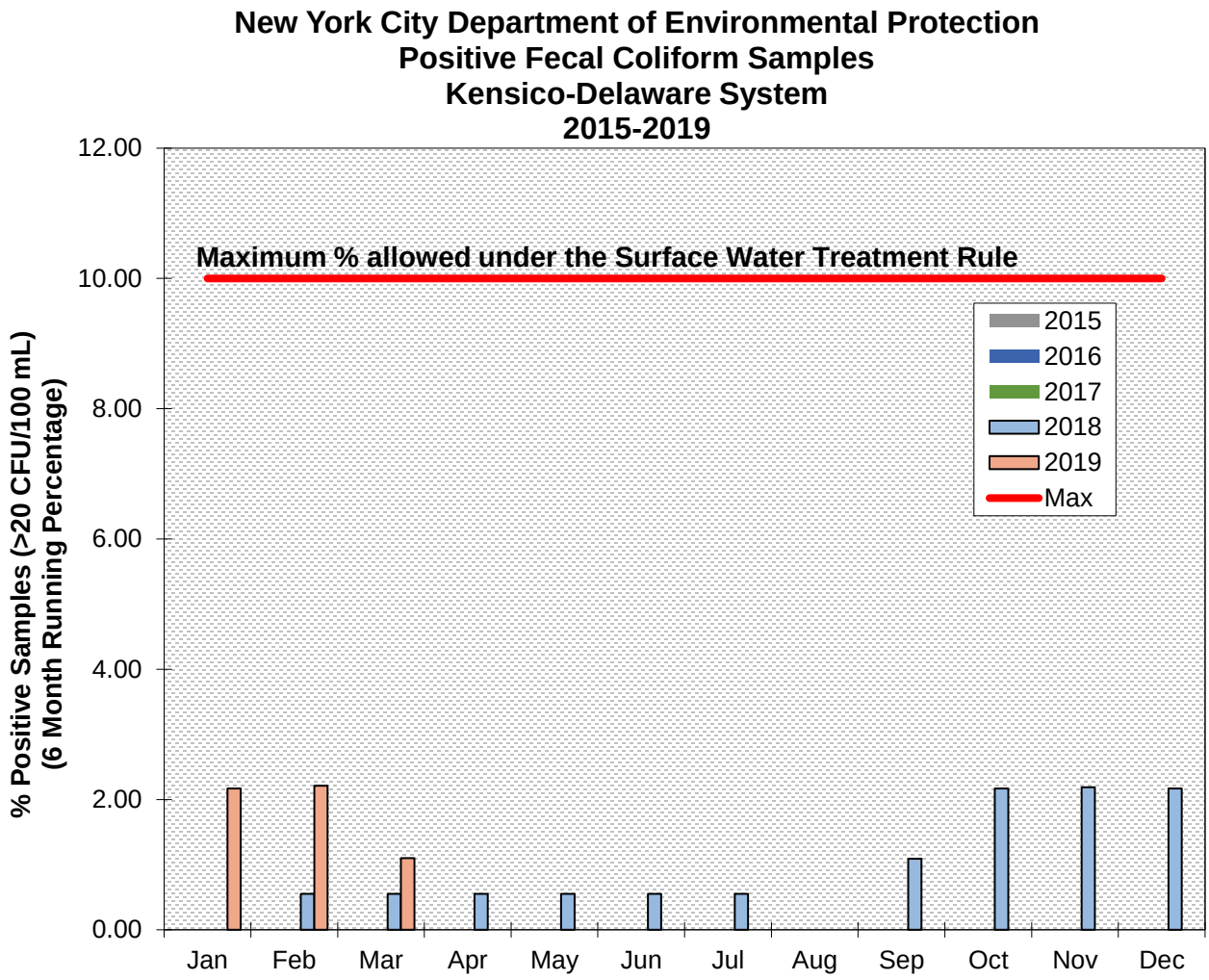

Figure 2.1 Positive fecal coliform samples, Kensico-Delaware System, 2015-2019.

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 2019 calendar year (Figure 2.2). No samples were collected from the Catskill Aqueduct in 2019 because the Catskill Aqueduct between Kensico Reservoir and CDUV was offline.

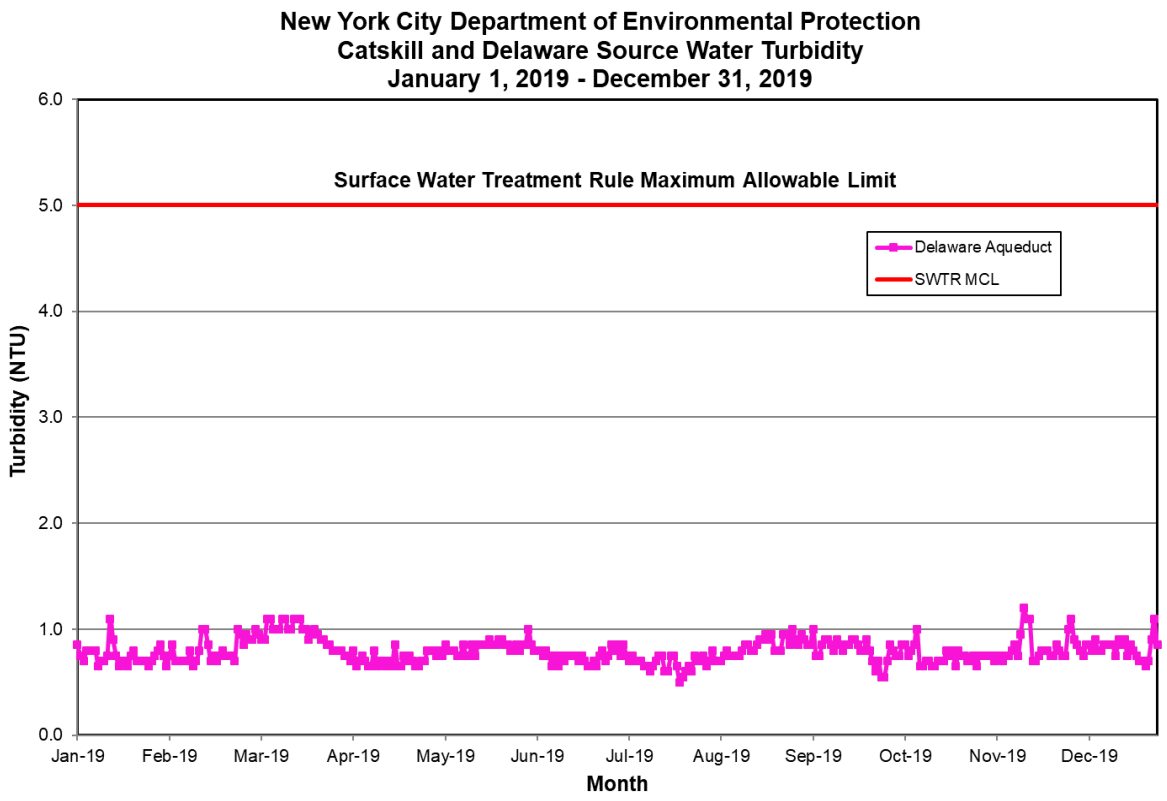

Figure 2.2 Delaware source water turbidity, January 1, 2019-December 31, 2019.

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

CT values recorded each day during the year for the Catskill and Delaware systems produced net inactivation ratios (IAR) greater than or equal to 1.0. The first segment of the Catskill Aqueduct was offline from Kensico to Eastview, so the net IAR was measured using the IAR from the first segment of the Delaware Aqueduct from Kensico to Shaft 19 at CDUV, and adding the IARs from the CDUV to Hillview on each aqueduct (second segments). The lowest net IAR in 2019 was 1.5 for the Catskill Aqueduct and 1.4 for the Delaware Aqueduct.

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 2019; 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 0.20 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 15,939 samples measured for residual chlorine within the distribution system during 2019, all were greater than or equal to 0.01 mg/L, except for six 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 2019, performed on a quarterly basis, resulted in a maximum total trihalomethane (TTHM) value of 77 µg L^{-1}. The analysis for haloacetic acids, also performed on a quarterly basis, resulted in a maximum haloacetic acid five (HAA5) value of 57 µg L^{-1}.

The highest TTHM quarterly running annual average during 2019, recorded during the third and fourth quarters, 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 quarter, was 46 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 0.5% for all 12 months of 2019 (Figure 2.3). The number of compliance samples analyzed for total coliforms was 9,719, of which 14 were total coliform positive, and none were *E. coli* positive for 2019. The annual percentage of compliance samples that were total coliform positive was 0.1%. Since 1995, DEP has collected 258,688 coliform compliance samples, and only 17 of them have tested positive for *E. coli*.

In 2019, 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 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.

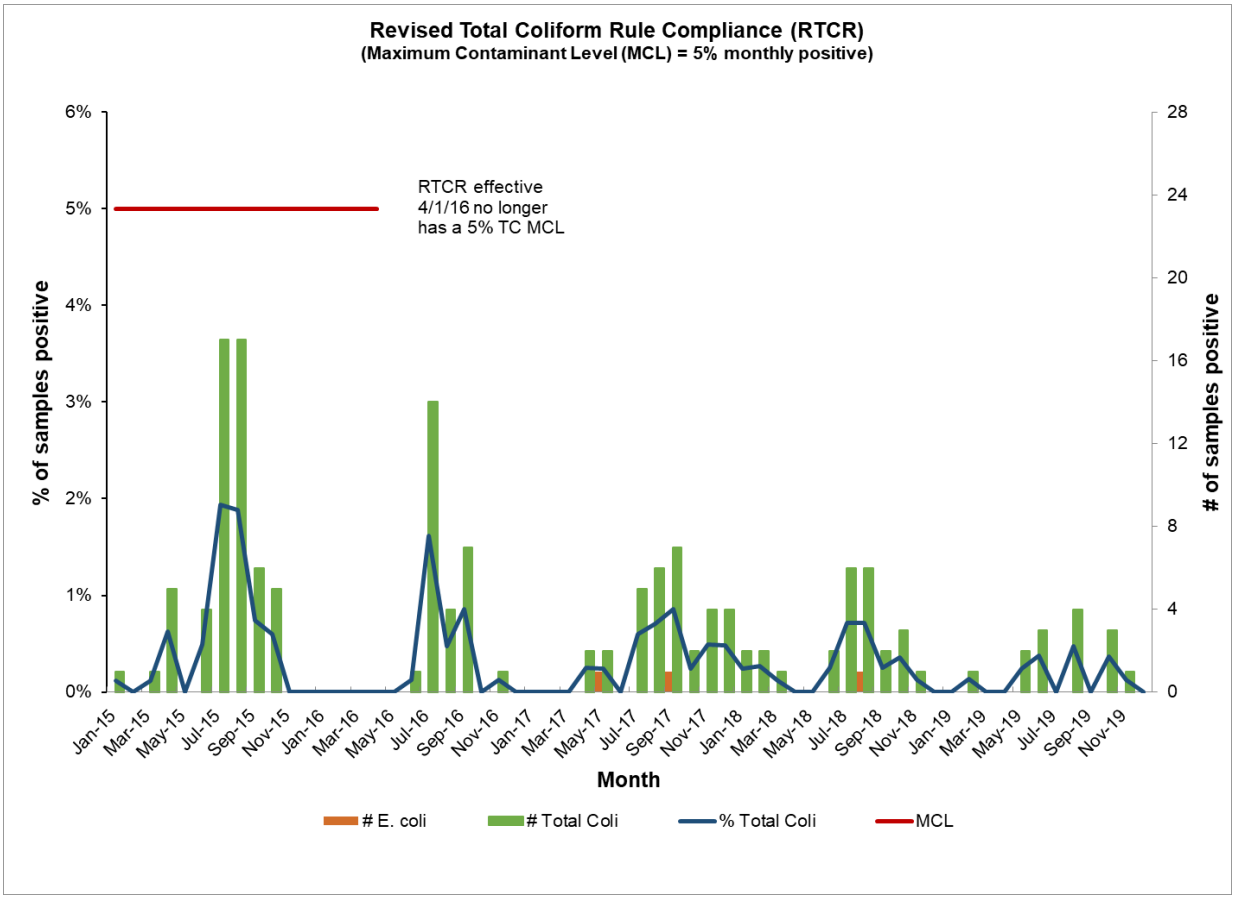

Figure 2.3 Positive total coliform samples, NYC distribution system, 2015-2019.

2.2.2 Chlorine Residual Maintenance in the Distribution System

During 2019, DEP continued a number of programs to ensure adequate levels of chlorine throughout the distribution system, including maintaining chlorination levels at the distribution system's entry points, conducting spot flushing when necessary, and providing local chlorination booster stations at remote locations. Two permanent chlorination booster stations were operated during 2019 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 of these steps, detectable chlorine residuals were maintained throughout the distribution system in 2019.

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. Key questions the expert panel will evaluate include:

- Are individual program elements (e.g., agriculture and stormwater best management practices, wastewater technologies, requirements for streamside buffers) based on the most relevant and up-to-date science?
- Are the City's water quality monitoring and modeling, as well as the performance monitoring of individual measures, adequate to assess the effectiveness of the overall watershed protection program? How might they be improved?
- How can operational controls be improved to protect water quality and comply with filtration avoidance determination requirements?
- Can the various watershed protection components (e.g., operational controls, regulatory programs and their enforcement, voluntary programs, and partnership programs) be better balanced to be more effective and sustainable?
- How might the watershed protection program evolve to account for future risks to the water supply due to, for example, climate variability, invasive species, and regulatory trends?

The project commenced on March 23, 2018. The list of NASEM committee members and their backgrounds can be found on the NASEM website: https://www8.nationalacademies.org/pa/projectview.aspx?key=49938.

During 2019, the expert panel met four times:

- February 4-6, West Harrison, NY
- May 13-14, Hunter, NY
- July 22-23, Woods Hole, MA
- September 30-October 1, Woods Hole, MA

The February and May meetings had sessions open to the public, including opportunity for direct public comment to the panel. Additionally, the public is always able to submit comments through the project website (http://nas-sites.org/dels/studies/nyc-watershed/). The last two meetings were work sessions for the committee members only.

To date, DEP staff have given 20 presentations, participated in several technical conference calls, arranged for field visits to operational facilities and project sites, and supplied over 180 pieces of information, including operational and water quality data and technical reports. Two additional meetings are planned in 2020 with a final report scheduled for release in July 2020.

3. Environmental Infrastructure

3.1 Septic Programs

3.1.1 Septic Rehabilitation and Replacement Program

DEP has committed over $100 million to rehabilitate, replace, and upgrade more than 5,700 septic systems serving single- or two-family homes in the West of Hudson (WOH) watershed. The Septic Rehabilitation and Replacement Program is managed by the Catskill Watershed Corporation (CWC). In 2019, CWC completed 230 projects, including 227 funded through the Priority Area Program and three funded through the Reimbursement Program. Eligibility under the Priority Area Program now includes the entire WOH watershed.

3.1.2 Septic Maintenance Program

The Septic Maintenance Program is intended to reduce septic system failures by subsidizing of regular pump-outs and maintenance. In 2019, the program subsidized 340 septic tank pump-outs. The program has funded 2,623 septic tank pump-outs since its inception.

3.1.3 Other Septic Programs

The Small Business Septic System Rehabilitation and Replacement Program funds the repair or replacement of failed septic systems serving eligible small business owners in the WOH watershed. One small business septic system was remediated in 2019. CWC has funded the repair or replacement of 21 failing septic systems for small business owners to date.

The Cluster Septic System Program pays for the planning, design, and construction of cluster systems in 13 WOH watershed communities. CWC contacts communities about their eligibility for the program when failures are identified. No communities opted to participate in this program during 2019. DEP has committed $1 million in operation and maintenance (O&M) funds for potential future cluster systems.

3.2 Community Wastewater Management Program

The Community Wastewater Management Program (CWMP) provides funding for 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 areas identified in the MOA include Shandaken, West Conesville, Claryville, Halcottsville, and New Kingston. The hamlet of Shokan was added to the CWMP in 2017. Project highlights for 2019 are below.

- Shandaken – DEP approved a block grant of $6.77 million in May 2017 for a septic maintenance district. In 2019, DEP issued the design approval for the project and the town awarded the construction contract. Construction is scheduled to commence in 2020.

- West Conesville – DEP approved a block grant of $8.41 million in July 2017 for a community septic system. DEP received the 95% design drawings in June 2019 and the proposed final design drawings in November 2019. Final stamped design plan sets and project bidding is anticipated to commence in 2020.
- Claryville – DEP approved a block grant of $8.65 million in April 2017 for septic maintenance districts in the towns of Denning and Neversink. In 2019, the contractor completed construction on the Denning portion and will return in spring 2020 to complete final site restoration. DEP issued design approval for the Neversink portion in May 2019 and construction commenced in November 2019. After winter shutdown, construction will resume in spring 2020.
- Halcottsville – DEP approved a block grant of $8.95 million in September 2017 for pump stations, a sewer collection system, and a force main connection to the City-owned Margaretville Water Resource Recovery Facility (WRRF; also known as a Wastewater Treatment Plant (WWTP)). Submission of the 65% design drawings is pending resolution of siting issues with the pump station.
- New Kingston – DEP approved a block grant of $5.2 million in November 2018 for a community septic system with 28 connections. In May 2019, the Middletown Town Board established the sewer district and approved the Sewer Use Law. The project is now in the preconstruction phase as CWC and the town continue to secure the necessary property for siting the community septic system.
- Shokan – CWC and the Town of Olive have entered into a program participation agreement and commenced the project's study phase. In 2019, DEP registered the contract with CWC for the design and construction of the project. DEP received the draft preliminary engineer's report in September 2019 and requested the project engineer undertake a more thorough examination of alternative options. Upon receipt of this additional information, DEP and CWC will determine the appropriate wastewater option and associated block grant for Shokan.

3.3 Sewer Extension Program

The Sewer Extension Program funded the design and construction of wastewater sewer extensions connected to City-owned wastewater treatment plants in the WOH watershed. This program concluded prior to the 2017 FAD.

3.4 Stormwater Programs

3.4.1 Stormwater Cost Sharing Programs

DEP pays for incremental costs associated with stormwater measures incurred as a result of the New York City Watershed Rules and Regulations to the extent they exceed the costs of complying with state and federal requirements. Funding can cover the design, construction, and

maintenance of stormwater pollution prevention plans and individual residential stormwater plans for new construction after May 1, 1997, through two separate programs: the WOH Future Stormwater Controls Program (MOA 128) and the Future Stormwater Controls Paid for by the City Program (MOA 145). Both programs are now administered by CWC. Funding for eligible projects can be paid completely from the MOA 128 Program for municipalities and large businesses, completely from the MOA 145 Program for low-income housing projects and single-family home owners, or 50% from each program for small businesses.

DEP provided $31.7 million to CWC to administer the MOA 128 Program. From this allotment, CWC has reimbursed approximately $8 million to program applicants and transferred over $17 million to other eligible watershed protection programs. In 2019, pursuant to the FAD, DEP added $4,720,869 in new funding to the MOA 128 Program. CWC's uncommitted fund balance was $16.8 million at the end of 2019. Table 3.1 summarizes projects approved for funding under both programs in 2019.

Table 3.1 Future stormwater controls projects in WOH approved for funding in 2019.

Applicant	Project	Funding
Ulster County Rail Trail	Rail Trail	$20,227.00
Eric Dahlberg	Conesville Convenience Store	$79,793.66
Bear Pen Mountain Sports	Tubing facility, parking area, irrigation pond, building, ice skating area, gravel walking path and bridge	$34,773.76
Delhi Rehabilitation and Nursing Center	Additional funds – Delhi Rehabilitation and Nursing Center	$9,047.63
Full Nelson	Gas station	$234,704.00
Fromm Realty	15-lot subdivision in Windham	$63,227.80
Sea Mountain Ventures II	Neversink Dollar General	$186,413.00

Applicant	Project	Funding
Benjamin Dates	Additional funds - McMurdy Brook subdivision	$44,350.00
Creative Environments	Additional funds – Full Moon Resort	$7,625.65
John Gleason	McMurdy Brook subdivision	$13,900.00
Masserson Holdings	The Roxbury at Stratton Falls – Additional funds	$2,455.90
Frost Valley YMCA	New cabins, parking lot, road	$36,185.00
Windham Mountain Partners	New condominium, parking areas, roadway and ski slope	$176,912.78
Whistler Partners	New condominium, parking areas, roadway and ski slope	$135,650.09
Bovina Farm and Fermentory	Brewery and inn	$17,844.00
Mountaintrail at Hunter	Hunter Peak subdivision	$41,978.74
William Moran	Individual residence	$1,800.00
Windham Equipment Rentals	Equipment rental facility and home heating oil delivery service	$201,850.58
Windham Car Wash O&M	Maintenance of best management practices (BMPs)	$5,000.00

Applicant	Project	Funding
Verona Oil (Walton) O&M	Maintenance of oil/water separator	$14,816.00
Verona Oil (Windham) O&M	Maintenance of oil/water separator	$14,816.00

3.4.2 Stormwater Retrofit Program

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

Through 2019, the program has completed 91 stormwater retrofit projects, including 75 capital projects and 16 planning and assessment projects. Presently, there are four open construction projects and three open planning and assessment projects. Program participation in the retrofit program and the planning and assessment programs is voluntary. Coordination of projects with other initiatives may affect the timing of completion. Summaries of open projects are presented below in Table 3.2 and Table 3.3.

Table 3.2 Status of open stormwater retrofit construction projects.

Applicant	Project description	Approval	Status
Town of Shandaken	Hamlet of Pine Hill stormwater collection, conveyance, and treatment	2/2010, 11/2018	Design
The Onteora Club	Onteora Club stormwater collection, conveyance, and treatment	12/2015	Hold
Village of Delhi	Riverwalk Phase II stormwater collection, conveyance, and treatment	3/2017	Construction
Delaware Academy	School stormwater collection, conveyance, and treatment	3/2017	Design

Table 3.3 Summary of open planning and assessment projects.

Applicant	Grant amount	Funding Date
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

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, 2020. (https://www1.nyc.gov/site/dep/about/filtration-avoidance-determination.page)

4.2 Land Acquisition

DEP's Land Acquisition Program (LAP) permanently protects high priority sensitive lands in the Catskill/Delaware watershed through fee simple acquisitions and the purchase of conservation easements (CEs), both directly by the City and in partnership with the Watershed Agricultural Council (WAC Farm and Forest CE Programs), Catskill Center (Streamside Acquisition Program), and local municipalities (Flood Buyout Programs).

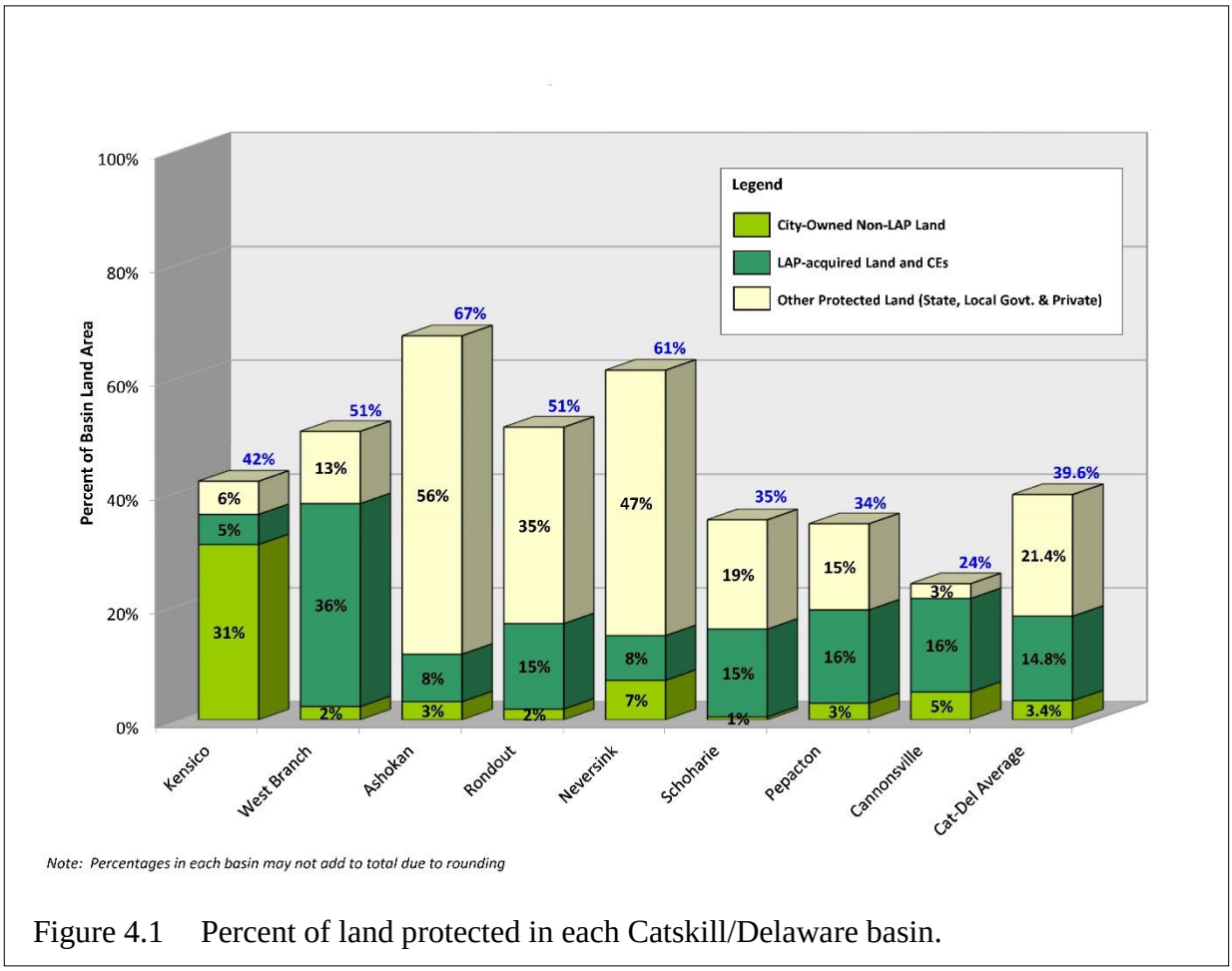

Figure 4.1 Percent of land protected in each Catskill/Delaware basin.

Through December 2019, nearly 40% (39.6%) of the Catskill/Delaware watershed is permanently protected by the City, state and others. Figure 4.1 illustrates that in many high priority reservoir basins, City land holdings have increased dramatically compared with pre-MOA ownership. In the Rondout, West Branch/Boyd Corners, and Schoharie basins, for example, the City has increased the number of protected acres by almost 800%, 1,500%, and 2,900% respectively. As of December 31, 2019, the City owned or controlled a total of 186,835 acres in the Catskill/Delaware watershed, or 18.3% of the land area.

4.2.1 Solicitation Goals

The FAD requires the LAP to solicit 350,000 acres over the seven-year period 2018-2024. During 2019, DEP and its LAP partners solicited 59,389 acres towards this FAD goal, with DEP soliciting 39,389 acres and the remaining 20,000 acres representing the maximum credit available per the FAD as a result of solicitations through the WAC Farm and Forest CE Programs (20,590 acres), Streamside Acquisition Program (SAP) (644 acres), and New York City-Funded Flood Buyout Program (NYCFFBO) (9 acres).

Combined with the 41,213 acres solicited in 2018, the LAP has thus far solicited 100,602 acres of the 350,000-acre FAD goal (29%). Since 1997, the LAP has solicited over 480,000 total acres, with an increasing number of properties being resolicited. All core LAP solicitations carefully adhere to DEP's April 2018 proposed solicitation modifications, which were approved by NYSDOH in 2019. These modifications enabled DEP to focus more closely on surface water features and proximity to hamlets, and agreeing to limit outgoing solicitations in specific towns should certain acquisition thresholds be reached in the future. Andes, Walton and Delhi are the current towns in which LAP can no longer undertake outgoing solicitation, in addition to Shandaken which was designated as unavailable for solicitation under Special Condition 10(c) of the 2010 Water Supply Permit.

4.2.2 Purchase Contracts

As depicted in Table 4.1, DEP and its LAP partners signed 42 purchase contracts in 2019 comprising 1,516 acres and totaling $7.1 million. To date, DEP and its LAP partners have signed 1,810 total contracts comprising 154,367 acres at a cumulative fair market value of $492.7 million, plus an additional $42 million for DEP "soft costs" such as appraisals and surveys.

