NYC
Environmental
Protection

Caswell F. Holloway
Commissioner
cholloway@dep.nyc.gov

59-17 Junction Boulevard
Flushing, NY 11373

(718) 595-6565 tel
(718) 595-3525 fax

January 21, 2010

Mr. William Adriance
Chief Permit Administrator
Division of Environmental Permits
New York State Department of Environmental Conservation
625 Broadway, 4th Floor
Albany, New York 12233-1750

Dear Mr. Adriance:

Enclosed are four copies of New York City's application for a Public Water Supply Permit. The Permit is being sought to continue the City's watershed Land Acquisition Program, currently operated under Water Supply Permit #0-9999-00051/00001. The Permit Application sets forth the critical role that DEP's Land Acquisition Program plays in ensuring the continued high quality of the City's drinking water supply.

Attachment A to this letter provides an annotated list of application components. The list derives from DEC's web site (http://www.dec.ny.gov/permits/6377.html) and was discussed by DEC and DEP during a pre-application meeting on December 17, 2009.

Attachment B to this letter contains information requested in the instructions for the Supplemental W-1 Form.

If you have any questions on his matter please do not hesitate to contact me.

Sincerely,

Caswell F. Holloway

cc: Roger Sokol, NYS Department of Health
Phil Sweeney, US Environmental Protection Agency
Dennis Lucas, Coalition of Watershed Towns

Attachment A

Permit Application Exhibits

The following components are included in the application unless as referenced pursuant to and in agreement with a discussion between NYC DEP and NYS DEC on December 17, 2009.

Exhibit	Description
1	**Project Authorization**
2	**General Map**
3a & b	**USGS Topographic Maps, or equivalent**
4	**Detailed profiles of the proposed facilities:** Not applicable; confirmed by DEC.
5a & b	**Detailed contract plans and specifications:** Per DEC's request, this consists of DEP's standard purchase contracts for acquisition of fee simple (5a) and conservation easements (5b).
6	**Engineer's Report**
7	**Maps showing the lands to be acquired:** Per DEC's request, this section provides a narrative discussion regarding the Land Acquisition Program and refers to maps submitted in Exhibits 2, 3a, and 3b; it includes DEP's Long-Term 2012 – 2022 Land Acquisition Plan.
8	**Cost Estimate**
9a & b	**Water Quality Analyses:** 2008 Watershed Water Quality Annual Report (9a) and 2008 Drinking Water Supply and Quality Report (9b)
10	**Proposed Treatment Methods**
11	**Project Justification:** includes the following items: a. Public necessity b. Consideration of other supplies c. Work is proper and safe d. Sufficient supply e. Supply is protected f. Just and equitable to residents g. Fair and equitable compensation h. Conservation program.

Other Components:

Description

SEQR Compliance