Figure 4.2 provides a summary of all Catskill/Delaware watershed acres secured annually under all types of LAP real estate contracts executed since 1995. Calendar year 2019 represents the lowest number of acres signed to purchase contracts since the start of the program, which may be attributable to a variety of factors: (1) the increasingly selective nature of LAP after two decades of acquisitions, (2) difficulties in negotiating – and securing local municipal approvals for – subdivisions, which are more often necessary to meet stricter surface water criteria, (3) no City or WAC CEs being signed in 2019, and (4) the fluctuating and interrelated nature of local real estate markets, property taxes, landowner interest, and macroeconomic forces.

Table 4.1 Purchase contracts signed in the Catskill/Delaware watershed during 2019.

Type	Contracts	Acres	Average Size	Price
City Fee	26	1,436	55	$5,298,005
City CE	0	0	0	$0
NYCFFBO	9	5	1	$1,325,500
SAP	7	75	11	$462,710
WAC Farm CE	0	0	0	$0
WAC Forest CE	0	0	0	$0
Totals	**42**	**1,516**	**36**	**$7,086,215**

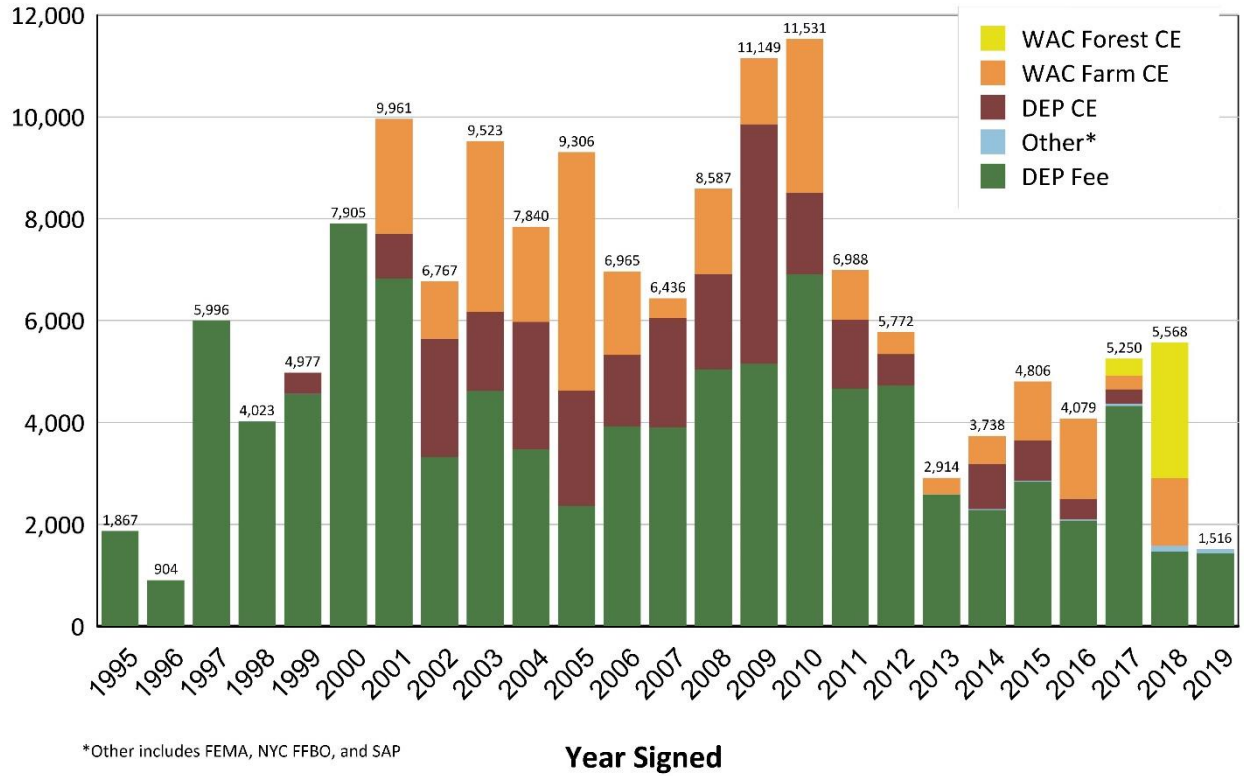

Figure 4.2 Annual acres secured in the Catskill/Delaware watershed under all LAP programs 1995-2019.

As depicted in Table 4.2, DEP and its LAP partners closed on 60 purchase contracts in 2019 comprising 5,912 acres and totaling $14.2 million. To date, DEP and its LAP partners have closed on 1,744 total contracts comprising 149,786 newly acquired acres; this includes 93,233 acres acquired by the City in fee simple, 25,933 acres acquired by the City in CEs, 27,885 acres acquired by WAC in Farm CEs, 2,563 acres acquired by WAC in Forest CEs, 86 acres acquired by the City in fee simple through the SAP, 74 acres acquired by the City and/or municipalities

through the FEMA Buyout Program, and 12 acres acquired by the City and/or local municipalities through the NYCFFBO. Table 4.3 summarizes these newly-acquired watershed lands by LAP Priority Area for 2019 and the prior cumulative period 1997-2018.

Table 4.2 Purchase contracts closed by program in the Cat/Del watershed during 2019.

Type	Contracts	Acres	Average Size	Price
City Fee	29	2,130	73	$7,281,782
City CE	2	285	142	$891,346
NYCFFBO	8	7	1	$1,282,600
SAP	8	74	9	$514,003
WAC Farm CE	8	1,176	147	$2,026,111
WAC Forest CE	5	2,240	448	$2,174,056
Totals	**60**	**5,912**	**99**	**$14,169,898**

Table 4.3 Summary of executed contracts in the Cat/Del watershed by Priority Area.

Period	Priority Area	Contracts Signed	Acres	Price (millions)
1997-2018	1A	132	5,083	$ 34.3
2019	**1A**	**3**	**95**	**$ 0.3**
Subtotal		135	5,178	$ 34.6
1997-2018	1B	336	18,740	$ 135.2
2019	**1B**	**1**	**3**	**$ 0.0**
Subtotal		337	18,743	$ 135.2
1997-2018	2	197	11,729	$ 36.9
2019	**2**	**5**	**13**	**$ 0.8**
Subtotal		202	11,742	$ 37.7
1997-2018	3	416	42,514	$ 93.8
2019	**3**	**10**	**510**	**$ 1.9**
Subtotal		426	43,024	$ 95.7
1997-2018	4	687	74,785	$ 185.4
2019	**4**	**23**	**895**	**$ 4.1**
Subtotal		710	75,680	$ 189.5
Grand Totals		**1,810**	**154,367**	**$ 492.7**

Totals may vary from figures previously reported due to purchase contracts that fail to close, differences in acreage between tax map data and surveys (each of which are used in calculations at different points during a project), and/or refinements to data tracking systems.

4.2.3 Transfer of Conservation Easements to New York State

DEP is required to convey CEs to New York State on all watershed lands acquired in fee simple using City funds. DEP in 2019 did not convey any new CEs to the state, but the New York State Department of Environmental Conservation (NYSDEC) recorded two previously conveyed CEs covering 1,041 acres. To date, DEP has conveyed to the state 85 CEs comprising 74,716 acres. Of these, 78 CEs (67,414 acres) have been recorded by the state.

4.2.4 New York City-Funded Flood Buyout Program

In April 2019, the NYCFFBO resumed acquisitions of municipally-owned properties after DEP and its partners finalized the model CE to be applied to such properties located wholly within a 100-year floodplain. Monitoring for these conservation easements will be conducted by the Catskill Watershed Corporation (CWC) under an agreement with the easement holder, NYSDEC. DEP continues to work with the Coalition of Watershed Towns and NYSDEC toward finalizing a model CE that will apply to municipally-owned properties with upland areas outside the 100-year floodplain.

During 2019, DEP ordered 11 appraisals through the NYCFFBO, for a total of 35 appraisals ordered to date. One appraisal previously completed for a property to be municipally-owned in the Village of Walton is no longer counted towards the NYCFFBO because the property was ultimately not acquired through that program. Appraised values to date total nearly $3.9 million, with projects thus far falling into the categories of Local Flood Assessment, Stream Projects, Erosion and Inundation. Through December 2019, there were 24 accepted offers, five pending offers, and six refused offers. An additional 11 landowners are interested in the program with resolutions already passed by their respective towns.

DEP signed nine purchase contracts under the NYCFFBO during 2019 for a program total of 21 signed contracts comprising 48 total acres. In 2019, DEP closed on eight of these contracts. Figure 4.3 shows a property acquired under the program and Table 4.4 provides a summary of all NYCFFBO contracts executed and closed to date. For all properties listed, the City is expected to own 11 properties (42 acres) while municipalities are expected to own 10 properties (6 acres).

Figure 4.3 This 0.4-acre property with its flood-prone building in the Village of Tannersville, Greene County was signed to purchase contract in 2019 and will be acquired under the NYC-Funded Flood Buyout Program. NYC will pay for the acquisition but the village will own and manage the land.

Table 4.4 Status of all NYCFFBO purchase contracts as of December 31, 2019, by county.

County	Municipality	Expected Owner	Acres	Status
Delaware	Fleischmanns (Village)	City	0.2	Signed
	County Subtotal	**1**	**0.2**	
Greene	Windham (Town)	Town	0.3	Signed
	Tannersville (Village)	Village	0.4	Signed
	Tannersville (Village)	Village	0.4	Signed
	Tannersville (Village)	Village	0.5	Signed
	Hunter (Town)	City	21.5	Signed
	Jewett (Town)	City	4.8	Closed
	Hunter (Village)	City	1.2	Closed
	County Subtotal	**7**	**29.1**	
Schoharie	Conesville (Town)	City	2.8	Signed
	Conesville (Town)	Town	0.6	Closed
	Conesville (Town)	City	0.6	Closed
	County Subtotal	**3**	**4.0**	
Ulster	Olive (Town)	Town	1.2	Signed
	Olive (Town)	Town	0.3	Closed
	Olive (Town)	Town	1.3	Closed
	Olive (Town)	City	1.2	Closed
	Olive (Town)	City	0.9	Closed
	Shandaken (Town)	City	1.6	Signed
	Shandaken (Town)	City	1.2	Signed
	Shandaken (Town)	City	6.0	Signed
	Shandaken (Town)	Town	0.5	Closed
	Shandaken (Town)	Town	0.5	Closed
	County Subtotal	**10**	**14.7**	
	Grand Total	**21**	**48.0**	

4.2.5 Streamside Acquisition Program

DEP administers the pilot SAP through a contract with the Catskill Center, which was amended in 2019 to increase City funding by $3 million pursuant to the FAD. The City's total funding commitment to the SAP is now $8 million through 2022.

During 2019, the Catskill Center ordered 14 appraisals and signed seven purchase contracts on 74 acres. To date, the SAP has conducted 58 appraisals (including two updates) on 56 properties which resulted in 23 signed contracts on 192 acres, of which 74% are within 300-foot stream buffers and/or 100-year FEMA floodplains. To date, the SAP has closed on 12 contracts protecting 85 streamside acres.

In March 2019, following extensive discussions with watershed stakeholders, DEP submitted a FAD report proposing incentives intended to increase landowner participation in the SAP. These incentives were approved by the FAD regulators in 2019. The Catskill Center and DEP are scheduled to begin implementation in 2020.

4.2.6 Farm and Forest Easement Programs

DEP funds the Farm CE Program and pilot Forest CE Program through a $29 million contract with WAC. During 2019, DEP and WAC completed negotiations on a successor contract that includes $11 million in new City funding for the Farm CE Program and $8 million to continue the Forest CE Program pending a written determination from NYSDEC. The City's total funding commitment to the WAC Farm and Forest CE Programs now totals $138.2 million, inclusive of 2017 FAD funding commitments and the WAC Stewardship Endowment.

During 2019, WAC ordered eight appraisals (1,549 acres) on farm CEs and one appraisal (140 acres) of a forest CE. As summarized in Table 4.1 and Table 4.2, WAC signed no purchase contracts in either program, but closed on eight farm CEs comprising 1,176 acres and five forest CEs totaling 2,240 acres. To date, WAC has executed (including closed) a total of 156 farm CEs protecting 27,885 acres and nine forest CEs protecting 2,982 acres.

During most of 2019, it was necessary for WAC to pause acquisition of forest CEs due to depletion of contract funds for the $6 million pilot. In December 2019, with agreement from NYSDOH, DEP submitted a FAD status report on the WAC Forest CE Program that was originally scheduled for submission in 2020. Given the current lack of acquisition funds, DEP recommended the WAC Forest CE Program be continued using the $8 million to be committed by the City in the successor WAC CE program contract.

4.2.7 Water Supply Permit

The 2010 Water Supply Permit (WSP) authorizes the LAP to acquire up to 106,712 acres of land in the Catskill/Delaware watershed through 2025, beyond the 102,287 acres acquired as of January 1, 2010. Between January 1, 2010, and December 31, 2019, DEP and its LAP partners signed contracts on 52,162 acres (49% of the total 106,712-acre limit), leaving a balance of 54,550 acres for potential acquisition pursuant to the WSP.

4.2.8 Federal Emergency Management Agency 2012 Buyout Program

As reported previously, the Federal Emergency Management Agency (FEMA) funded buyouts of certain properties damaged by tropical storms Irene and Lee in 2011. The FEMA buyout program has been completed in Greene, Ulster and Delaware counties and no additional properties are being acquired. A total of 36 properties were acquired representing 61 acres, with some properties held by the City and others by a municipality. DEP does not anticipate future reporting unless new activities occur.

4.2.9 Cooperative Activities with Land Trusts

Although five towns (six eligible properties) opted into the Enhanced Land Trust Program (ELTP) in 2011, there has been no activity since and DEP does not expect any further activity until 2021, when towns will have a third opportunity to elect in or out of the ELTP. In 2019, DEP continued to contract with two locally-based land trusts, WAC and the Catskill Center, to operate FAD-mandated acquisition programs administered through the LAP.

4.2.10 Use of LAP-Acquired Land by Local Communities

The 2017 FAD requires DEP to participate in a workgroup convened to assess opportunities to use LAP-acquired lands to relocate development out of floodplains. Local communities did not convene any meetings with DEP on this topic during 2019.

4.3 Land Management

As the City continues to make significant investments in purchasing water supply lands and conservation easements (CEs), DEP has developed a comprehensive, long-term plan for land management primarily focused on two major categories of activities: (1) management of water supply lands and CEs, and (2) beneficial uses.

4.3.1 Management of Water Supply Lands and Conservation Easements

The City now manages 180,706 acres of land and reservoirs owned in fee simple; this includes pre-MOA reservoir buffer lands, newly acquired properties through the Land Acquisition Program (LAP), and land along aqueducts and shaft sites. As DEP acquires new properties under the City-Funded Flood Buyout Program and Streamside Acquisition Program, these properties are generally smaller in size and present additional stewardship challenges. They are often isolated from other City-owned parcels and typically involve active neighbors. If or when adjacent lands are acquired, these isolated parcels could become larger complexes. The average size of parcels acquired since 2012 has fallen from 62 acres to 56 acres. The largest assemblage of newly acquired lands now totals 2,862 acres.

Property Inspections

DEP inspects all water supply lands owned by the City in fee simple per a monitoring policy that outlines procedures for property inspections and boundary maintenance. Property inspections are divided into three types: standard, focused, and aerial (although DEP has not used aerial inspections yet). The type of inspection a property receives depends on its priority, which

is assigned based on its location, number of adjacent properties, the various uses conducted on the property (e.g., recreation, land use permit), and any history of trespass or encroachments.

DEP performs standard inspections on "standard priority properties," those on which minimal or no trespass or encroachments have been observed, or those which have minimal road frontage and/or public use. These properties receive a boundary inspection at least once every five years. Five-year boundary inspections are the most comprehensive type of inspection and include a traverse of all property boundary lines as well as the interior of the property; this ensures proper survey monumentation and maintenance of boundary lines over the long term.

DEP annually performs focused inspections on "high priority properties." These are parcels on which recreational use is high, where there is a history of encroachments or repeated trespass, where there are active land use permits or other projects, or where there are many adjacent landowners.

DEP can change a property's inspection priority at any time depending on changing circumstances, such as the discovery of encroachments, or perform additional site visits as needed. DEP records all inspections and site visits, along with journal notes, photos, encroachments, and observations, in its Watershed Lands Information System (WaLIS). DEP also schedules property inspections using WaLIS.

All City lands are posted as appropriate. Signage includes "Posted," "No Trespassing," and for recreation areas "Public Access Area," "Day Use Area," or "Entry by Permit." DEP may utilize other types of signs as site-specific conditions dictate.

Encroachments

DEP works diligently to cure encroachments when they are discovered on City-owned lands, often during routine inspections of properties and other DEP land management or volunteer stewardship activities. Once a potential encroachment is identified and categorized as minor, major, or criminal, DEP coordinates the appropriate response with other entities, including the City Law Department and DEP Police as necessary.

In 2019, DEP discovered only a small number of minor encroachments on City-owned watershed lands. These encroachments included two abandoned vehicles, fencing, a small timber trespass, a basement sump-pump pipe, and spotlights attached to trees. DEP remedied several of these through internal coordinated actions and resolutions for others are still pending.

Land Use Permits

DEP issues Land Use Permits (LUPs) to qualified entities seeking opportunities for limited use of City-owned land where no appropriate alternatives exist. LUPs have a term of five years and may be renewed with approval by DEP. The conditions in LUPs are intended to ensure protection of water quality as well as City-owned property, assets and infrastructure, such as aqueducts and shaft sites. During 2019, DEP issued 29 LUPs and renewed 157 LUPs.

Conservation Easement Stewardship

At the end of 2019, DEP held 177 CE properties totaling approximately 26,000 acres in the Catskill, Delaware, and Croton watersheds. This includes two CEs that DEP acquired in 2019 that expanded holdings by 285 acres. DEP conducts two annual inspections of all easements in compliance with the MOA. One inspection is an on-the-ground visit in which the property is traversed, especially in areas where potential violations could occur (e.g., around building envelopes, wetlands and streams). DEP also performs one annual inspection of CEs by helicopter, which provides an efficient inspection of larger properties and allows DEP to inspect over 10,000 acres of CEs in one day. Potential violations that could have serious water quality impacts, such as land clearing, construction, and bridge or road building, are clearly visible from the air. Combined with on-the-ground inspections or a ground check if problems are observed, aerial inspections provide a high level of protection for the City's investment.

DEP is aware of seven CE property transfers that took place in 2019, with another seven CE properties currently listed for sale. Sales to new owners require stewardship resources to promptly explain the easement restrictions, answer questions about allowed activities, and share the deed and maps with potential buyers. Once a CE property is sold, DEP's policy is to meet the new owners at the property, provide copies of the baseline documentation, and answer any questions about the easement restrictions and activity approvals. This provides an important opportunity for DEP to establish good landowner relationships. In 2019, DEP provided maps and deeds to all identified new owners. Site meetings are planned during 2020.

Four new CE violations occurred in 2019, some of which DEP discovered during field inspections. One minor violation involves a drafting error in an easement deed; a corrected deed is being resolved and executed. Other more serious violations include a large forest harvest project that was underway without DEP's prior approval; excavation for a residential mining borrow pit within a stream setback area that prohibits mining; and an abandoned logging bridge that has fallen into a watercourse. DEP is currently addressing each of these violations with the individual CE property owners.

DEP received five new requests for "prior approval" of restricted activities in 2019, including stream work (approved); surface disturbance, hobby-farming with herbicides, herbicide use to control invasive plants (all approved); and construction of an accessory structure in a stream setback area (denied). DEP is extending 17 expired farming and livestock activity approvals. Six forest harvest project plans were reviewed and approved in 2019 and harvest site inspections were performed at eight easement properties.

The Watershed Agricultural Council (WAC) performed all MOA-required farm and forest easement inspections in 2019, including aerial inspections. WAC reported seven easement violations in 2019, of which five are resolved. The remaining open violations involve improper waste storage and are in process of being resolved.

4.3.2 Beneficial Use

Watershed Recreation Program

One of DEP's land management priorities is to allow and enhance low-impact recreational activities compatible with water quality protection. DEP provides outstanding recreational opportunities at 19 reservoirs, two controlled lakes, and thousands of acres of City-owned land throughout the Catskill, Delaware, and Croton watersheds.

In 2019, DEP finalized a revision of its "Rules for the Recreational Use of Water Supply Lands and Waters." Primary changes include the ability to designate Public Access Areas (PAAs) in the East of Hudson watershed; eliminating sailboats and pedal-kayaks as a recreational boating vessel; increased DEP control over the storage of fishing boats on City lands; prohibitions on mountain bikes, horses, and smoking; and the ability to waive Access Permit requirements for certain events such as Family Fishing Days. DEP continues to increase the acreage of watershed land available for recreation while expanding public access and supporting local economies through eco-tourism. In 2019, DEP opened an additional 3,992 acres of watershed land for recreation, bringing the total lands and reservoirs available for public use to 140,795 acres. DEP continued to open West of Hudson watershed lands as PAAs. Users of these lands may hunt, hike, fish, or trap without a DEP Access Permit. Figure 4.4 provides a

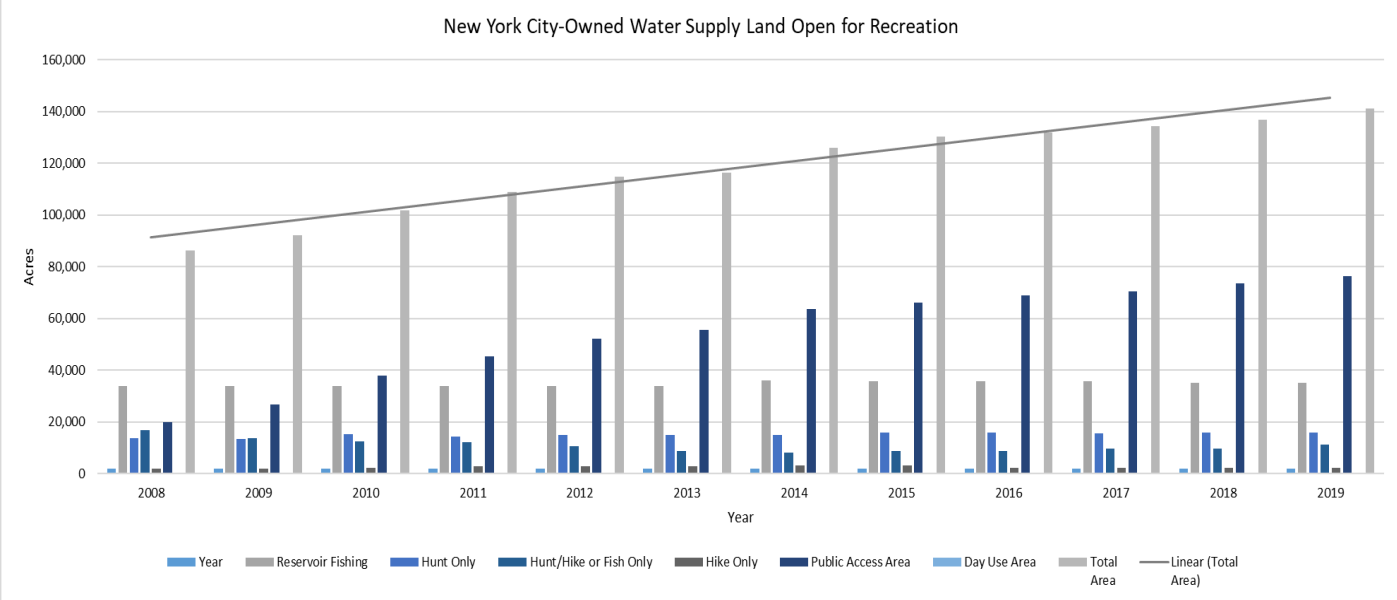

Figure 4.4 Acres of DEP land open for recreation since 2008.

breakdown of the acres of land, by category, opened for recreation since 2008, which continues the upward trend that began in 2003.

In 2019, DEP and Ulster County completed the Ashokan Rail Trail (Figure 4.5), which was officially opened to the public on October 19. This recreational trail follows an 11.5-mile-long former rail bed along the northern shore of the Ashokan Reservoir, with three trailheads

Figure 4.5 Walkers on the Ashokan Rail Trail.

constructed and opened. DEP estimates that over 18,000 visitors used the trail during the final months of 2019, with some minor instances of users venturing off the trail, unleashing dogs, or leaving behind dog waste. DEP continues to work with Ulster County to install better signage and increase enforcement efforts. To that end, the county is working with the Woodstock Land Conservancy and NY/NJ Trail Conference to engage a team of trail stewards during peak times who can assist with enforcement and educate recreational users about the importance of source water protection and the proximity of the trail to the Ashokan Reservoir.

DEP supported three additional trail projects that were opened in 2019. The Catskill Mountain Club constructed the Ashokan Quarry Trail in West Shokan, where DEP installed a new parking lot at the trailhead. The Town of Hunter completed a section of the Kaaterskill Path on the DEP Twilight Park Recreation Unit and the Town of Prattsville constructed the Huntersfield Creek Trail, located adjacent to the popular tourist destination Pratt Rock. DEP, working with many trail partners (including Catskill Mountain Club, NY/NJ Trail Conference,

and The Finger Lakes Trail Conference), now has 16 trails on City-owned lands totaling approximately 66 miles. DEP provides guidance and criteria for locating and constructing new trails on City-owned watershed lands.

DEP continued to allow NYS-licensed guides to take clients on DEP lands and waters for hunting, fishing, hiking, and other allowable activities. DEP issued permits to four additional guides in 2019 for a total of 40 approved guides. DEP sponsored three Family Fishing Days in 2019, which attracted over 200 participants. DEP and several partners also sponsored a 2019 clean-up day on nine reservoirs, in which 350 volunteers filled 279 garbage bags with 4,675 pounds of the following debris: 2,968 glass, plastic or metal beverage containers; 1,026 food wrappers; 2,941 small pieces of foam, glass or plastic; 1,253 cigarette butts; 134 yards of fishing line; 930 grocery bags; 738 disposable cups and plates; 873 bottle caps; 424 take-out food containers; and 38 tires.

Fishing Boat Program

DEP provides for the traditional use of fishing boats on water supply reservoirs, which is a very popular program. Individuals must register their boats and obtain a permit from DEP to store their boat on a reservoir. All boats must be steam cleaned prior to storage and they must remain on their assigned reservoir. DEP has more than 13,000 fishing boats permitted throughout the watershed. Boat owners must renew their registration every four years and abide by DEP's recreation rules.

In 2019, DEP began to implement the new four-year boat tag renewal period as provided for in the new recreation rules. DEP regulates the number of allowable boats for each reservoir, limiting numbers and closing reservoirs or boat storage areas to new boats when they reach capacity. As part of the new recreation rules, DEP placed limits on the number of boats an individual could have both in total and per reservoir. DEP also eliminated the transfer of boats in closed boat storage areas to help limit the impacts of boats on the water supply lands immediately adjacent to reservoirs.

Recreational Boating Program

The recreational boating program caused very little interference, if any, with those storing rowboats on the reservoirs for fishing. No serious safety issues were encountered. Only a few vessels were put into reservoirs without being properly steam cleaned, and each time both DEP and concerned recreational users approached the violators to inform them about the program requirements. DEP continues to increase outreach efforts to boaters with updated signs at certain boat launch sites to prevent impact to the land and reservoirs. Under the new recreation rules, boating season now runs May 1-October 31.

Watershed Stewards Program

DEP has engaged recreational users as volunteer stewards of City-owned watershed lands since 2016. DEP trains these stewards on important watershed protection issues, such as invasive

species and DEP's recreation rules. The stewards submit monthly reports that are followed up by DEP as needed. In 2019, DEP initiated a notification system for stewards to relay information regarding the status of boats on the reservoirs. The stewards notified DEP about 41 damaged boats, 105 improperly stored boats, 21 boats in the water, 83 expired boat tags, seven unsecured boats, and one case of illegal dumping.

During 2019, volunteer stewards collected trash at East of Hudson and Pepacton reservoirs, ensured boats were stored properly, and talked with their fellow anglers and boaters as ambassadors for their respective reservoirs. In addition, the Croton and New York City chapters of Trout Unlimited continued to steward streams flowing into City reservoirs.

Agricultural Use Program

DEP allows City-owned lands to be used for agricultural activities through a landowner-lease program that establishes certain conditions such as minimum buffers along all streams and wetlands, a prohibition on spreading raw manure during frozen or snow-covered conditions, and, if fertilizers will be used, an approved nutrient management plan.

Most farmers using City lands are enrolled in a WAC Whole Farm Plan, which ensures good farming practices are utilized. These plans can be adapted for use on City lands and include various agricultural best management practices (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 Enhancement Program (CREP) and/or Whole Farm Plan BMPs already installed on them, such as fencing and tree planting. The City, as landowner, must maintain these BMPs.

The most common agricultural use on City land is the harvesting of hay. In 2019, DEP approved nine new projects covering 167 acres, for a total of 143 projects in 26 towns covering 3,281 acres. DEP inspected most projects in 2019 and observed no major issues. On projects where no riparian area existed prior to City purchase (they were being farmed right up to the streambank), the streamside vegetation is reestablishing and will form an effective buffer.

Over the past few years, DEP has worked with the Watershed Agricultural Council (WAC) to allow certain low-impact BMPs to be installed on City land. When a lessee has a Whole Farm Plan with WAC and a BMP can help the farming operation on City land, DEP will allow for its installation and maintenance.

4.4 Watershed Agricultural Program

The Watershed Agricultural Council (WAC) administers the Watershed Agricultural Program (WAP) using DEP contract 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 CREP.

To date, the WAP has developed 455 Whole Farm Plans (WFPs) on 375 West of Hudson (WOH) farms and 80 East of Hudson (EOH) farms. At the end of 2019, 328 of these WFPs (72%) remained active, including 260 WOH farms (69%) and 68 EOH farms (85%). By comparison, 330 WFPs were reported active at the end of 2018.

During 2019, the WAP developed five new WFPs on three WOH farms and two EOH farms. Six farms became inactive (two EOH and four WOH), two WOH farms withdrew from the program and one farm previously reported as inactive is now active. WAC anticipates developing six to eight new WFPs within the next 18 months. For the 330 active WFPs at the end of 2018, WAP conducted 328 annual status reviews (99%), which exceeds the 90% FAD metric. WAP also completed 112 WFP revisions on 92 WOH farms and 20 EOH farms.

In 2019, the WAP implemented 487 BMPs on all participating farms at a total cost approaching $6.3 million. These figures include 453 BMPs on WOH farms ($5.9 million) and 34 BMPs on EOH farms ($0.4 million). These figures also include the repair or replacement of 73 BMPs on WOH farms and eight BMPs on EOH farms.

To date, approximately 8,379 BMPs have been implemented on all watershed farms at a cost exceeding $70 million; these figures include 7,581 BMPs on WOH farms ($63.7 million) and 798 BMPs on EOH farms ($7.2 million). In 2020, the WAP anticipates implementing approximately 343 BMPs on WOH farms at an estimated cost of $5.4 million and approximately 33 BMPs on EOH farms at an estimated cost of $406,000. For a detailed description of numbers and types of BMPs implemented in 2019, and planned for design or implementation in 2020, 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 intended to reduce by 50% an existing backlog of BMPs identified in WFPs prior to January 1, 2017, and limit a future backlog of new BMPs identified after January 1, 2017. The 50% backlog reduction metric applies to “new” BMPs not yet implemented in WFP pollutant categories I-VI, as well as previously implemented BMPs, regardless of pollutant category, in need of repair or replacement.

DEP and WAC developed and adopted an official BMP backlog list dated January 1, 2017, to serve as a baseline for measuring annual backlog reductions. This official BMP backlog list includes 1,754 total BMPs estimated to cost $35.8 million, comprised of 1,410 “new” BMPs not yet implemented in WFP pollutant categories I-VI (estimated cost of $28.1 million) and 344 repair or replacement BMPs (estimated cost of $7.7 million). To achieve the new FAD metric of 50% BMP backlog reductions as measured against this baseline, the WAP must implement 705 backlog BMPs in WFP pollutant categories I-VI and 172 repair or replacement BMPs.

In 2019, WAC and DEP agreed to modify WAP reporting standards for defining BMP implementation. Prior reporting in 2017 and 2018 counted a BMP as implemented in a given year if an individual BMP that was part of a project with multiple BMPs had been implemented, even if other component BMPs for the project were not carried out until the following calendar

year. The WAP now reports more accurately on the total number and cost of BMPs implemented only when all of a project's component BMPs have been fully implemented, certified and paid.

Between January 1, 2017, and December 31, 2019, the WAP implemented 259 backlog BMPs in pollutant categories I-VI (at a cost of $4,254,659), thereby reducing by 18% the total backlog of "new" BMPs not yet implemented while achieving 37% progress towards the FAD metric of 705 BMPs. The WAP also implemented 229 repair or replacement BMPs during this same period (at a cost of $3,847,749), thereby reducing the total backlog of repair or replacement BMPs by 67% and exceeding the FAD metric of 172 backlog BMPs by 33% in just three years.

In addition to modifying BMP reporting standards in 2019, WAC and DEP also revisited the official BMP backlog list dated January 1, 2017, to ensure the list remains an up-to-date and accurate baseline for measuring FAD-mandated BMP backlog reductions. As part of this review, WAC identified 66 backlog BMPs (18 "new" and 48 repair and replacement) that were actually implemented prior to January 1, 2017. DEP agreed to count these BMPs towards fulfillment of the FAD metric, so they are included in the numbers for the period reported above. WAC also deleted 360 BMPs from the backlog list (324 "new" and 36 repair or replacement) due to farms becoming inactive, changes in farm operations or practices, and WAP data reporting discrepancies. As of December 31, 2019, the official BMP backlog list included 906 total BMPs remaining, comprised of 827 "new" BMPs and 79 repair or replacement BMPs.

Of the total 437 BMPs implemented by the WAP in 2019, 143 were backlog BMPs (116 "new" and 27 repair or replacement) costing $4,544,470 ($2,910,745 for "new" BMPs and $1,633,725 for repair or replacement BMPs). In 2020, the WAP anticipates designing approximately 189 backlog BMPs (166 "new" and 23 repair or replacement) for implementation over the next several years. To achieve its FAD goal of 50% reduction of the BMP backlog, the WAP needs to implement an additional 446 "new" backlog BMPs before December 31, 2024, which is an average of 112 per year. Since January 1, 2017, the WAP has identified in WFPs an additional 1,230 new BMPs totaling $14,583,580. These numbers, generated primarily by WFP revisions, represent a growing future backlog of BMPs, which is contrary to one of the dual goals of the FAD metric.

During 2019, the WAP completed 81 new or updated nutrient management plans (NMPs) on 75 active WOH farms and six active EOH farms. In the WOH watershed, 226 participating farms are following NMPs, of which 98% are current (developed within the last three years). In addition, 137 WOH farms participated in the Nutrient Management Credit Program in 2019, an increase of five participants from the previous year. One farm left the program because it no longer met the eligibility requirements.

The WAP implemented its fourth full year of the Precision Feed Management (PFM) Program, completing 10 new or revised feed management plans in 2019. The PFM Program now has 48 active participants including 45 participating dairy farms (32 in the Cannonsville basin,

eight in the Pepacton and five in the Schoharie basin) and three beef farms (two in Cannonsville and one in Pepacton basin).

In 2019, 10 CREP contracts were re-enrolled covering 158.2 acres of riparian forest buffers. Six contracts expired in FFY19 (111.7 acres) and were not re-enrolled. One previously enrolled contract was split into two contracts. There are currently 173 CREP contracts with 135 landowners that contain 1,690.1 acres of riparian forest buffers.

WAP conducted 24 farmer education programs in 2019 attended by 677 participants, of which 31% were watershed farmers, 22% were other farmers, and the rest were students, agribusinesses or agency staff. An estimated 31% of all WAP participants attended at least one farmer education program during 2019, with highlights including the annual Catskill Regional Agricultural Conference, pesticide application training, and several farm tours and workshops covering topics such as livestock production and pasture management.

Finally, the WAC Economic Viability Program reached more than 55,000 people through its annual Pure Catskills print guide, e-newsletters, and marketing website (purecatskills.com). Additionally, 2019 was the first full year of implementation for a new City-funded micro-grants program, which WAC created to enhance the economic viability of farm and forest businesses in the WOH watershed. The micro-grants program received 36 applications in 2019 and awarded 26 grants totaling $96,144 to support activities such as marketing and staff training. WAC also sponsored 35 events promoting the marketing and sales of agricultural and wood products from the watershed region.

4.5 Watershed Forestry Program

The Watershed Agricultural Council (WAC) Forestry Program 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 landowners and school-based audiences.

In 2019, WAC funded the development of 35 forest management plans covering 4,427 acres. Seven of these plans resulted in the new enrollment of 585 acres in the NYS Forest Tax Law (480-a tax abatement program), while the remaining 28 plans (3,842 acres) represented re-enrolled properties. A total of 54,946 watershed acres are enrolled in 480-a management plans funded by WAC. A landowner who enrolls in this tax abatement program agrees to restrict development, limit subdivision, and commit to a schedule of forest stewardship activities for a rolling 10-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, while still being utilized for timber production.

WAC also funded the completion of 68 MAP projects including 31 timber stand improvement projects, 19 wildlife improvement projects, eight invasive species control projects, one tree planting project, and nine landowner site visits. To date, the program has funded 688

MAP projects on 5,576 acres of forestland, with timber stand improvement and wildlife improvement representing 77% of all completed projects.

In 2019, WAC funded the completion of 54 road erosion control BMP projects which included 16 stream crossing projects on active timber harvesting sites. WAC also loaned out six portable bridges and distributed 10 free BMP samples. Additionally, WAC completed six Croton Trees for Tribs projects that planted 337 trees and shrubs along 250 linear feet of streams.

Since 2015, WAC has supported an interactive website called MyWoodlot.com that educates forest landowners through online modules and helps them to customize goals and management activities for their properties. The website contains 48 goals, 217 activities, 639 pieces of "how-to" information, and 198 blogs and feature stories available as educational content for interested landowners. In 2019, 46 landowners created MyWoodlot profiles, for a total of 271 profiles to date; 30 of these profiles (11%) belong to WAC staff, WAC committee members and partners. Website diagnostics suggest that 43,803 unique users visited MyWoodlot.com during 2019.

In collaboration with the NYS Trained Logger Certification Program and Cornell Cooperative Extension, WAC sponsored 10 professional logger training workshops during 2019 attended by 102 participants. Approximately 202 loggers working in the Catskill/Lower Hudson region were "Trained Logger Certified" (TLC) during 2019. The Catskill/Lower Hudson region experienced a 46% increase in the number of TLC loggers over the past year, in part attributed to the robust efforts to certify local BOCES students. Loggers are an aging demographic and training the next generation is vital to the future of working watershed forests.

WAC and its partners sponsored numerous forest landowner education programs in 2019, including 42 workshops reaching more than 1,263 participants. The Cornell Master Forest Owners (MFO) Program conducted 51 landowner visits. In 2019, 38 MFOs continued to serve the Catskill region, of which 16 are based in the watershed.

The Watershed Forestry Program implemented the following school-based education programs in 2019: Green Connections School Partnership Program, Watershed Forestry Institute for Teachers, and the Watershed Forestry Bus Tour Grants Program. Green Connections engaged 141 students from three partner schools (six classrooms), while 27 teachers attended the Watershed Forestry Institute held at the Sharpe Reservation in Dutchess County. WAC sponsored 30 bus tours attended by 351 adults and over 1,429 students (primarily City residents); these included 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 four watershed model forests hosted 376 educational programs and outreach events for 24,562 participants including youth, landowners, loggers, and water consumers. The Lennox Model Forest educated 118 campers with forest-based programs such as wilderness survival and nature hikes, while the Frost Valley Model Forest attracted 18,745 campers and visitors. The Siuslaw Model Forest hosted 1,287 youth and adult programs, covering topics such

as beekeeping, invasive species, mushroom cultivation, stream protection, and forest ecology. The Clearpool Model Forest reached 4,412 students from East of Hudson and New York City.

4.6 Stream Management Program

Throughout 2019, the Stream Management Program (SMP) continued to work closely with watershed communities to restore and protect stream system stability and ecological integrity by promoting the long term stewardship of streams and floodplains. Community participation continued to expand in the Flood Hazard Mitigation Program as applications for implementation funding increased, particularly requests for property protection assistance by both homeowners and businesses. The SMP completed an additional 12 stream projects (Figure 4.6), which taken together with 14 Catskill Streams Buffer Initiative (CSBI) projects, results in a

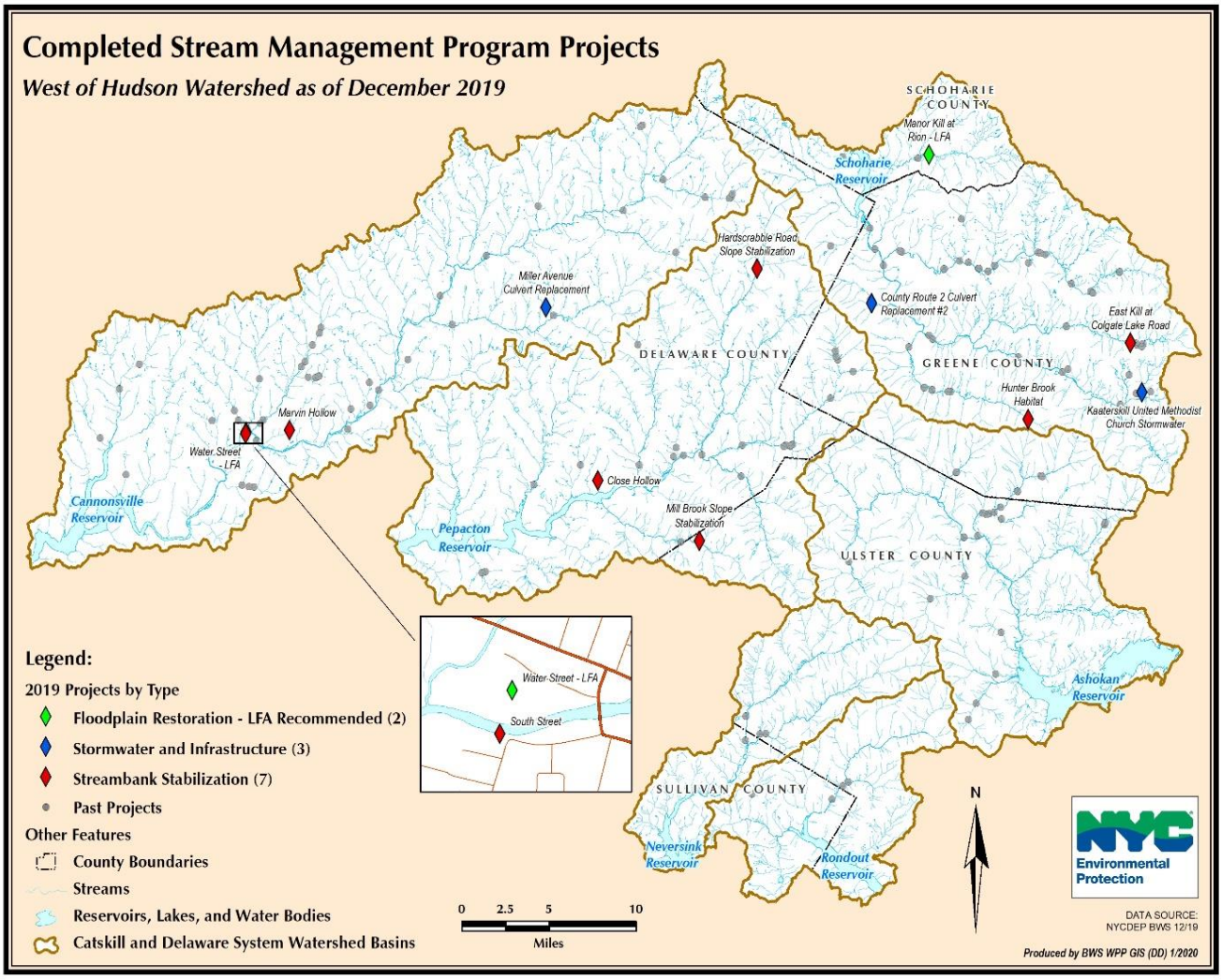

Figure 4.6 Location of SMP projects, 2019.

total of 420 completed projects treating more than 48 miles of stream. The SMP conducted stream feature inventories (SFIs) on 38.5 miles of priority waterways in 2019, nearly doubling last year's assessment, and delivered a broad base of educational programming, professional engineering and technical assistance.

The following sections summarize progress within the major functional program categories of Water Quality Stream Projects, Flood Hazard Mitigation, Stream Management Plan Implementation, and Stream Studies. The CSBI is reported in Section 4.7.2.

4.6.1 Water Quality Stream Projects

Water quality stream projects (WQSPs) prioritize improvements in water quality and are approved by NYSDOH towards fulfilling FAD requirements. While SMP projects serve multiple objectives and all projects can benefit water quality, each project has a principal goal and associated funding category within the SMP. Other project categories include Local Flood Analysis (LFA), Stream Management Implementation Program (SMIP), and the CSBI. The 2017 FAD requires the completion of 24 WQSPs based on SFIs that support project prioritization. DEP outlined the process for prioritizing SFIs and WQSPs in a June 2019 FAD report.

Each year the SMP nominates WQSPs for NYSDOH approval under the 2017 FAD. In 2019, one project was approved and constructed: East Kill at Colgate Lake Road in Jewett. Four additional projects were approved. Table 4.5 summarizes the status of WQ projects at the close of 2019.

Table 4.5 Status of WQ projects toward fulfillment of the 2017 FAD requirement.

Project Name	Status	Length (feet)	Basin
Batavia Kill at Kastanis	Completed	3,800	Schoharie
Bush Kill at Watson Hollow	Completed	250	Ashokan
Batavia Kill at Red Falls Phase 1	Approved	2,700	Schoharie
Batavia Kill at Red Falls Phase 2	Approved	4,400	Schoharie
West Branch Neversink River at Clothes Pool	Approved	800	Neversink
Hillslope Stabilization at Bull Run	Approved	300	Pepacton
East Kill at Colgate Lake Road	Completed	700	Schoharie
Warner Creek Site 1	Approved	540	Ashokan
Warner Creek Site 2	Approved	560	Ashokan
Stony Clove Above Jansen Road	Approved	1,600	Ashokan
West Kill above Wolff Road	Approved	600	Schoharie

East Kill at Colgate Lake Road

Greene County Soil and Water Conservation District (GCSWCD) identified the East Kill at Colgate Lake Road project through the East Kill SFI and prioritized this site in the East Kill Stream Management Plan. The project halted hydraulic erosion at the toe of a 45-foot-high and 350-foot-long hillslope to reduce mass wasting and restore adjacent floodplain connectivity. This will mitigate contact with extensive sources of clay. The reach contributed turbidity even at low flows. BMPs included minor modifications of channel alignment and dimensions, construction of a stable bankfull bench, and removal of a berm. The bankfull bench included live stone revetment and eight root wads to protect the toe of the hillslope. Bioengineering included 1,470 willow stakes, 850 feet of willow fascine, and 1,000 native potted plants. Native riparian and wetland grass seed mix was established over approximately 3.5 acres to increase bank stability and restore a healthy riparian buffer. GCSWCD constructed this project in 2019 at a cost of $360,560. Figure 4.7 and Figure 4.8 illustrate the project.

4.6.2 Flood Hazard Mitigation Program

The Flood Hazard Mitigation Program supports the Local Flood Analysis (LFA) process, which identifies flood hazards in West of Hudson population centers through hydraulic models. This is followed by the funding and implementation of LFA-recommended projects through the SMP, Catskill Watershed Corporation (CWC) Local Flood Hazard Mitigation Implementation Program (LFHMIP), or the New York City-funded Flood Buyout Program (NYCFFBO).

Figure 4.7 East Kill at Colgate Lake Road before construction.

Figure 4.8 East Kill at Colgate Lake Road after construction.

SMP Local Flood Analyses and Recommended Projects

In 2019, the SMP funded the substantial completion of two LFAs in Halcott and Roxbury; two LFAs remain ongoing in Stamford and Grahamsville. To date, 33 population centers have completed 19 LFAs, marking substantial completion of the LFA process. DEP has committed a total of $1.7 million to the development of LFAs through 2019. Figure 4.9 depicts the locations and status of LFAs. A full list of completed LFAs can be found at Catskillstreams.org\LFA.

In 2019, SMP made six funding awards to LFA-recommended projects. The total number of awards to date is 19, towards 13 discrete projects. Through 2019, $8.2 million has been spent or committed out of the $10.1 million funding requirement that was initially codified in the Revised 2007 FAD and remains a deliverable in the 2017 FAD.

Table 4.6 summarizes the two LFA projects completed in 2019. GCSWCD completed the Manor Kill at Rion Floodplain Restoration project in Conesville. This project will mitigate flooding on NYS Route 990V with the restoration of 0.5 acres of floodplain. DEP purchased this flood-damaged property and CWC funded the demolition of the structure in 2018 through the LFHMIP. GCSWCD oversaw the removal of hazardous material, restored the floodplain and stabilized the adjacent streambank. The project exemplifies DEP's coordination with various program partners to achieve multiple objectives (Figure 4.10 and Figure 4.11).

Table 4.6 Summary of LFA-recommended projects completed in 2019.

Basin	Type of Project	Name of Project	Length (feet)
Delaware	Floodplain Restoration	Water Street	640
Schoharie	Floodplain Restoration	Manor Kill at Rion	610

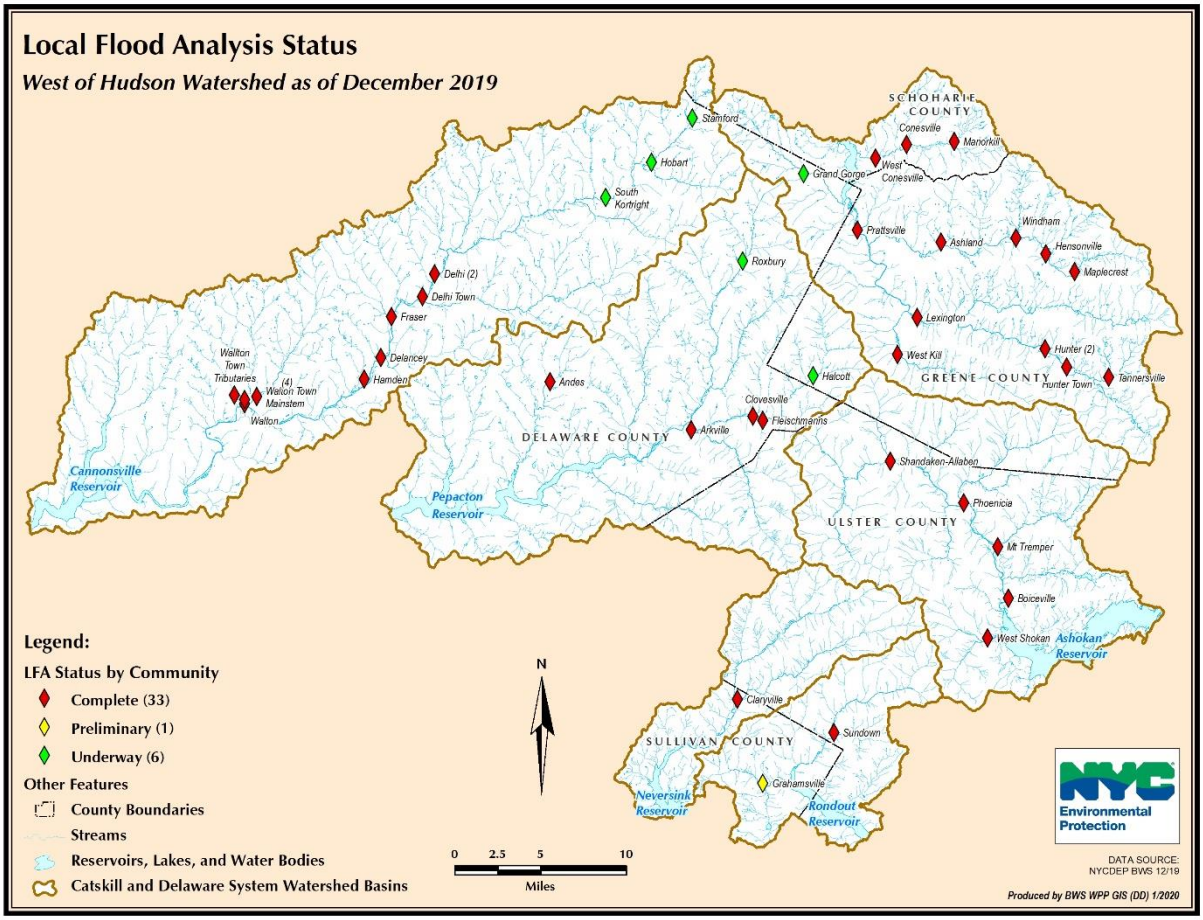

Figure 4.9 Location and status of LFA projects, 2019.

Also in 2019, the Delaware County Soil and Water Conservation District (DCSWCD) completed construction of the Water Street Floodplain Restoration Project, which restored 6.6 acres of floodplain by removing 48,784 cubic yards of fill from a site along the West Branch Delaware River in the Village of Walton. The project will lower flood elevations by up to 0.5 feet in the 100-year flood and cost a total of $1.2 million, including a $468,285 contribution from the U.S. Army Corps of Engineers (USACE) through the federal Water Resources Development Act. The project is a first in a series of proposed LFA-recommended projects for the village, which plans to use this site as a recreational boat launch.

Figure 4.10 Manor Kill at Rion before construction.

Figure 4.11 Manor Kill at Rion after construction

CWC Local Flood Hazard Mitigation Implementation Program

In 2019, CWC funded an additional 17 property protection feasibility studies for potential elevation and floodproofing of structures located in floodplains, bringing to 36 the number of feasibility studies approved to date. Of these, CWC has received nine completed studies. CWC has contracted with Chazen Engineering to accelerate the completion of feasibility studies to address a growing backlog of applications. In 2019, CWC also awarded funding to design three property protection projects and to elevate a business in the Village of Hunter.

With CWC funding, Ulster County completed a design for the Mount Pleasant Bridge removal and the Town of Denning initiated design of the Rondout Stream Restoration Project at Sundown. CWC acquired the former Breakey Motors property in Walton, awarded a contract for its demolition, and is working with DCSWCD for the design and restoration of the floodplain. CWC also funded the purchase of a property for the relocation of the Boiceville Fire Station out of the Esopus Creek floodplain to a nearby upland site.

CWC approved 11 fuel tank anchoring projects in 2019 to address pollutant sources in flood-prone areas. To date, CWC has funded the anchoring of 47 propane tanks (13,760 gallons) and 16 fuel oil tanks (4,450 gallons). CWC continues to fund removal of structures associated

with the NYCFFBO. In 2019, a contractor removed an erosion hazard property in the Village of Hunter and initiated removal of the former Breakey Motors garage in the Village of Walton.

New York City-funded Flood Buyout Program

In 2019, DEP supported Ulster County and the Town of Shandaken with the NYSDOT's replacement of the NYS Route 28 Bridge over the Esopus Creek by acquiring two properties important to the road replacement and realignment. This LFA project includes removing an USACE levee, restoring the Esopus floodplain, and lowering local flood elevations. The NYSDOT is scheduled to construct a new bridge in 2020, with floodplain restoration in 2021. Upon completion, the Town of Shandaken will manage the project area as greenspace.

4.6.3 Implementing Stream Management Plans

In 2019, DEP and its SMP partners continued to deliver comprehensive basin-scale programming including stream assessments; project selection, design, and construction; LFA support; and education and technical training of stakeholders. The SMP partners met throughout the year with their advisory councils and working groups to implement the recommendations made in stream management plans, track status and progress via annual action plans, and administer the Stream Management Implementation Program (SMIP).

Locally-driven projects are those funded by SMP partners through the competitively-based SMIP. Table 4.7 summarizes the total number of SMIP awards in 2019 and to date. For the 256 SMIP grants awarded to date, 209 are complete (82%), 43 are in process (17%), and four are in the design phase (1%). In 2018, the SMP began to track flood hazard mitigation projects separately as LFA-recommended projects to be consistent with the 2017 FAD. Additional information on all SMIP projects can be found at catskillstreams.org/smip/.

Table 4.7 Number of SMIP awards by category for 2019 and totals to date (2009-2019).

SMIP Category	2019	Total
Education and Outreach	9	68
Recreation and Habitat Improvements	2	20
Stormwater and Critical Area Seeding	0	7
Highway/Infrastructure	1	50
Landowner Assistance/Streambank Restoration	1	37
Planning and Research	5	47
Flood Hazard Mitigation	0	27
Total	**18**	**256**

The total reflects new projects as well as accounting for withdrawn projects.

Ashokan Basin

Through DEP's partnership with Ulster County Soil and Water Conservation District (UCSWCD) and Cornell Cooperative Extension (CCE), the Ashokan Watershed Stream Management Program (AWSMP) advanced numerous initiatives. These included funding seven SMIP projects totaling $1,711,101, installing three CSBI projects, monitoring two previously

constructed stream restoration projects, completing a 12.3-mile-long SFI on the Esopus Creek main stem, and seeding and mulching 4.7 miles through the roadway seeding program. The AWSMP advanced the design of flood hazard mitigation projects that were recommended through LFAs, including the Maltby Hollow Bridge replacement, and culvert replacements on Burgher, Desilva, and Upper Boiceville roads. Education and outreach highlights included the inaugural Ashokan Watershed Month; an elevation and flood-proofing workshop; and the Esopus Creek Newsletter in print and digital format. The AWSMP website (ashokanstreams.org) continues to provide an excellent resource for news, publications, and events.

Delaware Basins (Cannonsville and Pepacton)

In partnership with DEP and the Delaware County Planning Department, DCSWCD advanced implementation of the East and West Branch Delaware River Action Plans by completing the Water Street Floodplain Restoration Project, installing three CSBI projects and four CREP/CSBI projects, seeding and mulching 22.7 acres through the roadway seeding program, and completing five SMIP projects and one emergency project at Marvin Hollow. A final project, the Village of Delhi River Walk, is currently under construction. Additionally, DCSWCD completed an SFI on Huntly Hollow in the Town of Colchester.

In 2019, SMIP-funded projects were constructed in Delaware and Greene counties and are listed in Table 4.8.

Table 4.8 Summary of locally-driven SMP projects completed in 2019.

Basin	Type of Project	Name of Project	Length (feet)
Delaware	Streambank Stabilization	Mill Brook Slope Stabilization	950
Delaware	Streambank Stabilization	South Street	600
Delaware	Streambank Stabilization	Hardscrabble Road Slope Stabilization	340
Delaware	Streambank Stabilization	Close Hollow	160
Delaware	Stormwater/Infrastructure	Miller Avenue Culvert Replacement	110
Delaware	Streambank Stabilization	Marvin Hollow	175
Greene	Stormwater/Infrastructure	County Route 2 Culvert Replacement #2	40
Greene	Stormwater/Infrastructure	Kaaterskill United Methodist Church	0
Greene	Streambank Stabilization	Hunter Brook Habitat	400

Schoharie Basin

In 2019, GCSWCD and the Schoharie Watershed Advisory Committee advanced several action plan recommendations by funding six SMIP projects totaling $278,683; five CSBI projects, two SFIs for 16.7 miles of the East Kill and Sawmill Creeks, monitoring of seven former stream restoration projects, and seeding and mulching 8.1 acres through the roadway seeding program. GCSWCD also completed work on 17 SMIP projects totaling $948,336.

Education and outreach efforts included the 13th Annual Schoharie Watershed Summit and the 10th Annual Schoharie Watershed Month. GCSWCD held a public Streamside Landowner Workshop to promote the CSBI and collaborated with the AWSMP to develop a Floodplain Management for Real Estate Professionals course. The biannual GCSWCD newsletter was distributed in both print and digital formats. More information can be found at www.gcswcd.com.

Rondout and Neversink Basins

The Rondout Neversink Stream Program (RNSP), led by Sullivan County Soil and Water Conservation District (SCSWCD), approved seven SMIP projects totaling $51,216, advanced designs for an LFA project at the Hunter Road in Claryville and the WQSP for the West Branch Neversink River at Clothes Pool in Denning. The RNSP completed a new SFI on the Rondout Creek main stem, which was last inventoried in 2009. Six former CSBI project sites received substantial soil and/or plant augmentation. The RNSP awarded three new SMIP research grants in 2019: one to Frost Valley YMCA to continue supporting United States Geological Survey (USGS) fish population and habitat studies and two undergraduate research fellowships through Cary Institute for Ecosystem Studies' new Catskill Science Collaborative. The RNSP also hosted three major public educational events: "Forest to Frying Pan" (teaching residents to grow mushrooms on fallen streamside trees and the ecological role of large wood for stream stability); "Peek in the Creek," (teaching snorkeling and stream ecology in the Chestnut Creek); and the fifth annual Angler's Symposium. SMIP grants funded five education projects, including the Catskill Center (Blue Hole Leave No Trace), SygiSCI (Watershed Education Curriculum Development), and Tri-Valley School (Enviroscape). Additional information can be found at rondoutneversink.org.

4.6.4 Stream Studies

The SMP continued to provide scientific support to stream management activities. Priorities for 2019 included advancing the third year of the 10-year collaborative research effort led by the USGS and DEP; finalizing revisions to the SFI data dictionary used by all SMP partners; working with SMP partners on research and assessment initiatives; and revising the Catskill Mountain bankfull regional curves.

USGS collected continuous turbidity data at all Esopus Creek and Stony Clove watershed monitoring sites. USGS also collected continuous stage-discharge data and storm event suspended sediment samples at 14 locations throughout the study area. USGS continued the particle tracer pilot study in Stony Clove Creek using AWSMP SMIP grant funds to track a set of radio frequency-identified rocks placed in the creek in 2017. With consultant support, DEP continued geomorphic monitoring at selected suspended sediment source reaches in the Stony Clove watershed. With the SUNY Ulster Watershed Conservation Corps, DEP completed SFI mapping of erosional suspended-sediment sources in the Warner Creek tributary to Stony Clove

Creek. This data will be compared with similar data collected in 2010, 2011, 2012 and 2015 to analyze temporal variations in suspended-sediment sources.

DEP submitted two FAD deliverable reports as part of the Esopus basin sediment studies research. Submitted in January 2019, the first report detailed the research supporting the nomination of three priority WQSPs in the Stony Clove watershed. These three projects are scheduled to be constructed during 2020-2021 and represent the projects to be evaluated for reach-scale turbidity reduction. The second report, submitted in March 2019, provided a detailed accounting of methods and findings to date for the Upper Esopus Creek Watershed Turbidity/Suspended-Sediment Monitoring Study.

DEP submitted an additional FAD report in June 2019, detailing the content and results of 2018 meetings with the SMP partners on using available water quality monitoring data to help guide where to perform SFIs that might yield future WQSPs.

DEP concluded 2019 with a resumed effort to finalize revisions to the Catskill Mountain bankfull discharge and hydraulic geometry regionalized regression relationships (regional curves). Stream management programs use the regional curves to predict bankfull discharge and associated channel dimensions (width, depth and area) as a function of the stream drainage area. This work included an additional round of quality control/assurance checks on field data collected in 2016. Also, new regionalized regressions incorporating the 2016 survey data were developed as well as a regional mean annual runoff analysis to improve the regressions.

4.6.5 Watershed Emergency Stream Response and Recovery Plan

The 2017 FAD requires that DEP participate in and report on progress made by a working group to be convened by the NYSDEC to develop an Emergency Stream Response and Recovery Plan. The plan would outline in-stream and riparian emergency recovery activities typically needed both immediately and during the longer recovery period following flood events. To date, the working group has not been convened.

4.7 Riparian Buffer Protection Program

Protecting riparian buffers is a component of DEP's Long-Term Watershed Protection Strategy. Privately-owned lands contain approximately 64% 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 the 2017-2019 pilot partnership between the CSBI and the federal Conservation Reserve Enhancement Program (CREP) on fallow agricultural land (CREP/CSBI pilot).

4.7.1 Activities on City-owned or Controlled Land

DEP's Land Acquisition Program (LAP) includes 300-foot buffers on either side of a watercourse as a principal eligibility requirement under the "natural features criteria" set forth in

the MOA. Within the Catskill/Delaware watershed, 36.1% (90,376.4 acres) of all stream buffers are protected by ownership or conservation easements held by DEP, NYSDEC, WAC, municipalities, or land trusts. Of the protected stream buffers within the Catskill/Delaware watershed, 18.1% are protected by the City, including 72.6 acres that DEP acquired within the Schoharie basin through the Streamside Acquisition Program (SAP) in 2019.

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 35-foot buffer between farming activities and the stream. Proposals maintaining a larger buffer receive 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 streams and buffers.

4.7.2 Catskill Stream Buffers Initiative

The Catskill Stream Buffers Initiative (CSBI) is a component of DEP's Stream Management Program (SMP) and part 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.

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. The CSBI continues to supply Catskill native plant material through contracts with the Greenbelt Native Plant Center and One Nature, LLC, which in 2019 moved nursery sites and finalized the renewal of their contract with CSBI. In 2019, DEP and its partners received 4,000 gallon-sized trees and shrubs. Since program inception in 2009, over 63,500 gallon-sized trees and shrubs from locally collected seed have supported SMP planting efforts.

DEP works with five county Soil and Water Conservation Districts (SWCDs) whose CSBI coordinators develop Riparian Corridor Management Plans (RCMPs) for participating landowners. These serve to guide project design and educate landowners about their buffers. Since 2009, coordinators have completed 143 RCMPs, including seven new RCMPs in 2019.

In 2019, CSBI planting projects took place on three types of sites: the CSBI base program, CREP/CSBI, and extensions of existing CSBI projects (Table 4.9). The program added 14 new project sites (10 to the CSBI base program and four CREP/CSBI) and extended the buffer length on one existing CSBI project. Altogether, the program completed buffer restoration on 27.3 acres of streamside property that span over 14,450 feet (2.7 miles) of stream length. These projects planted 8,918 native Catskill trees and shrubs and installed over 2,000 feet of bioengineering treatments consisting of native willow species.

Table 4.9 Summary of CSBI projects completed in 2019 by project type: CSBI base program project site (B), CREP/CSBI (CR), extension of existing CSBI project site (+).

Basin	Project Type	Name of Project	Stream Length (feet)	Area (acres)
Ashokan	B	Kaiser	400	0.2
Ashokan	B	Emerson	700	0.4
Ashokan	B	Amenta	175	0.02
Ashokan	B	Stony Clove at Meadowbrook	100	0.1
Schoharie	B	Bilash 2019	1,200	0.7
Schoharie	B	Cotrone	1,800	2.4
Schoharie	B	DeSantis	300	0.7
Schoharie	B	Fleischman	700	0.3
Pepacton	B	Keller	210	0.9
Pepacton	B	Fleischmanns Site 4	590	1.0
Pepacton	+	Castellitto	200	1.0
Cannonsville	CR	D'Orazio	2,500	4.9
Cannonsville	CR	Parinello	2,500	12.1
Cannonsville	CR	Siegel	1,600	1.3
Cannonsville	CR	Hobbs	1,475	1.3
Total			**14,450**	**27.3**

Since 2009, the CSBI has completed 226 total projects spanning 140 riparian acres and over 20.5 miles of stream length (Figure 4.12). These projects installed over 47,138 gallon-sized trees and shrubs, in addition to plugs, tubelings, and cuttings from willow and dogwood species (all native Catskill species). In 2019, DEP also supported riparian planting activities on two non-CSBI stream restoration projects, which planted roughly 2,620 feet of riparian buffer.

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. The five county CSBI coordinators monitored 37 sites in 2019, 10 for the first time. Coordinators actively monitor 81 sites in total with assistance from summer interns hired through partnerships with SUNY Ulster and SUNY Delhi.

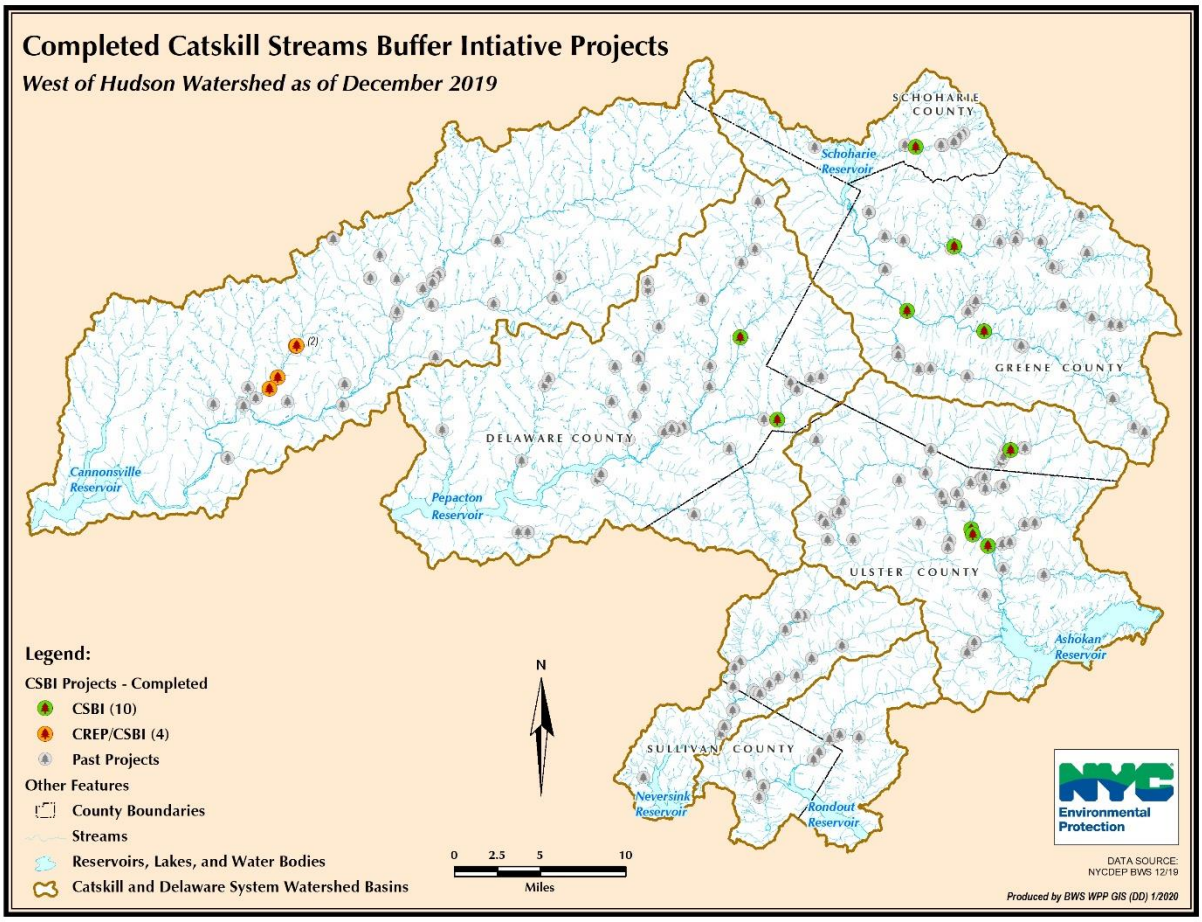

Figure 4.12 Locations of CSBI projects completed 2009-2019.

Starting in 2017, pursuant to the FAD, the CREP and CSBI programs have worked together to assess the potential for offering partnership projects that combine the benefits of both programs (i.e., incentive payments from CREP and enhanced resources for plantings from CSBI). The two-year CREP/CSBI pilot ended in 2019. In Greene, Schoharie, and Ulster counties, CSBI coordinators continued assessing parcels and soliciting landowner interest. Although no landowners enrolled in CREP/CSBI, outreach efforts led to a CSBI project in Schoharie County and prospective CSBI projects in Greene and Ulster counties. Sullivan County identified few parcels as candidates for CREP/CSBI, so did not solicit landowners for the pilot.

In Delaware County, WAC, NRCS, and the Delaware County Soil and Water Conservation District (DCSWCD) completed plantings for the four CREP/CSBI landowners who had enrolled in 2018. WAC and DCSWCD also distributed a second landowner survey and began one-on-one outreach to interested landowners.

Finally in 2019, DEP worked with WAC, NRCS, and DCSWCD to compile and report on progress towards achieving FAD-mandated metrics that NYSDOH and USEPA approved for evaluating the CREP/CSBI pilot in Delaware County. DEP submitted the CREP/CSBI evaluation report in November 2019 and recommended a two-year extension of the current pilot to continue assessing landowner interest and whether a permanent program is needed.

4.8 Ecosystem Protection Program

4.8.1 Wetlands Protection Program

DEP protects wetlands through regulatory means, land acquisition, and multiple stewardship programs. Wetland mapping and monitoring programs provide baseline information to support these protection efforts.

Regulatory 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 Connecticut 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 2019, DEP reviewed one Town of Greenwich, CT and three NYS Article 24 wetland permit applications for activities within FAD basins. None of these involved direct wetland encroachment. Three were for proposed activities within regulated adjacent areas in the Cross River and Kensico Basins and one was for aquatic nuisance species management in the Schoharie Basin. DEP reviewed an additional 24 wetland permit applications in Croton System basins, including 15 NYS Article 24 and nine town permit applications (Figure 4.13). The majority (92%) of activities reviewed did not involve direct wetland encroachments, but were within the regulated adjacent area, or for the treatment of aquatic nuisance species. Only two of these permit applications were for permanent encroachments, with proposed impacts of 0.1 acre or less.

DEP also provided comments on the February 14, 2019, publication of the rule proposed by the USACE and EPA to define the scope of waters federally regulated under the Clean Water Act. DEP reviewed geospatial data to assess the potential impact of the proposal on the scope of federally regulated waters in the watershed. In general, DEP concluded the rule would result in less regulatory certainty for the federal regulation of streams and wetlands in the watershed than the 2015 rule it was designed to replace. DEP also reviewed a NYSDEC general permit for utilities vegetation management and a Transportation Regional General Permit drafted by the New York and Buffalo districts of the USACE pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. The latter was for work related to transportation

projects proposed by the New York State Department of Transportation (NYSDOT), the New York State Thruway Authority (NYSTA), and the New York State Canal Corporation (NYSCC).

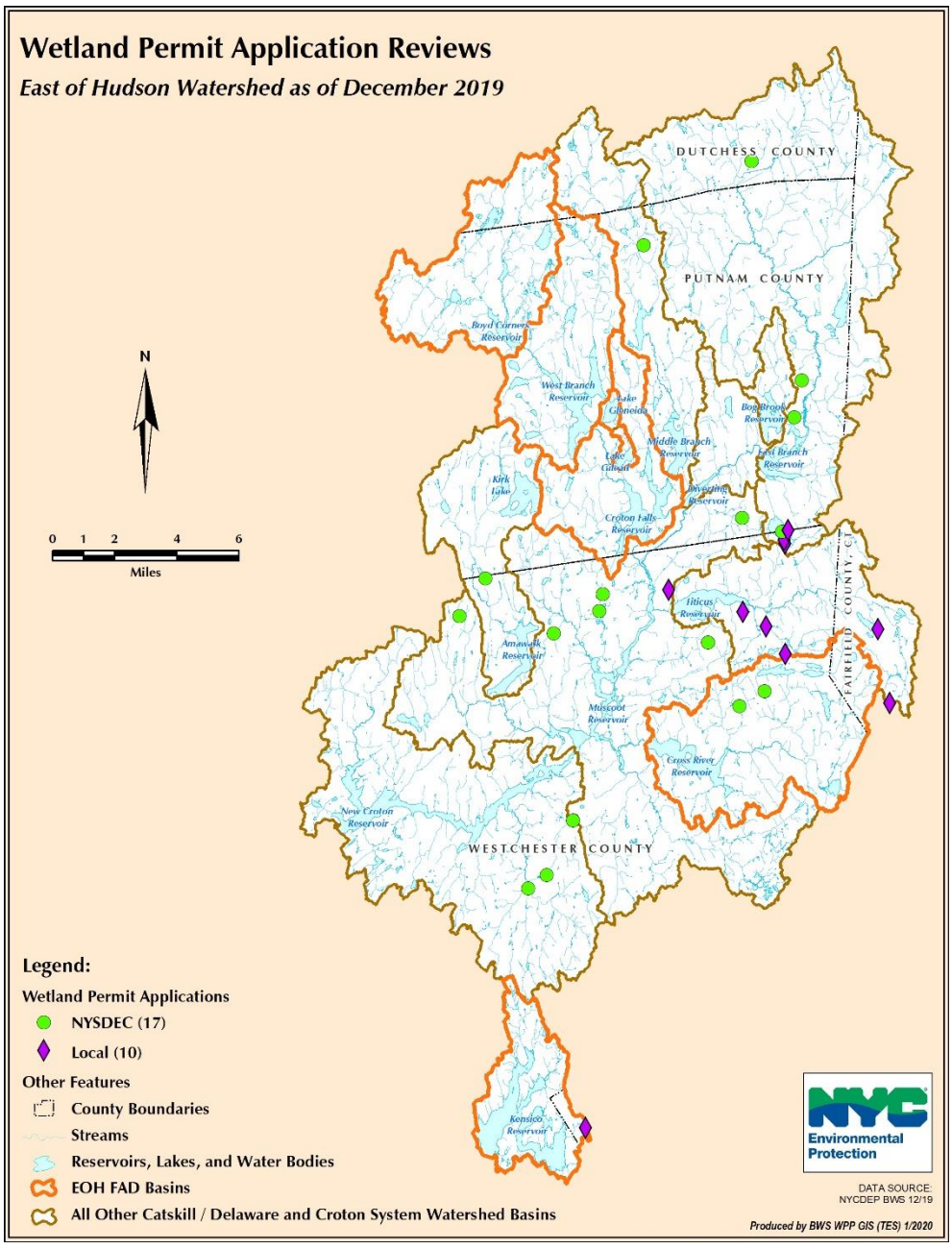

Figure 4.13 Locations of wetland permits reviewed in 2019.

Land Acquisition

According to the National Wetlands Inventory (NWI) and NYSDEC freshwater wetland maps, there are approximately 15,190 acres of wetlands in the Catskill/Delaware (CAT/DEL) watershed. Since 1997, DEP has protected 3,014 acres or 19.8% of these wetlands through its Land Acquisition Program, 50 acres of which were acquired in 2019 (See Section 4.2 for details of the Land Acquisition Program). In the CAT/DEL watershed, pre-MOA DEP lands contain an additional 968 acres (6.4%) of wetlands, with an additional 1,275 acres (8.4%) of wetlands located on state or other protected lands. This amounts to roughly 35% of wetlands in the CAT/DEL watershed being located on protected lands. Table 4.10 summarizes the acreage of wetlands protected through acquisition for both the CAT/DEL and Croton watersheds.

Wetland Mapping

In 2019, DEP awarded a contract to expand the Light Detection and Ranging (LiDAR) wetland mapping pilot study to the entire watershed as required by the 2017 FAD. The pilot study demonstrated that incorporating LiDAR-derived datasets and high resolution aerial photography in object-based image assessment increases the completeness and accuracy of wetland mapping. The pilot also developed methods to improve detection and mapping of connections between wetlands and stream features in the National Hydrography Dataset. Improving the accuracy and completeness of wetland maps will benefit the implementation of many watershed programs, from providing better base maps for reviewing wetland permit applications and other land use proposals to identifying parcels with significant wetlands for acquisition. These data will also provide a new baseline for wetland trends analyses.

Wetland Monitoring

DEP gains information on the characteristics and functions of watershed wetlands through its long-term reference wetland monitoring program. DEP has collected vegetation, soils, and hydrologic data from 19 reference wetlands comprising 117 acres throughout the CAT/DEL watershed for over a decade. These data provide reference standards to guide wetland protection and management efforts.

DEP forged a partnership in 2019 to help develop and apply New York Natural Heritage Program's (NYNHP) wetland conditional and functional assessment methodology in the watershed. This partnership will support DEP's goal to enhance its wetlands monitoring program, generate metrics from watershed wetlands that are comparable with statewide NYNHP values, and contribute to NYNHP's database as it further develops tools to guide wetland protection and stewardship. Conditional and functional assessment tools can help prioritize wetlands for enhanced protection, identify restoration opportunities and performance targets, and provide benchmarks for evaluating trends.

Table 4.10 Wetlands and deepwater habitats acquired or protected by the NYC Land Acquisition Program in the Catskill/Delaware and Croton systems as of December 31, 2019*

Description	*Acres*	*% of Total Watershed Acreage*	*% of Total Land Acquired*	*% of Total Wetlands/ Deepwater Habitats in System*
For Catskill/Delaware (Ashokan, Schoharie, Rondout, Neversink, Pepacton, Cannonsville, West Branch, Boyd Corners, Kensico basins):				
Total Acreage of Entire Watershed	1,048,660			
Total Acreage of Wetlands (both NWI and DEC-regulated) in Entire Watershed (excluding Deepwater Habitats**)	15,190	1.45%		
Total Acreage of Deepwater Habitats in Entire Watershed	28,335	2.70%		
Total Acreage of Wetlands and Deepwater Habitats in Entire Watershed	43,526	4.15%		
Total Lands Under Contract or Closed by NYCDEP as of 12/31/19†*:	151,449	14.44%		
Within those total lands under contract or closed:				
Total Acreage of Wetlands (both NWI and DEC-regulated, excluding Deepwater Habitats**)	3,014		1.99%	19.84%
Total Acreage of Deepwater Habitats**	200		0.13%	0.71%
Total Acreage of Wetlands and Deepwater Habitats**	3,215		2.12%	7.39%
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 12/31/19†*:	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, 2019. 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 farm easements. Excludes non-LAP and pre-MOA land.

Statistics produced by T. Spies, BWS WPP GIS, 1/24/2020

NYNHP's wetland conditional assessment methodology is comprised of a three-tiered approach. Level 1 is a statewide Landscape Conditional Assessment (LCA) GIS model that generates a score for wetland areas (or any polygon) summarizing cumulative anthropogenic stressors based on statewide development, transportation, and land use-land cover themes. Level 2 is a rapid assessment method of wetland stressors using basic photo interpretation and wetland and buffer field reconnaissance surveys. Level 3 is a fine scale assessment that uses quantitative vegetation sampling to capture floristic diversity and quality through a number of metrics such as coefficients of conservatism and floristic quality assessment indices (https://www.nynhp.org/epa-wetland-condition). In 2019, DEP calculated Level 1 LCA metrics for each of its reference wetlands using NYNHP's statewide model, conducted Level 2 surveys at a subset of eight reference sites, and calculated Level 3 floristic metrics for all reference sites using previously collected data (Figure 4.14).

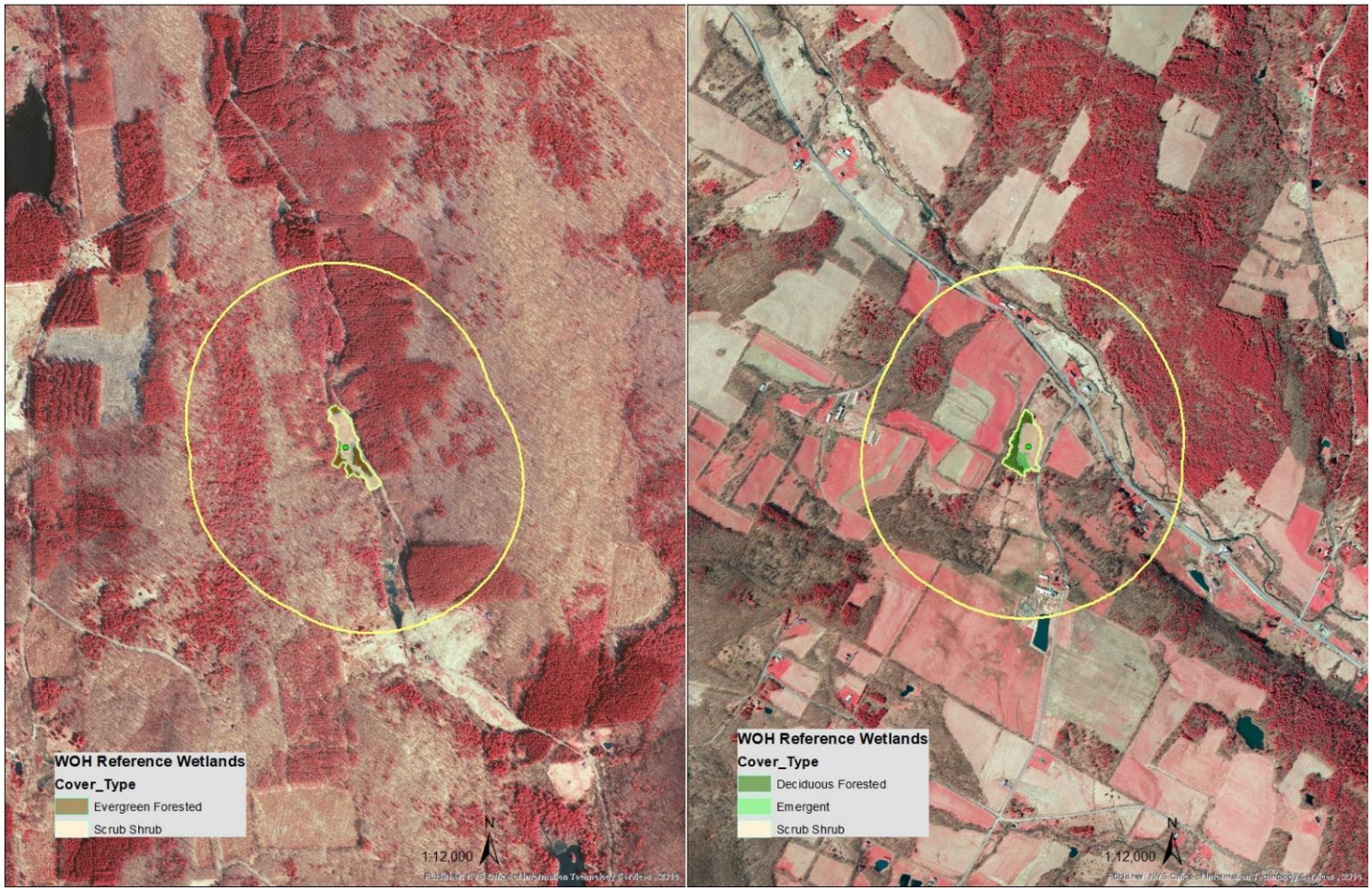

Figure 4.14 Surrounding landscape of reference sites CSB and SMS in the Cannonsville and Schoharie basins. CSB has a mean LCA score of 80 for its surrounding buffer area, while SMS's higher score of 740 reflects the higher buffer disturbance shown in the figure.

In 2019, DEP installed monitoring wells in four poor fens to be added to the reference wetland monitoring program. These peat-accumulating headwater wetlands have extremely low LCA scores, indicating low disturbance and potentially very high floristic quality to provide a benchmark of reference condition. DEP also added six new seasonal pool study sites to the reference wetland monitoring program. The program now includes 17 pools located in the Ashokan, Schoharie, Cannonsville, and Pepacton reservoir basins. Locations of DEP's current vegetated wetland and seasonal pool sites are shown in Figure 4.15.

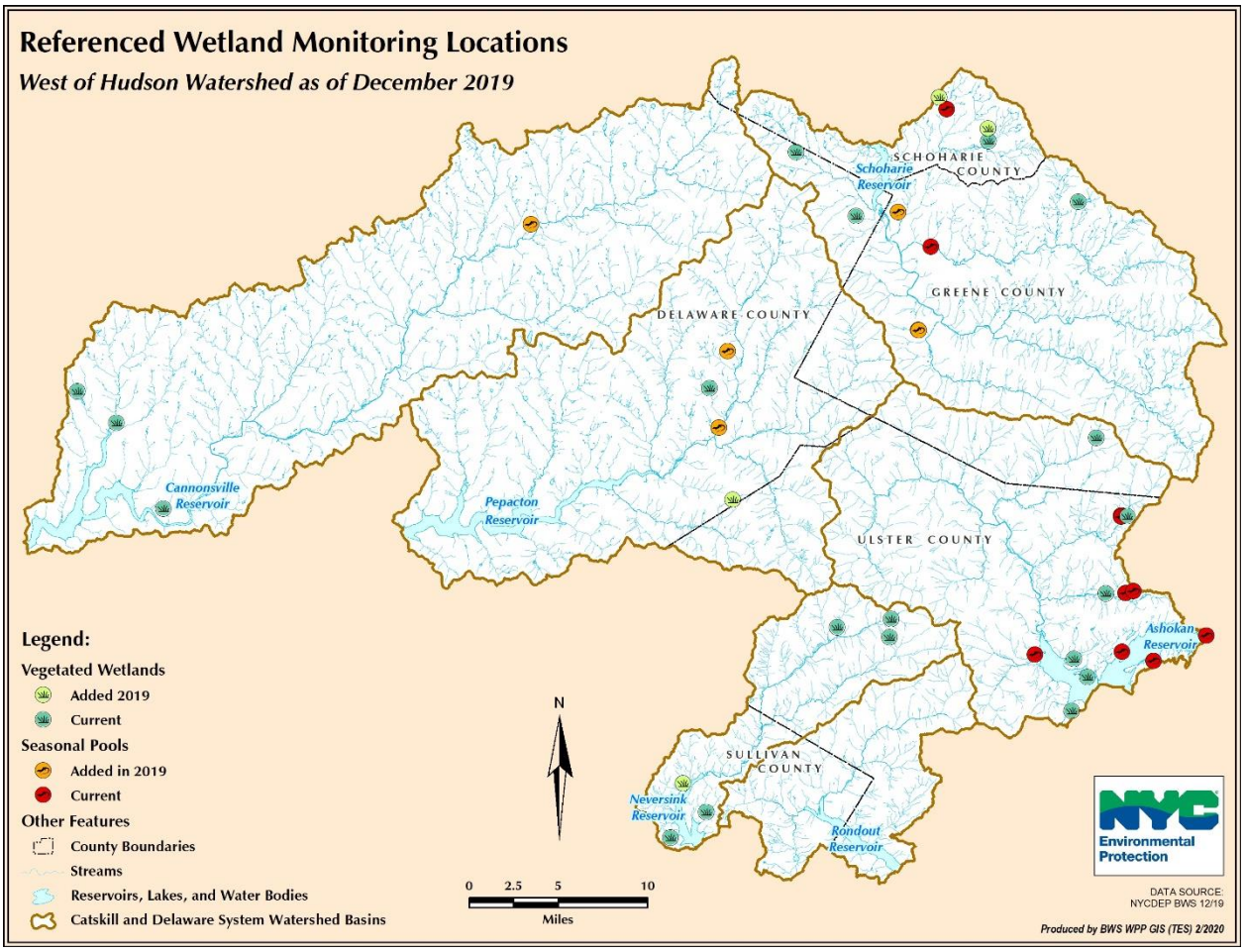

Figure 4.15 Reference wetland and seasonal pool monitoring locations in the CAT/DEL watersheds.

DEP also continued to collect 6-hour-interval water level data from 32 wells located in reference vegetated wetlands and seasonal pools throughout the CAT/DEL watershed in 2019. DEP also collected water quality data (pH, dissolved oxygen, temperature, and specific conductivity) from seasonal pool sites throughout the growing season. Spring adult breeding amphibian and invertebrate surveys, and amphibian egg mass counts were also conducted at

seasonal pool sites. DEP also conducted its first seasonal pool invertebrate surveys in 2019, as part of its ongoing effort to develop biotic indicators for assessing wetlands and pools in the watershed (Figure 4.16).

Figure 4.16 Invertebrate sampling at a seasonal pool in the Ashokan Basin.

DEP Forest Management Program

DEP conducts an interdisciplinary review of its proposed forest management projects to ensure long-term responsible stewardship of natural and cultural resources on City lands. 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 2019, DEP delineated 58 wetlands comprising 37 acres at eight 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 and hosted a wetlands pop-up educational

event at the Ashokan Reservoir for National Wetlands Month in May and lead a wetlands walk on the Ashokan Rail Trail. Wetlands program staff also presented findings from mapping and monitoring programs at the annual conferences of the New York State Wetlands Forum and the Society of Wetland Scientists, the Watershed Science and Technical Conference, and in a webinar hosted by the New England Interstate Water Pollution Control Commission. Staff attended the World Fishing & Outdoor Exposition at Rockland Community College, where 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 foresters, a data coordinator and a program manager. Six of the 11 forester positions were added to the organization in the fourth quarter of 2017. 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. However, salvage, stewardship and restoration projects are involved as well. The overall goal is to promote forest vigor, resistance, and resiliency to protect and enhance water quality over the long term.

In 2019, the program successfully awarded seven new forest management projects (FMPs). Table 4.11 lists each project, its respective basin, and area of the project.

Table 4.11 Awarded forest management projects, 2019

Project Name	Basin	Acres
Conklin Heights	Neversink	152
Ulster Heights	Rondout	57
Bear's Den	Cannonsville	161
Turkey Mountain	New Croton	147
Horsepound Ridge	West Branch	128
Damsite	Ashokan	120
Blind Miller	Ashokan	128
Total		**893**

The program also substantially completed the planning and internal review of 10 additional projects that will be bid out in 2020. (Table 4.12)

Table 4.12 2019 Forest Management Projects – Internal Review Substantially Complete

Project Name	Basin	Acres
Missing Jar	Ashokan	61
Hill & Dale	Schoharie	80

Project Name	Basin	Acres
Southslope	Schoharie	371
Aden Hill	Neversink	327
Hollow Brook	Neversink	137
Church Hill Rd	West Branch	55
Bailey Brook	Boyd's Corner	85
Heavy Nettle	Cannonsville	181
Neale Hollow	Pepacton	210
Carpenter's Eddy – Phase 1	Cannonsville	154
Total		**1,661**

A non-native invasive insect, the emerald ash borer (EAB) continued to spread westerly through the Cat/Del watershed system and affect all ash trees, which comprise 7% of City-owned forestland. Due to the rate of EAB spread, DEP continues to implement a mitigation strategy as opposed to management. The strategy focuses on identifying dense stands of ash to prioritize for harvest projects, and reducing the potential public health and safety risk caused by the decline and death of roadside and recreation area ash trees on City lands.

One such example is the completed Road X FMP in the Town of Neversink, Sullivan County. Located east of the Neversink Dam and along State Route 55 and Shields Road (Road X), this 307-acre site contained over 80,000 board feet of ash succumbing to infestation. The site also included hemlock trees impacted by the invasive hemlock woolly adelgid. Over half of the sale's total volume came from these two tree species. (Figure 4.17 and Figure 4.18)

Despite this discouraging forest health scenario, past treatment in the 1990s by the Forestry Program left the site with an otherwise diverse, vigorous, multi-layered forest. Beyond those mostly ash areas, thinning was prescribed to provide additional growing space. Hemlock trees with the fullest crowns were retained with the hope they persist.

On a more positive note, an extended cold snap in the 2018-2019 winter caused high adelgid mortality. Local biocontrol releases by the Cornell Cooperative Extension are intended to limit the impact of this invasive pest. In areas where forest pest and disease issues challenge City lands, like Road X, the Forestry Program considers treatments that mitigate these impacts and lead to a more resilient future forest condition.

Figure 4.17 A thinned hemlock-hardwood stand inside the Road X FMP.

The program continued the administration and oversight of a watershed-wide forest inventory and analysis contract with LandVest, Inc. The contract was awarded in 2018 and is anticipated to be completed by June 2020. The contract's purpose is to sample 3,000 forest inventory plots distributed across 29,894 acres of newly acquired properties, summarize and present the findings. From May to November 2019, LandVest, Inc. was measuring the remainder of the prescribed sample plots (2,426). All field measurements and sampling were completed by December 2019. The project is currently in the analysis phase.

Continuous Forest Inventory

Since 2002, DEP has been establishing and measuring permanent forest plots across New York City water supply lands to collect data to deepen our understanding of forest health, diversity and productivity, and changes that occur over time. This data contributes to development of data summaries, formulae and models that perform the following:

- Enable prediction of forest growth, mortality and recruitment of new seedlings into the forest over time.
- Allow estimation of merchantable tree heights or timber volumes from diameter measurements.
- Improve generation of acceptable construction project seed mixes and plant palettes that are based on regional vegetation patterns.

- Increase understanding of forest-habitat relationships.
- Verify whether applied silviculture techniques are contributing to achieving goals of increasing diversity in and among stands related to species, size classes, ages, etc.

Such long-term ecological assessment studies are necessary to guide decisions that will ultimately lead to healthy, managed, resilient, diverse forests that best protect water quality.

Figure 4.18 Road X FMP log landing with EAB impacted ash trees (background) and logs (foreground).

In 2019, 14 new continuous forest inventory (CFI) research plots were established in the Cannonsville Basin on newly acquired Land Acquisition Program lands. Datasets collected on CFI plots from 2002 to 2018 were inspected for inconsistencies and corrections were made as necessary. Finally, repeated measures analyses were started using a subset of CFI datasets in order to better understand how the watershed forest is changing over time. Preliminary findings from the Pepacton, Cannonsville, and Schoharie basins highlight elevated annual mortality rates (above 2% trees/year) for certain species in each basin. Ongoing analyses are investigating the potential factors contributing to the observed mortality, such as climate, soils, landscape position, tree-to-tree competition, and demographics. The developed tree mortality models will assist in predicting locations of future tree mortality. Additional planned analyses will determine the rates of forest structural and compositional change to determine forest functioning, and highlight areas of concern in the watershed forest.

4.8.3 Invasive Species

In 2019, DEP continued to implement the Invasive Species Management Strategy submitted as a FAD deliverable at the end of 2016. The strategy outlines actions to prevent new introductions of invasive species; to detect new infestations early and respond to them rapidly; to control and manage existing populations to support specific projects; to mitigate the impacts of species that cannot be otherwise managed; and to restore sites to prevent further impacts. This work is predominantly accomplished through intra-agency collaboration and partnerships.

Intra-Agency Collaboration

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 twice in 2019 and the sub-committees to develop a policy for managing reservoir firefighting operations continued to meet. The ISWG discussed ongoing projects and updates, environmental DNA to monitor for aquatic invasive plants throughout the Catskills, and potential invasive species impacts from firefighting activities. The group also discussed new projects for the development of a protocol to assess invasive species treatment projects, support hemlock woolly adelgid (*Adeliges tsugae*) biological control and conduct invasive species treatments year-round.

Partnerships

New York State Invasive Species Advisory Committee

DEP has a seat on the New York State Invasive Species Advisory Committee (ISAC), which was created through state 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 2019, DEP's representative served as vice chair of the committee. The ISAC covered such topics as aquatic invasive species spread prevention; the arrival of the Asian longhorned tick (*Heamaphysalis longicornis*) and other species; and the new NYS Invasive Species Comprehensive Management Plan. DEP attended three ISAC meetings in 2019.

Catskill Regional Invasive Species Partnership

DEP continued to work regionally with partners on invasive species management in the Catskill region. In 2019, DEP worked with the Catskill Regional Invasive Species Partnership (CRISP) to develop a management plan for the Ashokan Rail Trail. DEP participated in CRISP quarterly meetings, served on the steering committee, helped prioritize a species list, and aided in decision-making on project funding.

Lower Hudson Partnership for Regional Invasive Species Management (PRISM)

DEP continued to partner with the Lower Hudson PRISM and NYSDEC to survey for giant hogweed (*Heracleum mantegazzianum*) within the watershed. Due to the risk of serious injury and blindness, the state has been working to eradicate giant hogweed since 2008. No

plants were found for the second consecutive year on City lands in the Croton Falls Reservoir basin in the Town of Carmel. These sites will continue to be monitored for two years before achieving an eradication designation. DEP and the Lower Hudson PRISM are also partnering on the removal of silver vine (*Actinidia polygama*), an early detection species for New York State that crosses City and private lands. DEP served on the steering committee for the PRISM and facilitated working groups for capacity building tasks.

Prevention and Pathway Risk Management

Policies are one tool DEP employs to prevent the introduction of invasive species. Traditional firefighting operations were identified in 2018 as another potential vector through the drafting of water for tankers. In 2019, an ISWG subcommittee exploring a policy to address this made progress on gathering information from local fire departments.

To minimize the risk posed by watershed recreation users, DEP engages in education and outreach activities to share prevention messages. In 2019, DEP provided outreach on invasive species to the YMCA Camp Seewackamano and staffed pop-up outreach tables at the Ashokan Promenade for the state's Invasive Species Awareness Week.

Early Detection and Rapid Response

In addition to partnering with the Lower Hudson PRISM on the giant hogweed and silver vine responses, DEP initiated several other rapid response efforts to attempt to eradicate early detection species.

In 2019, DEP continued treating the infestation of *Hydrilla* in New Croton Reservoir. This pilot effort targeted populations in one isolated cove for a second year and employed two granular formulations of fluridone herbicide (Sonar H4C and Sonar One) as well as the liquid formulation (Sonar Genesis). Results show success in reducing the population with limited dispersal of the herbicide in the reservoir. But there is still a great deal of plant material in the reservoir that needs to be managed. DEP also continued to collaborate with NYSDEC on downstream management efforts in the Croton River.

For the second consecutive year, DEP controlled a small infestation of water chestnut (*Trapa natans*) in New Croton Reservoir just below the Muscoot Dam. The entire infestation was hand pulled in an afternoon by Ulster Community College interns with support from DEP Water Quality and Operations staff (Figure 4.19). This infestation has decreased from 2018.

Control and Management

DEP continued to manage priority invasive species on City lands through manual and mechanical removal, herbicide applications, and biological control in 2019. DEP awarded a contract to Cornell University to assess and improve the viability of biological control agents for hemlock woolly adelgid control. Cornell will continue to survey for the silver flies (*Leucopis* spp.) they released in 2016, 2017, and 2019 and study their impacts on hemlock woolly adelgid populations. Additional releases will be made in 2020.

Mitigation of Impacts

DEP continued to participate in a project to identify lingering ash trees in 2019. The Ecological Research Institute designed the Monitoring and Managing Ash (MaMA) project with researchers from the U.S. Forest Service. They trained 30 DEP staff and partners on the project and the protocols for identifying and surveying ash trees that may hold some resistance to emerald ash borer (*Agrilus planipennis*). DEP staff and Ulster County Community College interns monitored four ash mortality plots throughout the WOH watershed. More information about the MaMA project is available at: www.monitoringash.org.

Zebra mussels are another species that can have a significant negative impact on the water supply. DEP first received reports of mussels present in Lake Mahopac, an upstream lake that feeds the Muscoot River and Amawalk Reservoir, in 2015 and veligers were found in the Muscoot River and Amawalk Reservoir in 2018. In 2019, DEP established an enhanced monitoring program. There was a decrease in discharge from Lake Mahopac in 2019, which likely prohibited veligers from moving through the system in large numbers. However, adult mussels were still found downstream of Lake Mahopac in the Muscoot River. DEP staff are collaborating across directorates to stay on top of this infestation through expanded monitoring efforts and upgrades to water supply infrastructure.

Figure 4.19 Pulling invasive water chestnut plants from New Croton Reservoir.

Restoration

Staff continue to give attention to the reforestation project at Kensico Reservoir where Superstorm Sandy left large blowdowns in close proximity to the reservoir. Invasive species management of Japanese angelica tree (*Aralia elata*) and mile-a-minute weed (*Persicaria perfoliata*) supports the success of tree plantings. DEP created a new position in 2019 to oversee a Restoration Ecology Program. This position will be filled in 2020 and will provide support for future restoration efforts.

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 Program

Septic Reimbursement Program

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 meet the septic requirements of the NYSDEC MS4 General Permit, which obligates municipalities and counties to implement programs for the inspection, maintenance, and rehabilitation of septic systems.

DEP also continues to implement the Septic System Rehabilitation Reimbursement Program in the EOH Catskill/Delaware basins in partnership with the New York State Environmental Facilities Corporation (EFC). In 2019, DEP worked with EFC to expand program eligibility to septic systems located in basins upstream of or hydrologically connected to the Croton Falls Reservoir (i.e., Bog Brook, Diverting, East Branch, and Middle Branch). Through a direct mailing that described the program and provided contact information, EFC notified property owners in these areas of available funding. EFC also mailed the annual reminder letter to eligible residents in the EOH Catskill/Delaware basins and issued three septic reimbursements to eligible homeowners.

Community Wastewater Planning Grant Program

Pursuant to the 2017 FAD, DEP finalized and registered a contract with the New England Interstate Water Pollution Control Commission (NEIWPCC) to develop and implement the EOH Community Wastewater Planning Grant Program. DEP also commenced the initial outreach to eligible communities and offered to present information sessions to municipal officials.

Video Sanitary Sewer Inspections

DEP has established an inspection program for targeted portions of the sanitary sewer system within the West Branch Reservoir basin. These selected areas, identified as possible areas of concern over the past few years and during prior video inspection of sanitary infrastructure,

will be submitted as part of a comprehensive summary report. This report compiles the information obtained as part of the sewer pipe cleaning/video inspection/digital mapping of the sanitary lines and will be used to determine rehabilitation methods and costs. The contract to perform this service was approved by the City's Law Department in 2019 and is anticipated to commence in 2020.

4.9.2 Stormwater Retrofit and Remediation

DEP continues to advance two nonpoint source pollution reduction projects at Maple Avenue (Town of Bedford, Westchester County) and Drewville Road (Town of Carmel, Putnam County). DEP previously completed designs for both projects and awarded the construction contract to R. Pugni & Sons, Inc. During 2019, the contractor mobilized and completed shaping the basin and installing required piping, liner, and security fencing at the Drewville Road site (see Figure 4.20). The site is currently shut down for the winter. Final plantings are scheduled to for spring 2020. DEP is currently reviewing contractor submittals for the Maple Avenue site with construction expected to start in 2020.

Figure 4.20 Drewville Road stormwater basin during installation of liner

4.9.3 Stormwater Facility Inspection and Maintenance

DEP developed the Facility Inspection and Maintenance Program to ensure previously constructed stormwater remediation facilities, through routine inspections, continue to function

as designed. Maintenance is completed under the warranty in each facility's construction contract during the first year and under DEP's maintenance program contract thereafter. Inspection and maintenance follow procedures contained in the maintenance contract. During 2019, DEP inspected all facilities approximately three times each, with 60 facilities requiring vegetation removal, 55 requiring sediment and debris removal, 10 requiring seed and mulch, 10 requiring tree removal, and 23 requiring stone riprap repairs. All stormwater facilities are functioning as designed.

4.9.4 Stormwater Retrofit Grant Program

DEP previously established a grant program funded through the EOH Watershed Corporation (EOHWC) for eligible municipalities to construct the stormwater retrofits needed to satisfy municipal permit obligations under Section IX.A.5.b of the NYSDEC MS4 General Permit. The 2017 FAD required DEP to provide the EOHWC with an additional $22 million to continue to support construction of stormwater retrofits in the EOH FAD basins. During 2019, DEP registered the contract for this new funding and issued the first payment to EOHWC for $15 million.

4.10 Kensico Water Quality Control Program

4.10.1 Wastewater-Related Nonpoint Source Pollution Management Program

Septic Reimbursement Program

DEP implements the Kensico Septic System Rehabilitation Reimbursement Program through a contract with New York State Environmental Facilities Corporation (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. During 2019, EFC mailed the annual reminder letter to all eligible residents. EFC issued one septic reimbursement to an eligible homeowner.

West Lake Sewer

The West Lake Sewer Trunk Line, owned and maintained by the Westchester County Department of Environmental Facilities, 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. To date, there have been no overflows or concerns and the units appear to be working well. In 2019, DEP conducted an annual visual inspection of the trunk line to assess the condition of exposed infrastructure and routine partial inspections throughout the year related to ongoing maintenance of Kensico stormwater BMPs near the line. DEP noted no defects or abnormalities.

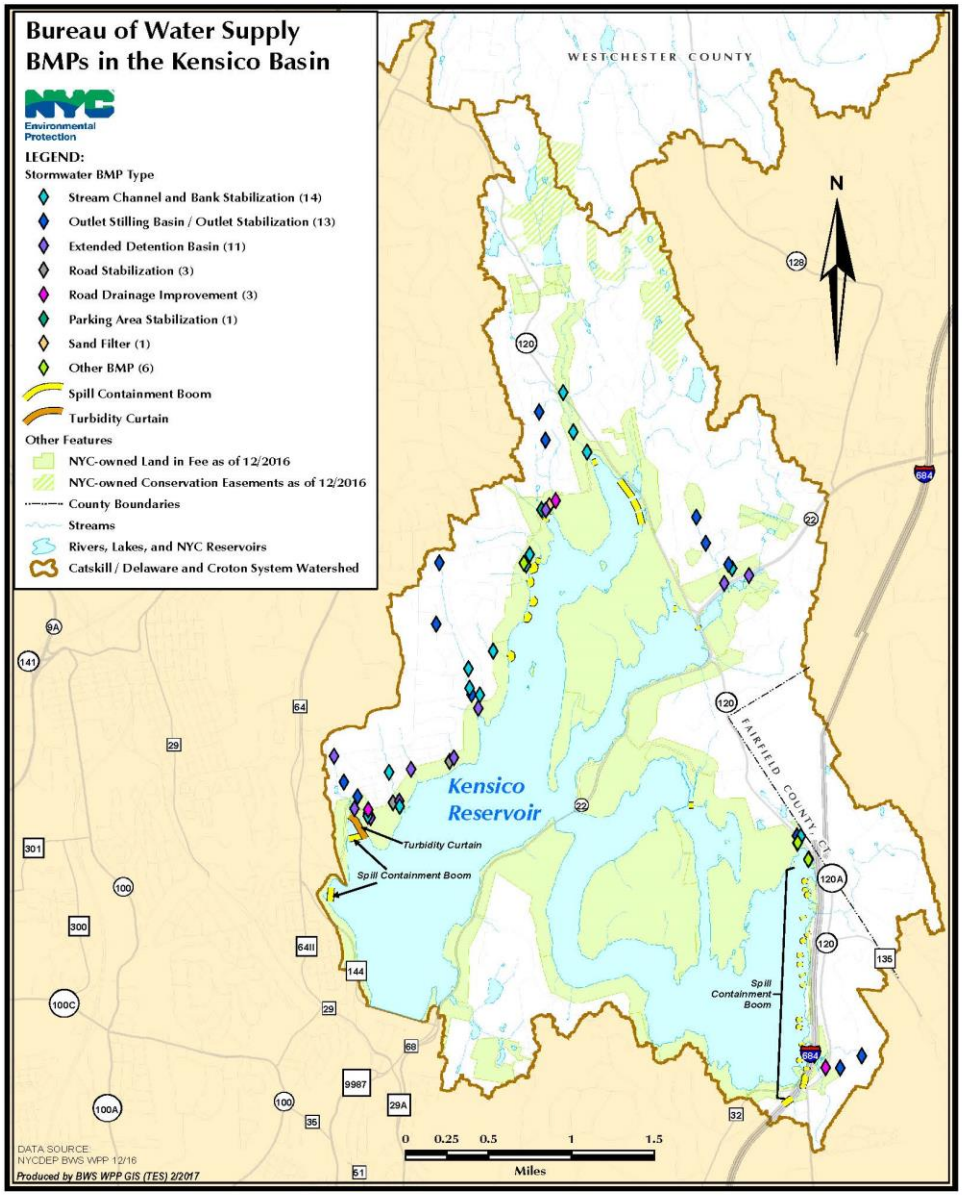

Figure 4.21 BMPs within the Kensico Reservoir Basin.

Video Sanitary Sewer Inspection

DEP has established an inspection program for targeted portions of the sanitary sewer system located within the Kensico basin. These selected areas, identified as possible areas of concern during prior video inspection of sanitary infrastructure in the Kensico basin, will be submitted as part of a comprehensive summary report. This report compiles the information obtained as part of the sewer pipe cleaning/video inspection/digital mapping of the sanitary lines. The report will be used to determine rehabilitation methods and costs. The contract to perform

this service was approved by the City's Law Department in 2019 and is anticipated to commence in 2020.

4.10.2 Stormwater-Related Nonpoint Source Pollution Management Program

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 its contractor inspected and maintained these facilities, shown in Figure 4.21, throughout 2019, according to the O&M guidelines. Maintenance consisted of mowing, vegetation removal, tree removal, and sediment and debris removal. All BMPs are performing as designed.

Wildlife Sanitary Survey

DEP conducts wildlife sanitary surveys to prevent wildlife excrement from washing into the Kensico Reservoir and potentially elevating levels of fecal coliform bacteria. DEP has identified sampling locations based on proximity to Delaware Aqueduct Shaft 18, which are surveyed approximately 24 to 48 hours prior to significant precipitation events. DEP developed a system of locating, identifying, and removing wildlife excrement as a proactive effort to reduce fecal coliform bacteria and other pathogens from potentially entering the water supply.

During 2019, DEP and its contractor conducted 17 wildlife sanitary surveys in advance of significant precipitation events at Kensico Reservoir (Table 4.13). Of the 499 fecal samples collected, 40% were attributed to white-tailed deer (*Odocoileus virginianus*), 17% to rabbits (*Sylvilagus* spp.), 2% to raccoons (*Procyon lotor*), and approximately 5% to other mammals. Avian species excrement included 19% from Canada geese (*Branta canadensis*) and 16% from passerine bird species.

Table 4.13 Kensico Reservoir 2019 wildlife sanitary surveys.

Date of Survey	White-tail Deer	Raccoon	Rabbit	Canada Goose	Coyote	Fox	Mink	Striped Skunk	Passerine (birds)	Domestic Dog	Mallard Duck	Meadow Vole	Other/ Unknown Mammal	Total (all species)
1/17/2019	39	0	0	0	0	0	0	0	0	0	0	0	0	**39**
1/23/2019	26	0	9	0	0	0	0	0	0	0	0	0	0	**35**
2/11/2019	47	0	0	0	0	0	0	0	7	0	0	0	6	**60**

Date of Survey	White-tail Deer	Raccoon	Rabbit	Canada Goose	Coyote	Fox	Mink	Striped Skunk	Passerine (birds)	Domestic Dog	Mallard Duck	Meadow Vole	Other/ Unknown Mammal	Total (all species)
1/23/2019	36	0	0	0	0	0	0	0	2	0	0	0	2	**40**
3/20/2019	18	1	5	0	1	0	1	0	0	0	0	0	6	**32**
4/5/2019	6	3	4	33	0	0	0	0	0	0	0	0	0	**46**
4/19/2019	3	1	1	1	0	0	0	0	0	0	0	0	0	**6**
5/3/2019	0	0	0	45	1	0	0	0	0	1	1	0	0	**48**
7/16/2019	4	2	0	18	0	0	0	0	64	0	0	0	2	**90**
10/7/2019	1	1	4	0	0	0	0	0	0	0	0	0	0	**6**
10/15/2019	2	2	0	0	0	0	0	0	0	0	0	0	1	**5**
10/30/2019	3	0	1	0	0	0	0	0	5	0	0	0	0	**9**
11/22/2019	6	0	8	0	0	0	0	0	0	0	0	0	1	**15**
11/29/2019	0	0	6	0	0	0	0	0	0	0	0	0	0	**6**
12/8/2019	6	0	16	0	0	0	0	1	0	0	0	1	0	**24**
12/13/2019	0	0	9	0	0	0	0	0	0	0	0	0	1	**10**
12/28/2019	2	0	24	0	0	1	0	0	0	0	0	1	0	**28**
Total by species	**199**	**10**	**87**	**97**	**2**	**1**	**1**	**1**	**78**	**1**	**1**	**2**	**19**	**499**

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 2019, DEP conducted routine maintenance at the spill boom sites to ensure they are available in the event of a spill. There were no spills that required the deployment of booms in the Kensico Reservoir. However, in March an unknown amount of diesel fuel spilled into a drain inlet that empties into a Kensico tributary. The fuel was contained and removed using hydrocarbon absorbent pads in the drain inlet and hydrocarbon absorbent booms in the Kensico tributary.

Shaft 18 Shoreline Stabilization

Since the Catskill/Delaware Ultraviolet Disinfection Facility (CDUV) began operating, all water in the Kensico Reservoir flows through Delaware Shaft 18 on the reservoir's southeast

shore. Increased reliance on Shaft 18, together with changing weather patterns, necessitates shoreline stabilization measures near the effluent chamber to maintain turbidity levels complying with state and federal water quality standards. Stabilization measures will include approximately 700 feet at the western shoreline and approximately 475 feet at the cove area. DEP previously awarded the contract to H&L Construction. In 2019, the contractor mobilized and began work at the cove location. Work to date includes clearing and grubbing, construction of sediment control measures and access road, and installation of the sheet pile cofferdam. DEP anticipates work will continue at the cove location and commence at the western shoreline location in 2020.

4.10.3 Other Kensico Management Programs

Turbidity Curtain

In 2019, DEP continued to monitor and inspect the extended primary curtain and the back-up turbidity curtain that are designed to direct flows from Malcolm and Young brooks farther into the body of Kensico Reservoir. No immediate repair work was required and the curtains appear to be functioning as intended.

Effluent Chamber Dredging

DEP continues to evaluate the potential need for dredging in relation to the construction of the connection between Kensico Reservoir and the CDUV. As noted in previous FAD reports, DEP anticipates completing this evaluation in 2020.

Westchester County Airport

DEP continues to review activities proposed at or in relation to the Westchester County Airport due to its proximity to Kensico Reservoir; including the Park Place development project, a 980-space multilevel parking garage proposed at 11 New King Street. DEP deemed the Stormwater Pollution Prevention Plan (SWPPP) application complete in February 2019 and subsequently issued technical comments in March 2019. DEP is awaiting submission of a revised SWPPP.

Based on news articles published in May 2019, it is DEP's understanding that Westchester County officials are ready to supplement the Airport Master Plan and environmental impact study. In line with 2018 public meetings, a request for proposals (RFP) has been issued to further study economic impacts, environmental concerns and overall safety at the airport. The RFP is to address significant issues associated with noise, air and water, and it will supplement the master plan by exploring additional alternatives for improved safety and performance and reduced environmental impacts. The project lead selected via the RFP process will prepare appropriate environmental review analysis and documentation in accordance with the New York State Environmental Quality Review Act (SEQRA). The environmental review will identify and

evaluate all potentially significant environmental impacts and proposed mitigation resulting from the implementation of the specific components of the Airport Master Plan. Additionally, the county will be issuing a separate RFP for a consultant to focus on public engagement related to the development of this master plan supplement

Pursuant to the state's emerging contaminants program, NYSDEC continues to investigate an uncapped landfill located on airport property near an unnamed tributary to Kensico Reservoir. It is DEP's understanding that NYSDEC and Westchester County officials continue to work cooperatively on a proposed site characterization work plan and, ultimately, a remediation plan.

In addition, Westchester County submitted a site characterization work plan to the state to assess PFOS, PFOA and other groundwater contaminants on and near the county airport in response to a May 2019 NYSDEC Consent Order. The county has also prepared a draft interim remedial measures work plan to address any impacted potable water supply wells in the area. Additionally, to facilitate further assessment and remediation, Westchester County has formally applied for acceptance into New York State's Brownfield Cleanup Program.

In 2019, DEP completed a study of the presence of emerging contaminants at certain locations in the water supply system, including Kensico Reservoir. The study focused on more than 140 contaminants, which were sampled quarterly during the year and analyzed using ultra-low concentration methods. The suite of contaminants tested included several perfluorinated compounds. DEP detected perfluorinated compounds in samples collected from small streams in the Kensico watershed, with the highest concentrations found near the Westchester County Airport. All samples taken at the intake at Kensico Reservoir were non-detect for all perfluorinated compounds. All sample results from this study are available on the DEP web site at https://www1.nyc.gov/assets/dep/downloads/pdf/water/water-monitoring/monitoring-for-contaminants/2019-q1-emerging-contaminants-monitoring-project.pdf.

4.11 Catskill Turbidity Control

4.11.1 Implementation of Catskill Turbidity Control Alternatives

Due to the nature of the 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.

National Academies Expert Panel Review

In September 2016, the National Academies of Sciences, Engineering and Medicine (NASEM) 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 final report was released on September 25, 2018 (https://www.nap.edu/catalog/25218/review-of-the-new-york-city-department-of-environmental-protection-operations-support-tool-for-water-supply). The expert panel strongly endorsed OST for guiding the operation of NYC's water supply, managing risks such as droughts and turbidity events, and planning for the future effects of climate change.

The NASEM provided a total of 21 individual recommendations, from the very technical to the very general. DEP has completed implementation of most of them, such as updating the input data to OST to include more recent years and conducting more data analysis to show the overall effectiveness of the Catskill Turbidity Program. This analysis was summarized in a March 2019 FAD deliverable entitled "Final Revised Performance Measures/Criteria for Evaluating the Efficiency of Catskill Turbidity Controls." A couple of recommendations required action by the National Weather Service and these are discussed in the next section. Finally, DEP concluded that several recommendations are not feasible, such as utilizing ensembles of different hydrologic models due to the intensive effort required to develop, calibrate, and verify hydrologic watershed models. Overall, this review was extremely helpful to DEP in our continued development and utilization of OST.

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.

During 2019 DEP continued with OST enhancements to better reflect current water supply system rules and status and elevate OST flexibility to provide modeling support for various applications. The enhancements included:

- Extended OST input flow time series (here after named "inflow file") from 2012 through September 2017. This inflow file extension is particularly important when using the model to support planning. This extension was also in response to National Academy of Science, Engineering and Medicine (NASEM) OST Expert Panel recommendations.
- DEP worked with the National Weather Services (NWS) to extend the number of traces for the HEFS (Hydrological Ensemble Forecast System) ensemble forecast from 38 to 53. OST relies on HEFS ensemble forecasts when used to support operations on a daily basis. The new ensemble includes hydrological information from 1960 to 2012.
- DEP started working with NWS, through its Northeastern and Middle Atlantic River Forecast centers, to develop post-processed ensemble forecasts for all OST forecast locations.
- DEP added three new nodes in the Delaware River Basin portion of the model: Lordville, Hancock and Bridgeville. The first two locations will support thermal release modeling which is an important component of the 2017 FFMP. Bridgeville is important for the OST inflow file development.
- DEP staff installed new OST test and production servers. The two servers are now operational.
- A new baseline run was created to provide modeling work to support the Rondout-West Branch Tunnel outage. This run built upon the 2018 updated version to include the most recent adjustments to better reflect system operations, CATALUM updates, as well as other model updates in the Delaware River Basin by the Delaware River Commission (DRBC). With these updates, OST will continue reflecting the current water supply system status and rules and provide necessary flexibility to support multiple infrastructure projects. At the same time, it will continue to be synchronized (produce similar model output) with the DRBC Planning Support Tool.
- DEP staff developed a version of a Volume Projection model. Starting with the system's current status, this software tool allows water supply operators to enter changes in diversion and releases out of reservoirs and receive first indication of the

system response, in terms of reservoir storage. This screening tool is often used to select operational scenarios that are subsequently run through OST.

During 2019, DEP's focus continued to be on using OST to support operational decision-making and planning, including the simulation and analysis to support daily operations during the Catskill Aqueduct outage, modeling to support the Schoharie outlet simulations and decision-making, as well as modeling to support the Shandaken Tunnel fall outage. Standard modeling practices, such as ongoing evaluation of model performance, forecast verification, and fine-tuning of model code and algorithms, were performed. Over 1,320 model runs were executed in 2019, underscoring the continued value and purpose of OST for water supply operations and management.

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 Influent 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 took into consideration feedback from the public review process and includes responses to the comments received. The EIS is underway, and a draft DEIS was submitted to NYSDEC on May 30, 2019.

5. Watershed Monitoring, Modeling and GIS

5.1 Watershed Monitoring Program

5.1.1 Routine Water Quality Monitoring

To ensure the delivery of high quality drinking water, DEP conducts extensive water quality monitoring encompassing all areas of the watershed, including sites at aqueducts and water supply intakes (keypoints); streams; reservoirs; and wastewater treatment plant (WWTP) facilities. DEP's monitoring objectives for 2019 are documented in the Watershed Water Quality Monitoring Plan (WWQMP) (DEP 2018) and its associated addenda, which are designed to meet the broad range of DEP's regulatory and informational requirements. 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 plan prescribes monitoring to achieve compliance with all federal, state, and local regulations; meet the terms of the 2017 FAD (NYSDOH 2017); 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. Many specific objectives fall within each of 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 enhancements, the New York City Watershed Rules and Regulations (WR&R) (DEP 2019), administrative orders, and State Pollutant Discharge Elimination System (SPDES) permits. The sampling sites, analytes, and frequencies are defined in each objective according to each permit, rule, or regulation.

FAD program evaluation: The 2017 FAD requirements form the basis for the City's ongoing assessment of watershed conditions, changes in water quality, and any modifications to the strategies, management, and policies of the Long-Term Watershed Protection Program (DEP 2016b). The City also conducts a periodic assessment of the program's effectiveness using DEP's water quality monitoring data. Program effects on water quality are reported in the Watershed Protection Program Summary and Assessment reports (e.g., DEP 2016c), which are produced every five years.

Modeling support: Modeling data are used to meet the long-term goals for water supply policy and protection and to 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 2019 activities are summarized in the Watershed Water Quality Annual Report.

Surveillance monitoring: The surveillance monitoring chapter of the WWQMP contains several objectives that focus on aqueduct monitoring to guide the short-term operation of the water supply system. 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. Zebra mussel monitoring is meant to trigger actions to protect the infrastructure from becoming clogged by these organisms if they are found. 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 proactively pursue appropriate actions.

5.1.2 Additional Water Quality Monitoring

In addition to routine monitoring, events or incidents may occur that necessitate additional water quality monitoring. Almost 1,600 additional watershed samples were collected for special investigations during 2019, including 336 stream samples, 828 reservoir samples, and 156 pathogen samples.

These special investigations (SIs) include monitoring related to the activation of the Croton Water Filtration Plant; testing effectiveness of an ultrasonic algal control project; implementation of an invasive species control project; activation of the Croton Falls and Cross River pumping stations; Kensico Shoreline Stabilization Project; elevated *Giardia* levels at Rondout Reservoir; and other smaller, less intensive monitoring events. The major 2019 SI efforts are outlined below.

Special Investigation: Croton Filtration Plant Activation

Due to both the planned shutdown of the Catskill Aqueduct in November and to help minimize the drawdown of Kensico and West Branch reservoirs, the Croton Water Filtration Plant (CFP) began delivering water to the City's distribution system in October 2019. CFP flow reached a maximum of 290 MGD in November. However, some consumers began registering taste and odor complaints with DEP, describing a musty/earthy odor. DEP addressed these complaints by gradually reducing CFP flow in late November through late December, when the

CFP was finally shut down. To support CFP operation, enhanced water quality monitoring of Croton system keypoints at the Croton Lake Gatehouse (mid-basin) and Gatehouse 1 (dam), as well as increased limnological monitoring of New Croton Reservoir was performed. Additional sampling and contract analysis for the odor causing compounds Geosmin and MIB was also performed prior to and while the CFP was on line in an effort to track these compounds. Additionally, two new robotic monitoring buoys were placed at sites near the Croton Lake Gatehouse and Gatehouse 1 to enable near-real-time monitoring and support operation of the Croton Reservoir. These buoys were deployed on July 30, 2019, and collected temperature, pH, field specific conductivity, dissolved oxygen and turbidity measurements four times per day. Data were relayed via a modem connection and the buoys remained on the water and active through the rest of 2019.

Special Investigation: Ultrasonic Control of Algae

A pilot program that began in 2018 was extended for the 2019 field season. The goal of this project was to continue to evaluate the effectiveness of ultrasonic technology to minimize or reduce the presence of algal blooms. The study area was focused on Croton Falls Reservoir and the ultrasonic buoy was deployed prior to the presence of any observed bloom.

The experimental design consisted of a treatment site with the ultrasonic buoy and a control site outside of the range of the ultrasonic emitters. An YSI EXO water quality sonde outfitted with a total algae probe was deployed at both treatment and control sites and logged measurements every 15 minutes throughout the duration of the project. In addition, a BBE Moldaenke Algae Torch probe was deployed at the treatment site and it also logged measurements every 15 minutes. Water samples were collected weekly at both sites at 1 meter below the surface and 1 meter off the bottom and were analyzed for phytoplankton, chlorophyll a, total phosphorus and total dissolved phosphorus. Dissolved oxygen profiles were also collected weekly at each site. Twice monthly zooplankton tow samples were collected at each site and samples for algal toxins were collected monthly. DEP sent zooplankton and algal toxin samples to independent contract labs for analysis.

Special Investigation: Invasive Species Control

DEP conducted a special investigation for a second year to evaluate the fate and transport of an applied chemical herbicide in New Croton Reservoir for the treatment of the aquatic invasive plant, *Hydrilla*. A contractor applied fluridone (trade names SONAR Genesis, SONAR H4C and SONAR ONE) in two forms (i.e., pellet and liquid) at a select treatment area in the reservoir from May through September 2019. Four New Croton Reservoir sites were sampled to quantify the presence and extent of fluridone transport in the reservoir before, during, and after application. In addition, three keypoint sites were also monitored for the presence of the chemical. DEP collected grab samples at all sites weekly and shipped them to a contract laboratory for fluridone analysis. Monitoring continued into early October to ensure there were no detections of fluridone at any site.

Special Investigation: Croton Falls and Cross River Pump Stations

Due to the shutdown of the Catskill Aqueduct, the use of the Cross River and Croton Falls pump stations were needed to supplement the water supply in 2019. The activation of these pump stations requires preliminary sampling to determine water quality conditions and to obtain subsequent approval by NYSDOH. This sampling is performed a minimum of two weeks prior to the actual activation of the pump station and consists of daily grab sampling, weekly pathogen sampling and weekly limnology surveys. Additionally, watershed wastewater treatment plant monitoring increased during the preliminary monitoring and the use of the pump stations. For the Croton Falls Pump Station in 2019, DEP performed this sampling for a total of nine weeks to provide water quality data prior to pump station activation and during pump station use. The Croton Falls Pump Station was activated in 2019 on June 26 and from June 28-July 1 for equipment testing; then from November 11-November 15, from November 18-December 1, and from December 3-December 21 in support of the Catskill Aqueduct shutdown. The Cross River Pump Station was operated from November 19-November 20, 2019, to test functionality.

Special Investigation: Kensico Shoreline Stabilization

Due to the influence of wind on the shorelines of the Kensico Reservoir Delaware Shaft 18 cove, it was determined that stabilization of the shoreline on either side of the cove was necessary to reduce the resulting turbidity issues. Construction on this project began on the point side of the cove, farther from Shaft 18. To ensure this construction did not negatively affect water quality at Shaft 18, the site was enclosed in three turbidity curtains with turbidity sensors between the curtains, which were maintained by the project contractor. Additionally, a robust buoy monitoring system was deployed at the site by BWS personnel. These buoys ring the outer edge of the project area and provide near real-time feedback about conditions in the reservoir and if construction activities are influencing the water quality. A fixed depth robotic monitoring buoy deployed outside of the work area provided background data for ambient conditions in the reservoir, allowing for comparison of data between the sites. Weekly grab samples were collected to monitor sensor health and confirm readings. The second phase of this project is scheduled to continue in 2020.

Special Investigation: Rondout Giardia Investigation

Beginning in mid-November 2018, elevated concentrations of *Giardia* were observed at the inflow to Kensico Reservoir (DEL17). Additional weekly samples were taken upstream at the Rondout outflow, along with samples from Rondout tributaries and reservoir elevation taps. While some results were elevated, no sample site presented a clear source of *Giardia* by the end of 2018. Precipitation in the area was exceptionally high in the months preceding November 2018 (total 3-month precipitation 26.12 inches).

The investigation continued into 2019, with additional water samples collected from suspect locations, as well as scat samples collected from beavers and other wildlife. Wildlife surveys were conducted around the shoreline of Rondout Reservoir and several beaver lodges

were identified. Scat samples were analyzed in-house for cyst concentration and sent to the Centers for Disease Control in Atlanta, GA for genotyping. Some water genotypes of *Giardia* matched types found in beaver scat, and some did not, indicating multiple sources. In April 2019, *Giardia* concentrations decreased (<5 cysts 50L-1) at DEL17, however, elevated results (>5 cysts 50L-1) continued at the Rondout diversion into August 2019.

Based on the information available, the elevated *Giardia* leaving Rondout Reservoir appeared to be from more than one source and were likely transported into the reservoir as a result of the record rainfall and runoff that occurred just prior to the increase in November 2018. This included rain on snow. An unusually wet year occurred in 2018 and there was record rainfall in the few months directly preceding this event (July, August, September and November). *Giardia* persisted in the reservoir at this time of year due to continued precipitation throughout the event and the extended preservation of cysts in cold, moist conditions which surpassed travel time through the reservoir. Preliminary loading estimates from the local beaver scat do not solely account for the concentrations seen in the reservoir; in fact, the Pepacton diversion and streams contribute equal or greater *Giardia* loading to the reservoir compared to the local beavers. At least three different genotypes/subtypes of *Giardia duodenalis* were identified at the outflow of Rondout, the inflow of Kensico, and an unnamed tributary. One of these three types was identical to the only type found in the Rondout beavers (assemblage B subtype 2), and the other two types were not isolated from beavers. These molecular data also suggest that the local beavers were not the only source of *Giardia* in Rondout Reservoir. While it is possible for these other types to exist in beavers, they were not found in beavers in this study, and could be from other animals that were not as well represented as the beavers in the scat data set. In addition, the assemblage A subtype 2 identified has been isolated from human sources more often than animals. More positive DNA samples from the watershed would need to be studied to better understand the sources of cysts found in the water. Since *G. duodenalis* assemblages A and B are both zoonotic, and therefore cross-infective, it is difficult to distinguish between sources without direct genetic matches between a source and the contamination. Further study of local wildlife scat and an investigation of any suspect human sources would be needed to increase the chances of finding such a match on a molecular level.

Robotic Monitoring

DEP utilizes a Robotic Water Quality Monitoring Network (RoboMon) as part of its routine monitoring program. High-frequency 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 to formulate management actions guiding 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 over 2.5 million measurements in the watershed in 2019.

5.1.3 Wastewater Treatment Plant (WWTP) 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 the effluents of the plants. In 2019, DEP collected 41 protozoan samples from 10 wastewater treatment plants throughout the NYC watershed. Eight plants were monitored in the WOH basins and two plants in the EOH basins (Figure 5.1 and Figure 5.2). FAD monitoring is scheduled on a quarterly basis at these 10 plants. An additional sample was taken at the Carmel plant in May 2019 after a Giardia detection in the routine quarterly sample.

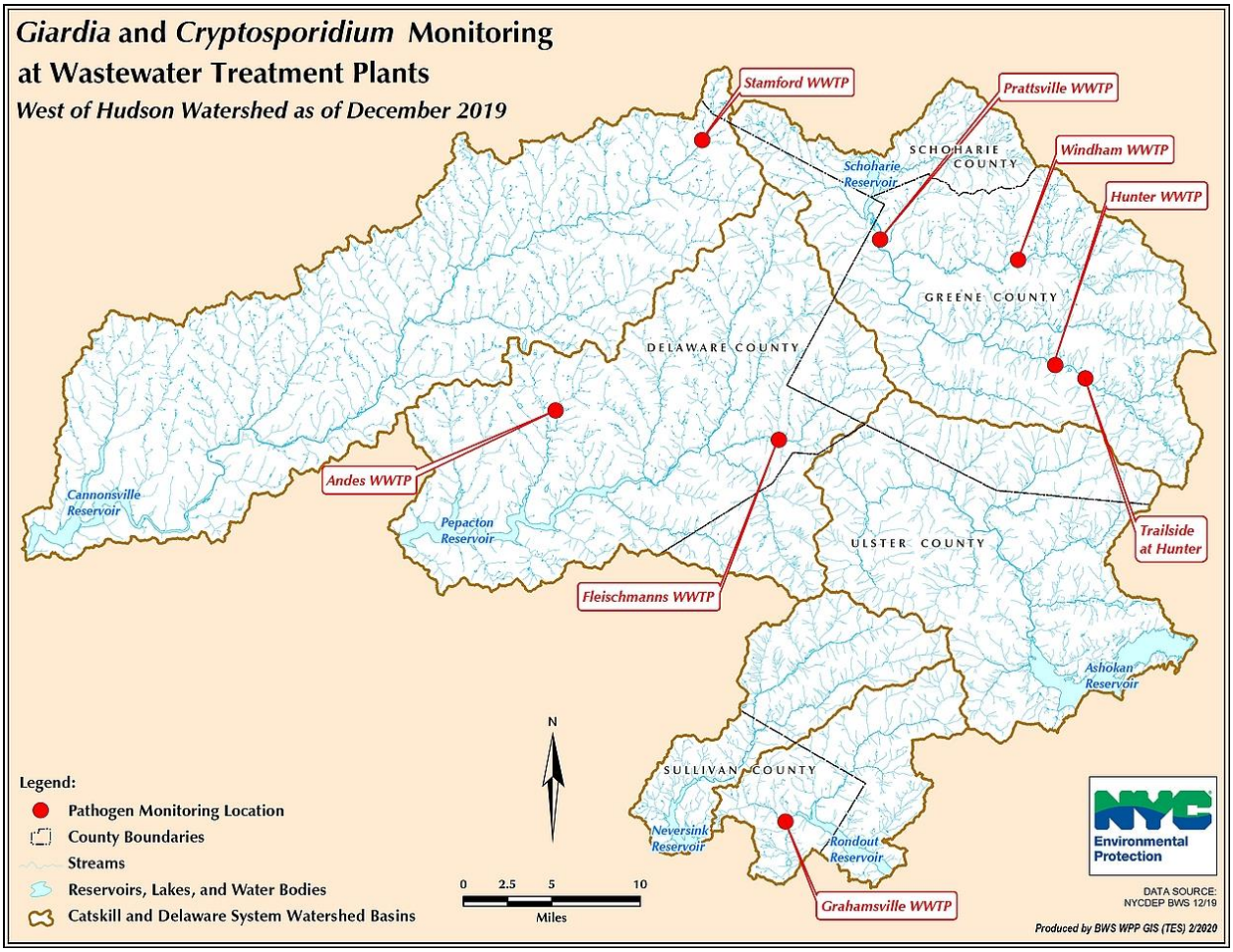

Figure 5.1 Wastewater treatment plants monitored for *Giardia* and *Cryptosporidium* in 2019 in the WOH watersheds.

Each sample for *Giardia* and *Cryptosporidium* involved the field filtration of 50 liters of water from the plant's effluent or a similar tap location after disinfection. Samples were analyzed by DEP according to USEPA Method 1623.1 (USEPA 2012). Four samples were positive for *Giardia* at three WOH plants (Trailside at Hunter LLC, Fleischmanns, and Windham), and one sample was positive at an EOH plant (Carmel). Those results and plant conditions are discussed below. None of the 2019 protozoan samples were positive for *Cryptosporidium* oocysts.

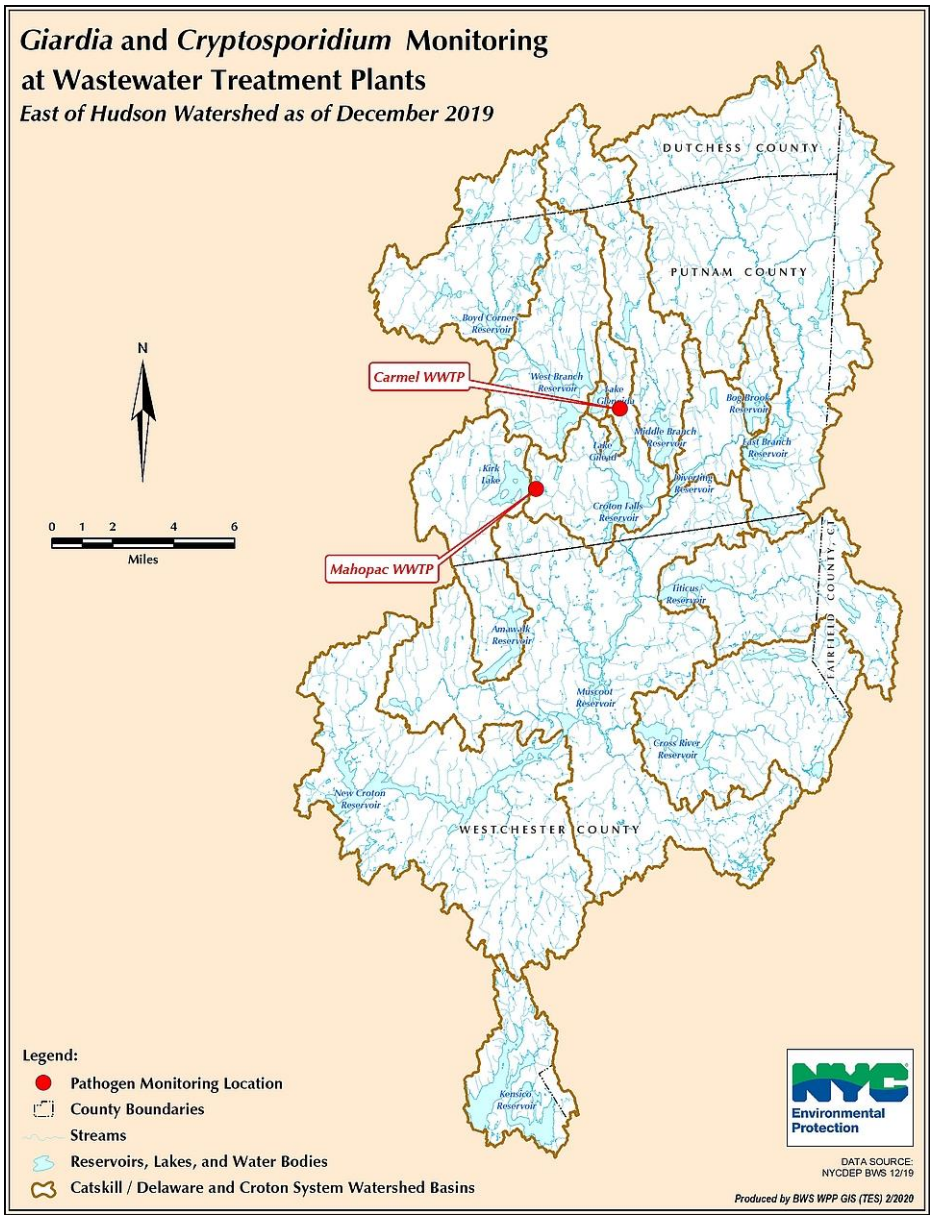

Figure 5.2 Wastewater treatment plants monitored for *Giardia* and *Cryptosporidium* in 2019 in the EOH potential FAD watersheds.

On March 20, a sample was taken at Fleischmanns WWTP and found to have three *Giardia* cysts in the 50.0L filtered sample. The facility operator was contacted to obtain background information on plant operations during the time of the sample. The sample was collected after three days of air lancing of the continuous backwash upflow dual sand filters (CBUD) and air lance cleaning of the filters continued on the day of sampling. The filter being air lanced at that time was in recirculation mode and not going to discharge.

The detection may have been caused by cysts dislodged from the air lancing on prior days or by the sand filter cleaning on the day of sampling. Although a concentration of three cysts is relatively low, it may be correlated to filter operation and maintenance (O&M) procedures. This issue was discussed with the operator and it was suggested that air lancing be performed when the plant is completely offline, as this plant is typically operated in plug flow mode. There were no further positive detections in 2019.

On March 26, a protozoan sample taken at the Trailside at Hunter LLC wastewater plant was found to have 82 *Giardia* cysts in the 50.0L sample. After the positive result, plant operators were asked about any operational issues or process abnormalities. Operators did not note any mechanical or process abnormalities at the plant. The sand filters are chlorine cleaned and air lanced every month, with the last cleaning noted on March 20. Positive samples have been noted at this plant over the past few years, most often in the colder months as ski season brings visitors to the area. Quarterly protozoan samples taken in February 2017 and February 2018 were both positive (10 and 73 *Giardia* cysts, respectively).

On May 20 a protozoan sample taken at the Carmel wastewater treatment plant was found to have one *Giardia* cyst in the 50.0L sample. DEP inquired with plant operators about any abnormal processes around the time of the sample. No abnormal conditions were noted on or before May 20, and the filtrate turbidity ranged from 0.07 to 0.10 NTU on the day of collection. A follow-up sample was taken at the plant on May 30 and was negative for both *Giardia* and *Cryptosporidium*. This May 20 sample was the first detection of a protozoan at this plant in more than 10 years of quarterly monitoring.

On August 27, a protozoan sample taken at Windham wastewater treatment plant was found to have two *Giardia* cysts in the 50.0L sample. DEP obtained the daily turbidity report for the plant which indicated turbidity remained below 0.50 NTUs for the entire day. The plant operator was not aware of any process abnormalities which may have caused the positive on that day. It should be noted that the protozoan sample was taken at about 11:00 a.m. when effluent flow reached the maximum for the day (138,000 GPD).

Windham wastewater treatment plant was sampled again on December 4. This quarterly sample was also positive for *Giardia* (1 cyst in 50.0L sample). DEP obtained the plant's daily turbidity report, which indicated there were three readings above 0.50 NTUs at about 11:00 a.m. This was also during the time when the plant recorded its maximum daily flow (352,000 GPD).

The operator stated the higher turbidity readings were found during a scheduled generator test run when the plant's power source switches from electrical grid to generator for one hour from 11:00 a.m. to 12:00 p.m. The protozoan sample collection began just before noon and ended shortly after noon.

While the transfer from grid to generator power should not directly impact protozoan sample results, the sample did overlap the generator test run and it is possible that a power disruption to the plant pumps could cause disturbances to pipe biofilms which could harbor protozoans. The short term increases in turbidity are indicative of such disturbances. There were no readings that were above the 5.0 NTU SPDES limit. No other abnormalities occurred that day.

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 a Watershed Water Quality Annual Report (WWQAR). This is submitted annually each July to NYSDOH and USEPA (e.g., DEP 2019). 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 year's major water quality modeling activities. DEP's watershed monitoring effort excluding all automated (robotic) monitoring consists of 454 routinely sampled aqueduct, reservoir, and stream sites, resulting in 11,584 samples and approximately 105,291 analyses annually. For the 2019 WWQAR report (due July 2020), the document's limnology and hydrology components will draw largely from information obtained from approximately 410 routinely sampled reservoir and stream sites, resulting in approximately 4,270 samples and almost 56,894 analyses. Limnological profiles conducted during the sampling surveys added over 59,822 additional analyses. For the pathogen component, 512 routine samples were collected at 42 sampling sites (including keypoints) and analyzed for *Giardia* and *Cryptosporidium,* along with turbidity, pH, and temperature, for a total of over 1,959 analyses. In addition, 33 samples were collected at five sampling sites for human enteric virus examination.

It is important DEP monitor pathogen concentrations on an ongoing basis to be able to meet regulatory requirements and to confirm their presence or absence throughout the water supply. To maintain constant surveillance and to provide information for DEP managers and regulators, pathogen data are reported frequently and in several different reports as noted below.

- 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 2019)
- Drinking Water Supply and Quality Annual Report (e.g., DEP 2019)
- Filtration Avoidance Annual Report (e.g., DEP 2019), or, every fifth year, the Watershed Protection Program Summary and Assessment (DEP 2017)

5.2 Multi-Tiered Water Quality Monitoring Program

DEP's Water Quality Modeling Program uses models to quantify the impact of climate change, changes in land use, individual and grouped components of the watershed protection program, operation of the water supply system, and water demand on the quantity and quality of water delivered to the City. A detailed description of water quality modeling progress and activities in 2019 will be included in the Watershed Water Quality Annual Report, which will be completed on July 31, 2020. A brief summary of these activities is given here.

While DEP and other government entities maintain rainfall gauges throughout the West of Hudson watersheds, the gauges alone are not sufficient to allow the spatial variation of precipitation to be directly measured. This is due in part to the significant topographical variation in the mountainous watersheds. Using the available measurements and topographical data for the watershed, DEP developed a statistical model to estimate the spatial variation of precipitation throughout the West of Hudson watersheds, along with uncertainty in these estimates. This precipitation model is described by Yeo et al. (2019).

The Water Quality Modeling section is following through on a recommendation to track changes in the water supply due to climate by calculating several climate-related indices. This recommendation originated from the National Academy of Sciences, Engineering and Medicine (NASEM) and its 2018 review of the Operations Support Tool. A system of indices will be used to track the impact of climate change on weather, hydrologic, and limnological conditions in the watersheds and reservoirs, and in system operations over time. The section is developing a database to assemble pertinent data, and to identify the existence of trends in the data that may be attributable to climate change.

DEP is continuing to put significant effort into the application and testing of the Soil and Water Assessment Tool (SWAT) to the West of Hudson watersheds. Building on the earlier application to the Cannonsville watershed, SWAT was extended to the Ashokan, Schoharie, Pepacton, and Neversink reservoirs in 2019. The first step in these model applications involved the simulation of hydrology and streamflow. Good streamflow simulations for historic periods were obtained for these four watersheds. In 2020, the model will be applied to the Rondout Reservoir watershed, and water quality simulations will be made in addition to hydrology.

Evaluation of the impacts of climate change undertaken in 2019 were based on predictions from global climate models that were downscaled to locations throughout the U.S., including the West of Hudson watersheds, by researchers at the University of Idaho. Following a secondary downscaling, or bias correction step performed by DEP, the predictions were then ready for use in watershed models. In order to account for the uncertainty in global climate mode predictions, a suite of 20 such models were used. It was assumed that the range in the predictions from these 20 models captures or represents the uncertainty in any one of the models. The climate models generally predict warmer and wetter conditions for the future. The process of generating these future climate predictions is described by Gelda et al. (2019).

The SWAT model for the Cannonsville watershed, which had been validated in 2017-2018 for hydrology and nutrients, was used to simulate the impact of climate change on the streamflow, suspended sediment, nitrogen, and phosphorus loading into Cannonsville. Using the climate predictions from the 20 models, SWAT was used to predict streamflow and loading for current (2000-2010) and future (2051-2060) conditions. The range in the predictions from multiple climate models is intended to capture the uncertainty in any one model. Average streamflow is predicted to increase in the future, as are loading of sediment and particulate forms of nitrogen and phosphorus. Dissolved forms of nitrogen and phosphorus are predicted to increase only modestly.

SWAT is still in development for many West of Hudson watersheds, as described above. In order to evaluate the impact of climate change on the entire West of Hudson system, the Generalized Watershed Loading Function (GWLF) was used. GWLF was used to simulate streamflow, stream temperature, and turbidity for current (2000-2020) and future (2041-2060) time periods for all WOH watersheds. These watershed predictions were used as inputs to DEP's Operations Support Tool (OST), operating with reservoir turbidity models active, and in "simulation" mode, allowing the optimization capabilities of OST to adjust operations day-to-day over the course of the simulations in response to future streamflow, stream temperature, and turbidity. Comparing OST simulations for current and future operation of the water supply system, diversion from the Delaware system is predicted to increase modestly, Delaware system spill is predicted to be slightly reduced, with a corresponding decrease in diversion and increase in spill from the Catskill system. These changes are driven largely by predicted increases in Catskill System turbidity. Occurrence of drought conditions in the water supply is predicted to increase slightly.

Many of these results were presented in greater detail at the annual progress meeting with regulators, which was held October 24, 2019, at DEP's Kingston office. Representatives of the NYSDOH and USEPA attended this all-day meeting, where DEP staff gave an overview of modeling activities during the previous year followed by a discussion session between DEP and regulatory agency staff.

5.3 Geographic Information System

DEP uses 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 2019, DEP continued to use its GIS to perform technical support and data development for a variety of 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, and 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 continued using digital elevation models (DEMs) to generate custom sub-basin boundaries for specific water quality sampling locations. DEP also incorporated DEMs into global climate models to generate local predictions of future climate conditions. DEP continues to rely on data sets such as reservoir bathymetry, SSURGO2 soils, land cover, and land use to drive model analyses.

In 2019, DEP finalized many additional GIS datasets and maps in support of the opening of the Ashokan Rail Trail. These features can be viewed online in DEP's Watershed Recreation Mapping Tool. DEP analyzed coniferous forest land cover data in support of the Wetlands Program. DEP also mapped acres of EOH Community Water service areas overlapping wastewater service areas, including diverted areas. Staff uploaded GIS datasets onto the DEP Police helicopter's navigation system to assist the pilot in rapidly and accurately identifying property boundaries for real-time conservation easement inspections, thus avoiding the need for paper maps.

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

In addition to procuring and maintaining GPS hardware and software year-round, GIS staff process and upload field-collected GPS data into GIS layers that are incorporated into DEP's GIS Library. In the 2019 summer field season, over 105 GPS datasets were collected, corrected, checked for quality assurance, and processed into over 30 GIS layers related to wildlife and wetland studies, forestry, property management, and land acquisition.

Under contract with DEP, USGS continued using boat-based sonar to conduct bathymetric surveys of all 13 reservoirs and three controlled lakes in the EOH watershed according to the same specifications used for WOH reservoir bathymetry mapping. During 2019, USGS completed field collection of data gaps and quality assurance measurements. USGS has also been working to edit and process raw sensor data into elevation measurements.

To improve cartographic presentation across all GIS and WaLIS-generated maps, DEP completed a complex dynamic labeling scheme, using the Maplex labeling engine, as a replacement for the often outdated USGS planimetric base maps. Place name labels and symbology for buildings, roads, and hydrography were redesigned to serve as a new base map that will be legible regardless of location, extent, and map scale.

Also in 2019, DEP obtained the latest version of SSURGO2 soils data from the USDA and numerous other data updates from the NYS GIS Clearinghouse, including NYSDOT transportation features and NYSDEC fisheries index numbers. DEP edited and updated several existing feature classes and mission-critical data sets, such as county-wide tax parcels, City-owned lands or interests, state-owned lands, water supply facilities, stream restoration projects, septic repairs, and engineering project locations.

Based on field verification, DEP made annual corrections and additions to National Hydrography Dataset (NHD) mapped water features, including all associated GIS layers that are 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 2019, DEP continued to maintain its GIS infrastructure by upgrading ArcGIS Desktop software; 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.

All GIS staff received new GIS-grade workstations, which improved software performance but required reconfiguring drives, network paths, software, and transferring all data and applications. Staff migrated tax parcel update scripts from Python 2 to Python 3, and investigated how ESRI portal software may impact GIS users in remote locations through web or mobile applications. DEP began upgrading user software to ArcGIS Pro, a major shift from previous versions of ESRI professional desktop GIS software because it is cloud-based with a more sophisticated user interface.

DEP also continued to upgrade and maintain WaLIS, which currently operates on 256 DEP user workstations. DEP released a new version of WaLIS with many updates, including streamlined mapping code to improve performance and support the Maplex labeling engine. Staff developed the following additional features in 2019:

- New eligibility rules and documented code for LAP solicitation planning within WaLIS
- New functionality to better track wetland permit applications and EOH septic repairs
- A set of standard WaLIS-generated maps for LAP Basin Status and Community Review in order to reduce the amount of required custom mapping (Figure 5.3)
- Custom reports to display New York Natural Heritage Program (NYNHP) data on threatened and endangered species for project review
- A report of historic WWTP flow data for REP

5.3.4 Data Dissemination to Stakeholders

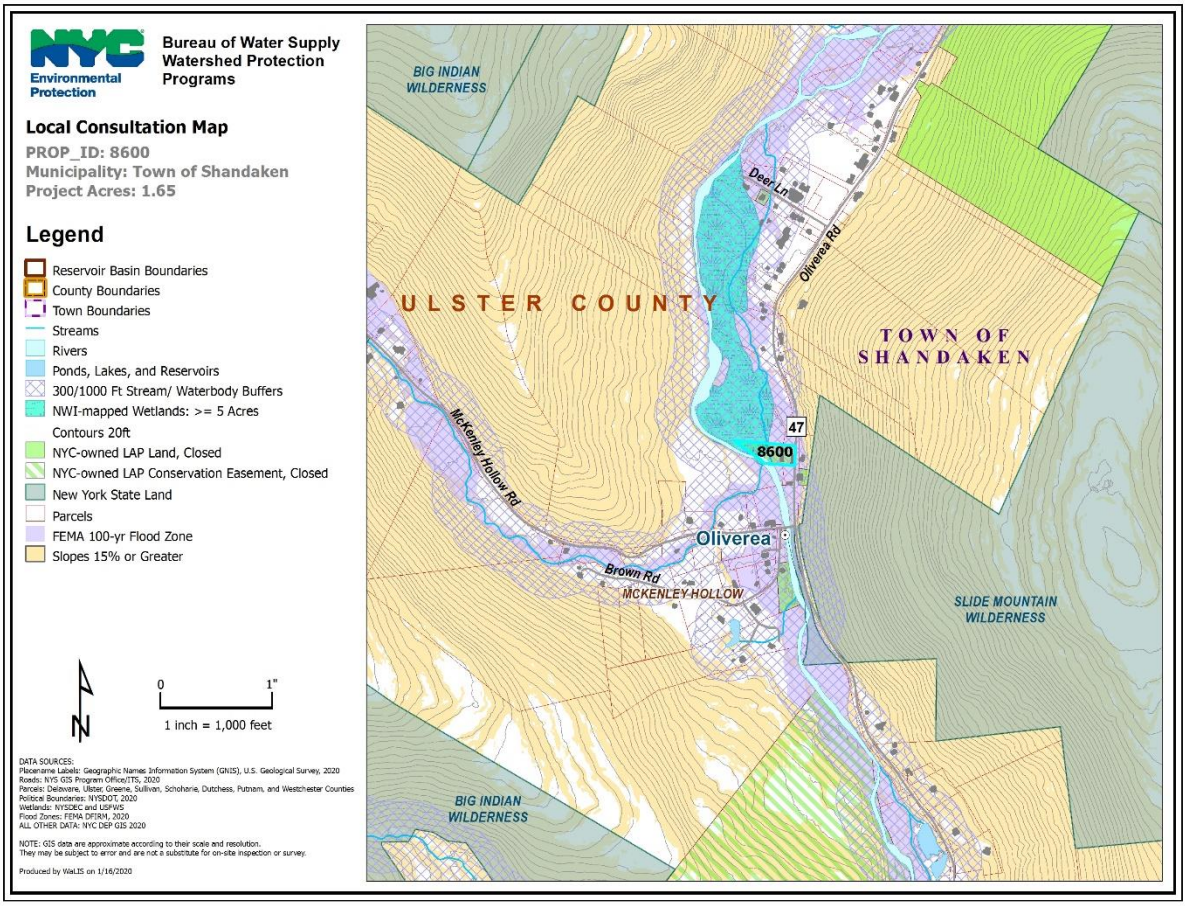

Figure 5.3 Example of an automated map generated directly from WaLIS to be used in local consultation with communities for proposed land acquisition parcels.

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. Each year, DEP provides over 52 stakeholders and communities with semi-annual data updates in January and July for newly-acquired and existing City-owned lands. DEP shared updated watershed recreation data with Ulster County, WAC, and the Catskill Center for their recreation website mapping applications, and with the NYC Open Data portal. Throughout 2019, DEP responded to data sharing requests from NYSDOH, NYSDEC, WAC, CWC, Catskill Center, and various counties, towns, and consultants working on DEP-related watershed projects.

6. Regulatory Programs

A primary component of DEP's overall watershed protection strategy is the enforcement of applicable environmental regulations, which include, but are not limited to, 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, and the New York State Environmental Quality Review Act (SEQRA). Of these, the primary mechanism for protection of the water supply is via administration of the WR&R.

DEP's regulatory efforts are focused on three primary functions: review and approval of land development projects within the watershed; inspection of the following: wastewater treatment plants, new subsurface sewage treatment systems and active construction sites; and pursuit and resolution of violations of the WR&R.

6.1 Project Review

Land development projects 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 wastewater treatment plants (WWTP), sewer collection systems, subsurface sewage treatment systems (SSTS); projects requiring the preparation of stormwater pollution prevention plans (SWPPP); and the construction of certain impervious surfaces. In addition, DEP reviews and issues individual residential stormwater permits (IRSP) and stream crossing/piping/diversion permits for other stormwater-related activities. DEP also ensures erosion control measures are properly sited and maintained during construction and that projects requiring post-construction SWPPPs or IRSPs have installed the necessary long-term best management practices. In addition, DEP reviews and offers comments on permit applications submitted to NYSDEC for activities such as mining operations, timber harvesting, industrial activities, landfill closures, stream disturbance and wetland incursions. DEP input is sought in accordance with the DEP/NYSDEC Memorandum of Understanding.

Lists of the new projects received during the previous calendar year in both the select East of Hudson reservoir basins and all West of Hudson basins are included in the Semi-Annual FAD report. The project lists represent all stormwater, variance, and new or repaired intermediate SSTS applications. The semi-annual Project Activities report also includes project summaries and maps reflecting project locations. In 2019, there were 11 new commercial septic applications, two wastewater treatment plant applications, three sewer connection applications, 26 stormwater applications and one variance application. There were also 17 stream disturbance permit reviews, 17 timber harvest reviews, two NYSDOT reviews and three other type projects within the Catskill and Delaware watersheds.

6.1.1 SEQRA Coordination

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

The semi-annual report includes a summary and mapping of all SEQRA reviews performed by DEP during the previous calendar year.

6.1.2 Delegation Agreements

The Westchester and Putnam County health departments perform reviews of 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 DEP delegation agreement.

During 2019, DEP received documentation related to 54 delegated SSTSs; 15 of these reviews are attributed to subsurface sewage treatment systems in the WOH watershed with the remaining 39 delegated SSTS applications located in the select EOH FAD basins.

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 in the watershed. Enforcement actions are prepared with input from both DEP's Bureau of Legal Affairs and Corporation Counsel of the City of New York. In addition to coordinating with NYSDEC, county health departments, municipal code enforcement officers, and the Catskill Watershed Corporation, DEP routinely refers water quality violations to partner agencies where DEP's authority under the WR&R relative to the activity is limited or non-existent. Examples of violations that DEP fully documents and refers to NYSDEC's regional offices are discharges from sites covered by industrial SPDES permits, such as concrete or asphalt manufacturing facilities. In 2019, DEP opened six new NOVs and closed seven NOVs. Details are available in the Semi-Annual Report.

The primary function of the DEP Police with respect to watershed enforcement is daily patrol of the watershed documenting a wide range of potential water quality incursions. Police 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 have the authority to issue summonses and notices of warning/violation of the New York State Environmental Conservation Law, the WR&R, as well as other state and local codes. DEP regulatory staff work cooperatively with the DEP Police

to ensure that citizen complaints of potential 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 WWTP that operates on a year-round basis. A minimum of two compliance inspections per year are conducted during the operating season at seasonal surface-discharging facilities. Similarly, at least two compliance inspections per year are conducted at non-contact cooling water discharges to surface waters, groundwater remediation systems, landfills, and oil/water separators. Treated industrial waste discharges to groundwater, via ground surface application, are inspected four times per year. This does not preclude DEP from performing inspections with greater frequency. DEP may also conduct unannounced facility inspections to manage instances of non-compliance, respond to abnormal or emergency operating conditions, react to mistakes or problems with self-monitoring data or record keeping, discuss DEP laboratory sampling results, oversee modifications or expansions to a facility, and 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

Thirty-one WOH WWTPs were inspected by DEP on a regular schedule in 2019. Of these, 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. These are the Chichester hamlet, Mountainside Farms, and Hanah Country Club. Three other facilities are classified as industrial non-contact cooling water discharges: Friesland Campina- DOMO, Kraft Dairy and Saputo Foods. Altogether, DEP conducted 149 scheduled compliance and emergency response inspections in 2019.

NYSDEC issued a Notice of Violation (NOV) on February 6, 2019, for collection system overflows and late reporting relative to the Hunter Highlands Wastewater Treatment Plant. The NOV required documentation of certain corrective measures, including an overflow response plan, by May 1, 2019. Hunter Highlands has undertaken the following steps in response to the NOV:

- Conducted an inflow and infiltration investigation, including CCTV, to evaluate the condition and integrity of the collection system.
- Prepared and submitted an updated O&M plan for NYSDEC review.

NYSDEC and DEP are working cooperatively to schedule a meeting with the Hunter Highlands facility owner in early 2020 to assess progress on resolution of the non-compliance issues noted in NYSDEC's February 2019 NOV.

DEP participates in Compliance Conferences (CC) with those facilities that continue to violate their SPDES permit limits and/or monitoring requirements. CCs are usually conducted after repeated attempts by DEP to remediate the problem with the facility owner and/or operator have failed. DEP, in conjunction with NYSDEC and local regulatory authorities, sends out an NOV letter prior to calling for a CC. DEP did not participate in any CCs in 2019. Many problematic and outdated facilities, which used to exceed their permits on a regular basis, have been connected to another upgraded facility, upgraded as a standalone facility, converted to subsurface discharge, or totally abandoned. As a result, the number of failed WWTPs has decreased greatly.

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 perform inspections of the collection system/pump stations maintained by Westchester County and the Towns of North Castle and Harrison within the Kensico basin. In 2019, DEP conducted 98 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 2019. DEP activated the Croton Falls and Cross River pump stations in fall 2019 to supplement the New York City water supply as repairs were undertaken to the Catskill Aqueduct. The operation of each station required a heightened level of vigilance to protect water quality within the Croton Falls and Cross River reservoir basins. Letters were sent to the permittees for prompt notification, at all hours, for any upset conditions within the WWTP or wastewater collection system and their components that could impact the aforementioned basins. Weekly reconnaissance inspections were performed until the pump stations were deactivated.

DEP performed compliance inspections of the Town of North Castle (Old Route 22, Cooney Hill Road, Route 120/Loudens Cove, New King Street, Old Orchard Street) and the Harrison (Park Lane) pump stations and collection system throughout the 2019 monitoring period. The inspections revealed no abnormal conditions.

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

6.3.3 Sampling of WWTP Effluents

Wastewater treatment plant (WWTP) effluent results are reported to NYSDOH and USEPA semiannually in the WWTPCI report as required by the 2017 FAD. Sampling data are also shared regularly with DEP's WWTPCI staff for the purpose of tracking compliance with SPDES-permitted effluent limits.

Sampling of surface-discharging WWTP effluents was conducted by DEP's state-approved laboratories throughout the year. In 2019, grab samples were collected monthly. In addition, composite samples were collected once for the year at non-City owned plants that have composite sample monitoring requirements in their SPDES permits. For City-owned plants, the frequency was biweekly and these plants are listed in DEP's Watershed Water Quality Monitoring Plan (DEP 2018). 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 sample depending on the parameter and were analyzed by DEP laboratories. Results were reported to NYSDEC in SPDES Discharge Monitoring Reports.

In the Catskill System, there are 17 WWTPs with active SPDES permits. One has no discharge, the Chichester plant in the town of Shandaken in Ulster County. It is a City-owned and operated, intermediate sized sub-surface sewage treatment system. The other 16 plants with effluents were sampled (including three City-owned and 13 non-City-owned) and composite samples were collected from eight (three City-owned and five non-City-owned) of these plants which have the composite sampling requirement.

In 2019, 1,760 analyses were performed on 402 influent and effluent samples (as required) from WWTPs in the Catskill System. Of the 402 samples, 231 were collected from City plants and 171 were collected at non-City plants. These samples underwent 1,741 analyses by DEP's Kingston laboratory and 19 analyses by a contract laboratory.

There were 13 WWTPs in the Delaware System with active SPDES permits sampled in 2019 (two City-owned and 11 non-City-owned). Composite samples were collected at nine of the Delaware WWTPs (two City-owned and seven non-City-owned). For the Delaware System, 323 influent and effluent samples were collected, with 134 from City-owned plants and 189 from non-City owned plants. These samples underwent 1,648 analyses performed by Grahamsville (723), Kingston (854), and contract (71) laboratories.

In the EOH System, there are 62 WWTPs with active SPDES permits. In this system, 2,896 analyses were performed by the Hawthorne laboratory on 382 WWTP effluent samples. (Mahopac is the only EOH plant with composite sampling.) Nine WWTPs are located in a FAD watershed with eight located within the Croton Falls and Cross River watershed and one within the West Branch watershed.

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 if either pump station were activated. The Cross River Pumping Station was activated in 2019 on November 19 and 20. The Croton Falls Pumping Station was activated in 2019 on June 26; June 28 to July 1; November 11 to 15; November 18 to December 1; and December 3 to December 31.

6.4 Capital Replacement Program

The City is obligated to pay for capital replacement of watershed equipment and methods at eligible WWTPs that are required by the WR&Rs and not otherwise required by federal or state law. In 2019, DEP worked to transition administration of the Capital Replacement Program from EFC to NEIWPCC. In July 2019, DEP registered the program contract with NEIWPCC and is currently working with NEIWPCC to develop the necessary program documents and participation agreements.

During 2019, EFC made no payments to WWTPs for replacement of watershed equipment. Minor equipment (e.g., filter cartridges, pumps) is replaced as needed to ensure the facility functions properly and in accordance with the WR&R. DEP is able to directly fund the replacement of minor equipment under established O&M agreements with each WWTP owner.

7. In-City Programs

7.1 Waterborne Disease Risk Assessment Program

The goal of EPA's Surface Water Treatment Rule is public health protection and a core objective in DEP's mission is the same: public health protection. A program that helps provide assurance that this goal has been met is New York City's Waterborne Disease Risk Assessment Program (WDRAP). WDRAP is a joint agency program involving the NYC Department of Health and Mental Hygiene (DOHMH) and DEP. Established in 1993, the program has continued under a series of intra-city agreements between these two city agencies. The current agreement was updated and signed in 2017. It lays out each agency's roles and responsibilities into 2022.

WDRAP has two major ongoing functions:

- To obtain data on the rates of giardiasis and cryptosporidiosis in the City, along with demographic and risk factor information on cases and patients.
- To provide a system to track gastrointestinal illness (as indicated by diarrhea or vomiting) to ensure rapid detection of any outbreaks.

Active laboratory surveillance (involving regular visits/calls to clinical labs by city staff) 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 which resulted in faster, less resource-intensive surveillance data collection for NYC. Electronic reporting of cases and follow-up by DOHMH has been ongoing, and continued through 2019.

Follow up on confirmed reported cases of cryptosporidiosis is conducted by public health epidemiologists working at DOHMH in order to collect additional information. The epidemiologists 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, health care worker, child care worker) or attends, or is thought to attend, daycare.

All data from 2019 are preliminary as of this writing, and are subject to change pending the results of confirmatory laboratory testing, and any other needed adjustments. In 2019, there were 1,205 cases of giardiasis and 395 cases of cryptosporidiosis reported to DOHMH (counts as of January 2020). Of these cases, epidemiologists completed eight giardiasis patient interviews (of patients in high transmission risk group, per above), and conducted 314 cryptosporidiosis patient interviews.

In recent years, shifts in clinical laboratory techniques have had a notable impact on both giardiasis and cryptosporidiosis surveillance in NYC and across the United States. An increase in the number of cryptosporidiosis cases in NYC first noted by WDRAP staff in late 2015 continued through 2019. The increase was initially observed in reports from a clinical laboratory

of a large university hospital. Further investigation linked many of the early cases to a new type of diagnostic known as a syndromic multiplex panel. These tests can detect the DNA of over 20 enteric pathogens in a single stool sample analysis. This new diagnostic tool is often ordered for patients who would not previously have been tested for *Cryptosporidium*. Approximately 27 laboratories are now using this test in the City. Though practices are different at each facility, once a laboratory introduces a syndromic multiplex panel, traditional diagnostics like microscopy are rarely used. The proportion of giardiasis patients diagnosed exclusively by a syndromic multiplex panel at a hospital or commercial laboratory has grown from 5% in 2015 to 46% in 2019. Similarly, the proportion of cryptosporidiosis patients diagnosed exclusively by a syndromic multiplex panel at a hospital or commercial laboratory has grown from 20% in 2015 to 74% in 2019. DOHMH is confident that the new diagnostic continues to lead to an increase in detection of both giardiasis and cryptosporidiosis cases, and that the case increase observed is not considered reflective of an increase of disease transmission. Similar increases in giardiasis and cryptosporidiosis rates have been observed in a number of other jurisdictions in the United States.

In 2019, routine DOHMH cluster detection algorithms detected an increase of cryptosporidiosis in Brooklyn at the end of September. Initial investigations suggested the infections were concentrated in the Orthodox Jewish communities of Borough Park and Williamsburg in Brooklyn. In total, there were 47 cases diagnosed between August–November 2019. The median age of patients was 13 years (range: <1 – 46 years). Based on data collected in interviews, DOHMH hypothesizes that the initial cases were related to travel to a community in upstate NY during the summer months, and that person-to-person transmission subsequently took place in the Orthodox Jewish communities in Borough Park and Williamsburg. Seventeen (36%) patients reported either attending or working in child care centers in Brooklyn; six patients were excluded as per the NYC Health Code. DOHMH conducted substantial outreach to the Orthodox community. Letters in English and Yiddish were sent to child care centers and schools in the community informing principals, teachers, and parents of the existence of the outbreak, and details were provided on the symptoms and transmission of cryptosporidiosis as well as instructing staff and children to wash hands frequently with soap and water. Evidence strongly suggests that this outbreak was related to person-to-person transmission within the Orthodox Jewish community in NYC and was unrelated to the City's water supply. A manuscript describing this outbreak will be submitted for publication in 2020 to inform clinicians treating this community in NYC.

In 2019, DOHMH authored a manuscript in collaboration with DEP detailing the epidemiology of cryptosporidiosis in NYC from 1995-2018[1]. In this work, trends in incidence

[1] Alleyne, L., R. Fitzhenry, K. A. Mergen, N. Espina, E. Amoroso, D. Cimini, S. Balter, A. M. Fireteanu, A. Seeley, L. Janus, B. Gutelius, S. Madison-Antenucci and C. N. Thompson (2020). "Epidemiology of cryptosporidiosis in New York City, New York, USA, 1995-2018." Emerging Infectious Disease **26**(3).

and demographic characteristics are detailed for all 3,984 cryptosporidiosis patients that were reported to DOHMH during this 24-year period. Reported cryptosporidiosis incidence declined with HIV/AIDS treatment rollout in the mid-1990s (as has been noted in previous WDRAP reports). Additionally, the introduction of syndromic multiplex diagnostic panels in 2015 led to a significant increase in incidence and to a shift in the demographic profile of reported patients. Finally, the burden of cryptosporidiosis in NYC was highest among men who have sex with men, as well as among international travelers. Specifically, children traveling to the Dominican Republic in the summer months were more likely to be diagnosed with cryptosporidiosis. A recommendation noted in this paper is prevention messaging for members of the community of men who have sex with men and their health care providers, as well as international travelers

In addition to tracking reported cases of giardiasis and cryptosporidiosis, New York City has four syndromic surveillance systems in place to detect outbreaks of gastrointestinal disease:

- Hospital emergency department logs are tracked electronically for chief complaint data (including gastrointestinal illness symptoms), on a daily basis.
- Sales of over-the-counter or non-prescription anti-diarrheal medications at major pharmacies are monitored electronically on a daily basis.
- The number of stool specimens submitted to a large clinical laboratory for microbiological testing are tracked.
- Several sentinel nursing homes across the City are monitored for gastrointestinal disease outbreaks.

The above 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 potential sources. For example, to assess whether the water supply might be the source of an outbreak, source water quality, watershed conditions, and/or other water system parameters could be examined. All four syndromic surveillance systems continued to be operational in NYC in 2019. There was no evidence of a drinking water-related outbreak in New York City in 2019, consistent with WDRAP findings of prior years.

Each year a WDRAP Annual Report is prepared which provides much more detail than is 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 a FAD requirement, and are submitted annually to USEPA, NYSDOH, and others as required. These reports are also posted on DEP's website:

- The latest annual report is available at: https://www1.nyc.gov/site/dep/water/waterborne-disease-risk-assessment.page.
- Annual reports going back to 1997 are available at: https://www1.nyc.gov/site/dep/about/document-portal.page.

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, 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. The goal is to increase knowledge and awareness among key audiences about source water protection, land conservation and stewardship, stream corridor protection, stormwater and wastewater, flood response and preparedness, invasive species, watershed recreation, riparian buffers, and other topics.

DEP directly disseminates information to a broad public audience through its website (nyc.gov/dep) and social media platforms. During 2019, DEP reached 11,997 followers on NYC Water Facebook, 4,194 followers on NYC Watershed Facebook, 18,740 followers on NYC Water Twitter, and 2,920 followers on NYC Water Instagram. The Drinking Water section of the DEP website received 129,705 page views, Watershed Protection received 10,099 views, Watershed Recreation received 51,441 views, and Environmental Education received 8,151 views. DEP's NYC Water Flickr Page (flickr.com/photos/nycwater/) continues to be an excellent source of photos for many of the educational programs described in this report.

DEP issued 97 press releases in 2019, many of which focused on water supply topics (e.g., Schoharie Reservoir intake project, Shandaken Tunnel shutdown, completion of a goat-grazing pilot program at Ashokan Reservoir, status of the Delaware Aqueduct Bypass Tunnel project, publicity for watershed recreation events). In May, DEP announced final updates to the recreation rules that govern access and activities on more than 140,000 acres of City-owned watershed lands and reservoirs. In November, DEP announced the adoption of updated NYC Watershed Rules and Regulations, which seek to protect water quality while easing the path to compliance for local homeowners and business owners. DEP finalized these updates after several years of consultation with watershed towns and environmental advocates.

One unique press release in 2019 highlighted that a DEP scientist discovered and photographed a rare and critically imperiled species of dragonfly living along a small tributary to the Rondout Reservoir. Known as the Southern pygmy clubtail, the dragonfly can only survive and reproduce in extremely clear, clean waters, making them an exceptional indicator of water quality. Another press release shared the results of the J.D. Power 2019 Water Utility Residential Customer Satisfaction Study, in which New York City ranked #1 in customer satisfaction among water utilities in the Northeast and #6 in overall customer satisfaction among the 89 largest water utilities across the United States.

Recreation and stewardship activities on City-owned lands continue to be popular ways that DEP engages target audiences, including over 100,000 subscribers to DEP's Watershed Recreation e-newsletter. In 2019, DEP organized three family fishing events at Lake Gleneida

and Pepacton and Rondout reservoirs that attracted 210 participants; a sixth annual reservoir clean-up event at Lake Gleneida and Ashokan, Pepacton, Kensico, Muscoot, New Croton reservoirs and along East of Hudson streams that engaged 350 volunteers and collected over 4,600 pounds of trash; an Earth Day reservoir clean up event at Lake Gleneida and New Croton Reservoir that collected more than 400 pounds of trash; and an annual wetlands interpretive program at the Ashokan Reservoir in celebration of American Wetlands Month.

In October, DEP and Ulster County achieved a significant milestone by announcing the opening of the Ashokan Rail Trail. The 11.5-mile-long recreational trail extending from West Hurley to Boiceville provides public access adjacent to the north shore of the Ashokan Reservoir for the first time since it was constructed over a century ago. More than 18,000 visitors are estimated to have used this recreational trail in its first few months since opening.

DEP's Education Office conducted more than 385 environmental education programs that reached nearly 30,000 students (pre-kindergarten through college graduate), formal and non-formal educators, government agency staff, and other professionals. This was accomplished through classroom visits, guided tours and field trips, professional learning opportunities, Trout in the Classroom, programs at the Visitor Center at Newtown Creek Wastewater Resource Recovery Facility, special events, and the use of multi-disciplinary online and print resources. In 2019, DEP became a Continuing Teacher and Leader Education sponsor, as approved by the New York State Education Department. State-certified teachers now receive credit towards their required training hours by participating in DEP's professional learning opportunities.

DEP's 2019 Water Resources Art & Poetry Contest engaged more than 1,700 students from over 85 schools in the watershed and New York City. Trout in the Classroom engaged over 20,000 students and teachers from approximately 150 schools in the watershed and New York City. DEP sponsored several performances of the new, updated "City That Drinks the Mountain Sky" and continued to collaborate with the Children's Museum of Manhattan to support educational events in connection with the "Dynamic H2O" splashy outdoor water exhibition. DEP's annual watershed bus tour for non-formal educators, funded by the WAC Forestry Program, allowed more than 50 educators from New York City to visit the watershed and learn about source water protection programs that support working landscapes. DEP, with WAC's support, also conducted a watershed forestry bus tour for 35 New York City classroom teachers on Veterans Day to learn about and experience the water supply system and watershed issues.

Another primary way DEP and its partners directly educate specific audiences is through targeted watershed protection programs. Accomplishments for 2019 include:

- The CWC Public Education Program awarded 33 education grants totaling nearly $200,000 to schools and organizations in the watershed and New York City; the estimated audience for all of these programs is more than 18,400 people. To date, CWC has awarded 616 grants totaling $3.3 million. For additional information, please visit the following CWC websites: watersheducators.org or cwconline.org.

- CWC, in support of its septic system rehabilitation programs, sponsored three septic system design workshops for local engineers and professionals. In July, CWC sponsored a public performance of "City That Drinks The Mountain Sky" in East Meredith. In October, CWC sponsored Catskills Local Government Day in Hunter that was attended by 60 participants, primarily local officials.
- The Watershed Agricultural Program conducted more than 24 farmer education programs attended by 677 participants. Highlights include the annual Catskill Regional Agricultural Conference, the annual WAC Farm Tour, and dozens of workshops, tours, pasture walks and seminars covering agricultural topics. WAC continued to promote its programs through its website (nycwatershed.org), in addition to promoting local farm and forestry products through the Pure Catskills Campaign (purecatskills.com).
- The WAC Forestry Program continued to utilize the MyWoodlot.com website for educating forest landowners and engaging them in stewardship activities, while the four watershed model forests continued to host dozens of educational events for all audiences. In 2019, WAC sponsored 10 logger training workshops for 102 participants and 30 bus tours for 351 adults and 1,429 students, primarily from New York City. Twenty-seven teachers attended the annual Watershed Forestry Institute in July and 141 students participated in the annual 2019 Green Connections School Partnership Program.
- The Stream Management Program continued to educate and train streamside landowners, municipal officials, watershed professionals, school-based audiences, and other basin-specific stakeholders. Highlights for 2019 include the Schoharie Watershed Summit, Ashokan Watershed Month, Ashokan Stream Explorers Youth Conference, Rondout Neversink Anglers Symposium, Leave No Trace Stream Stewardship Program at Blue Hole, Summer Youth Stream Snorkeling Program, Youth Climate Change Leadership Summit, three Earth Day events at watershed elementary schools, four Envirothons with high school students, erosion and sediment control workshops for contractors, a HEC-RAS workshop for modeling culverts and bridges, more than a dozen highway superintendent meetings, and a two-day flood hazard mitigation workshop on elevation and floodproofing measures for local professionals and community leaders. The Watershed Conservation Corps, a summer internship program funded by DEP through a contract with SUNY Ulster, enjoyed its 25th year as a pipeline for future stream stewards, scientists, and potential permanent hires for the agency. In October, DEP and its SMP partners hosted a week-long training by nationally acclaimed hydrologist Dave Rosgen, one of the foremost stream management experts in the world. While in the Catskills, Dr. Rosgen conducted a free public lecture at Belleayre Mountain titled "Living with Mountain

Rivers in a Changing Climate" that was attended by more than 100 people. The catskillstreams.org site continues to serve as an educational resource.

Throughout the year, DEP and its partners attended numerous community outreach events and speaking engagements which enable staff to interact directly with the public, share scientific knowledge with fellow professionals, and communicate key messages. Highlights for 2019 include the Catskill Forest Festival, Catskill Great Outdoor Expo, Delaware County Fair, Grahamsville Little World's Fair, Greene County Youth Fair, Kingston Summer Showcase, Lower Hudson Valley Engineering Expo, Margaretville Cauliflower Festival, NYC Environmental Expo, NYC Water Day, NYC Watershed Science and Technical Conference, New York State Floodplain Managers Annual Conference, New York State Wetlands Forum, Olive Day, New York State Woodsmen's Field Days, Northeast Outdoor Show, Rockland Community College World Fishing and Outdoor Expo, Shandaken Day, SPDES Permit Outreach Meetings, and Ulster County Fair.

DEP also continued the Water-On-The-Go Program by operating drinking water fountains (with messaging about the water supply) in public plazas, busy pedestrian areas, and parks throughout New York City during the summer months. These fountains occupied flagship locations such Brooklyn Bridge Park's Pier I and Union Square, and they could also be found at flagship events such as the NYC Pride March and Fourth of July Celebration.

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 40% 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.

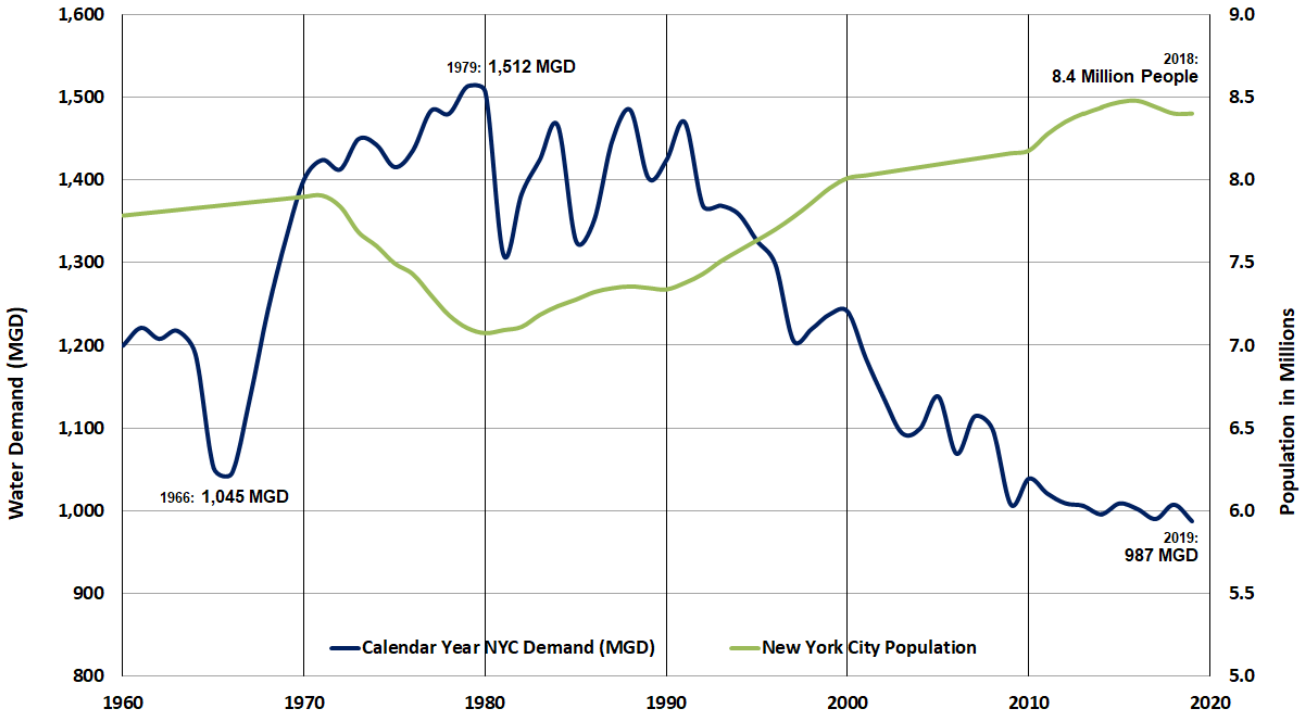

Figure 9.1 New York City water demand and population.

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 (MGD) by 2022. This goal is detailed in the 2018 Water Demand Management Plan (https://www1.nyc.gov/assets/dep/downloads/pdf/water/drinking-water/2018-water-demand-management-plan.pdf). The plan sets forth six major strategies DEP continues to implement to reduce water use. 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, hospitals, and universities.
- 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.
- Wholesale Customers Water Demand Management Program: Targets demand management planning and implementation for wholesale customers north of the City.

The following is a summary of DEP's 2019 progress in implementing the above listed strategies.

Municipal Water Efficiency Program

DEP has established partnerships and completed several projects with key municipal agencies and entities to support water efficiency measures in their facilities. Partners include the New York City Department of Education (DOE), the New York City Department of Parks and Recreation (DPR), the New York City Fire Department (FDNY), the City University of New York (CUNY), New York City Health and Hospitals Corporation (HHC), New York City Department of Citywide Administrative Services (DCAS), and New York City Department of Cultural Affairs - Cultural Institutions Group (CIG).

Through its ongoing partnership with DOE, DEP funded the replacement of over 34,600 toilets and urinals with high-efficiency models in 402 school facilities across all five boroughs through 2018. DEP received additional funding in 2019 to continue this important partnership, and anticipates retrofitting up to an additional 200 school facilities in 2020.

In 2019, DEP continued its partnership with DPR and received funding for implementation of two projects. In Central Park, DEP is partnering with Central Park Conservancy and DPR to connect the Harlem Meer outflow to the Jacqueline Kennedy Onassis Reservoir (Reservoir) to recirculate stormwater in the park's northern waterbodies. Recirculated

water will be used to refill the reservoir in place of potable water. This project is anticipated to result in a savings of 0.83 MGD. In Prospect Park, DEP is partnering with Prospect Park Alliance and DPR to replace a valve on the make-up water line for the park's lake system. This project is anticipated to result in a savings of 0.80 MGD.

In December 2019, DEP launched a fifth Water Challenge to all 14 Wastewater Resource Recovery Facilities (WRRFs) to encourage water reduction in DEP's own facilities. All plants are encouraged to reduce demand by 10% over a two-year baseline average (calendar years 2018 and 2019). If all facilities achieve this goal, an estimated 2.7 MGD of savings could be achieved. All 14 WRRFs have participated in previous challenges. Additionally, DEP is currently working to replace inefficient water pumps and water hoses with high-efficiency models used to clean equipment at each WRRF and other equipment with high-efficiency models at our treatment facilities.

In November 2018, DEP performed water audits at the three largest WRRFs. Through the auditing process, engineers completed an extensive review of water use at each plant, and identified parts of the water treatment process that could be modified to reduce consumption. In 2019, DEP identified several projects that can reduce water consumption, including expanding the use of effluent in place of potable water, retrofitting seal pumps, and replacing hose nozzles used for tank spray downs. Findings from the audits were compiled into a comprehensive report in 2019 that identifies cost-efficient water savings measures currently being considered for implementation.

In 2019, DEP continued its partnership with HHC and completed retrofits at Harlem Hospital. Retrofits at the hospital included more than 570 fixtures and ice machines, more than 900 faucets, and one industrial dishwasher, conserving 70,000 gallons of water per day. DEP will retrofit additional HHC hospitals through 2022. Overall, this partnership with HHC is expected to result in a savings of 1.22 MGD.

DCAS's portfolio includes approximately 50 public buildings throughout the city, including courts and City office buildings. Partnering with DEP, DCAS surveyed 10 buildings within their portfolio. In total, over 1,300 fixtures (toilets and urinals) are inefficient and eligible for retrofit. Retrofits began in 2019. This partnership with DCAS is expected to result in a savings of 0.24 MGD.

In 2015, DEP partnered with CIG and helped support funding for a pump system as part of a stream corridor restoration project to conserve water in Brooklyn Botanic Garden (BBG). Previously, BBG's stream system was fed by a combination of groundwater and City water inputs. The stream corridor restoration project was completed in April 2019 and reduces BBG's outdoor potable water consumption for its water features from 22 million gallons to less than one million gallons per year (a nearly 96% decrease), a reduction of 57,800 gallons per day.

Residential Water Efficiency Program

In June 2019, DEP concluded the Toilet Replacement Program after five years of successful implementation. The program provided eligible residential building owners with $125 vouchers to replace old, inefficient toilets with high-efficiency, WaterSense-certified models. DEP managed contracts with four toilet wholesale vendors to accept the vouchers and provide the toilets to consumers through the program's online application tool. Through the program, approximately 13,300 toilets were retrofitted citywide for a savings of 0.63 MGD.

In addition to 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 2019, Honeywell conducted surveys in 4,244 individual apartments in 2,127 single-family apartment buildings. Honeywell also surveyed 209 multi-family buildings, and 4,212 individual units within these properties.

Non-Residential Water Efficiency Program

DEP successfully launched three Water Challenges to different commercial sectors: hotels, restaurants, and hospitals. 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.

In 2018, DEP launched a Water Challenge to Universities: https://www1.nyc.gov/site/dep/water/nyc-water-challenges-for-non-residential-sectors.page. New York City is home to more university students than any other city in the country and the challenge builds upon ongoing campus sustainability initiatives at each participating university. The six participating universities are Fordham University, Long Island University, New School, Pace University, St. John's University, and Weill Cornell University. Identical to previous Water Challenges, the goal of this challenge is for the six participants to achieve a 5% reduction in water consumption, which is 42,000 gallons per day. In 2019, Water Challenge participant consumption declined by 10%, or approximately 0.1 MGD, surpassing the 5% reduction goal.

Water Distribution System Optimization

Water distribution system optimization includes system repairs and upgrades, water pressure management, refining water meter accuracy, and leak detection. In 2019, DEP surveyed 1,099 miles of water mains.

In 2014, DEP implemented a strategic approach to leak detection. Borough-based teams are trained in leak detection to 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 2019, DEP repaired 9,668 hydrants, replaced 1,328, and provided other maintenance services to 13,234 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 1,843 large meters in 2019 (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 understanding of City water use. DEP anticipates formal adoption of the revised rules prior to the 2022 shutdown.

Wholesale Customers Water Demand Management Program

As of 2019, DEP offers assistance and is working with seven upstate wholesale customers (utility partners) in upstate watershed communities to develop demand management plans for their systems with a target 5% reduction in consumption.

In 2019, the Village of Ossining continued to implement its demand management plan. Additionally, the remaining six utility partners finalized and approved their demand management plans, and each will work to implement conservation measures identified in their plan. Individual intergovernmental agreements (IGAs) were also developed and reviewed by each utility partner in 2019, and are anticipated to be fully executed in 2020. Each IGA represents a contractual funding obligation from DEP and commitment from the utility partner to implement their demand management plan.

9.2 Updates to Drought Management Plan

In 2019, monthly average precipitation was above normal for just under 50% of the year (based on historical average for the period 1989-2019). The NYC Delaware Basin Reservoir

System storage stayed above the "Normal" storage level 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 have been established to identify when a Drought Watch, Warning, or Emergency should be declared and when the appropriate responses should be implemented. These guidelines are based on prevalent hydrological and meteorological conditions, certain operational considerations and other factors. In some cases, other circumstances may influence the timing of drought declarations.

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

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

9.3 Delaware Aqueduct Leak

DEP efforts to repair the Delaware Aqueduct continued in 2019 and included the following major activities:

- Completion of the bypass tunnel mining activities in August 2019.

- Catskill Aqueduct Repair and Rehabilitation (CATRR): Continued construction during shutdown two (of three), which initiated in 2018.
- Preparation of a Delaware Aqueduct Shutdown Management Plan describing water supply operations before, during and after the Delaware Aqueduct Shutdown is underway. The completed plan document will be finalized by mid-2020.

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 ready to operate. Quarterly meetings are held to review status of the monthly testing of the pumping station.

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

The bypass tunnel contract, BT-2, is underway. The tunnel boring machine completed its excavation on August 13, 2019, and installation of steel interliners is in progress. Upon completion of this effort, the tie-in to the existing RWBT will commence in fall 2022. 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 during 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 DEP's DEL-LTA contract. The purpose of this program is to determine if tunnel conditions are changing. DEP routinely monitors tunnel flow rates, operational trends, and surface expressions to confirm the steady-state condition of the RWBT leak. The monitoring efforts resulted in a determination of no substantial change during 2019.
- The DEL-LTA contract supports autonomous underwater vehicle and remote-operated vehicle flights within the RWBT as needed. No inspections were deemed necessary during 2019.

Catskill Aqueduct Repair and Rehabilitation (CATRR)

The CATRR project focuses on the section of the aqueduct between Ashokan Reservoir in Ulster County and Kensico Reservoir in Westchester County. The project's scope focuses on inspection of the entire aqueduct, repairing deficiencies (including concrete and mechanical components), and removing a biofilm layer on the interior walls to improve the hydraulic characteristics of the tunnel and restore tunnel capacity. CAT-RR construction commenced in August 2018 and the second tunnel shutdown was completed between November 2019 and January 2020 with significant scope achieved.

Two related projects include building chemical addition facilities at the Ashokan Screen Chamber (CAT-213E) and the Pleasantville Alum Plant (CAT-213F) to deliver chlorination and

dechlorination chemicals, respectively. They are underway and substantial completion is anticipated in late 2020.

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. In recognition that the work supporting the existing preliminary plans was over 25 years old, the 2017 FAD required the City to contract for a comprehensive review of filtration methods and technologies, resulting in the development of a new conceptual design for a filtration facility or facilities.

Next Steps

In 2018, the City met the milestones specified in the 2017 FAD implemented for the CAT/DEL Filtration Plant Design. DEP advertised a new contract to perform engineering services for studies and conceptual design enhancements for the treatment of Catskill and Delaware water supply systems in upstate New York 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. The design review process includes:

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

During 2019, the protocols for bench scale testing were finalized and water collection and testing began in July 2019. Weekly sampling continued for a six-month period and concluded with bench scale testing officially ending on December 20, 2019. Monthly reports were provided during the bench scale testing and the team is currently generating a final report that documents the results of the pilot studies and discusses the advantages and disadvantages of each process piloted. The pilot studies summary report is a FAD deliverable with a due date of June 30, 2020, and, once reviewed and discussed with the City and the independent technical review team, will mark the completion of Task 1 under the City's contract.

9.5 Arkville Office

DEP has committed to locate staff in a new office being constructed in Arkville, N.Y. by the Catskill Watershed Corporation (CWC). The goal of sharing space is to further improve coordination on joint programs and to enhance accessibility for watershed communities. The FAD requires DEP to assign specific numbers of staff to the new facility in the coming years.

Construction of the new building in Arkville began in late 2018 and proceeded rapidly throughout 2019. By the end of the year, the office was substantially complete. In parallel with the construction, DEP and the City's Department of Citywide Administrative Services (DCAS) negotiated a lease with CWC for the portion of the building to be occupied by DEP. The City and CWC reached agreement on the lease terms in late 2019. DEP secured funds to make payments required by the lease and began the process of registering the lease. CWC staff is expected to take occupancy of their portion of the building in the spring 2020 and DEP staff will begin moving in later in the year.

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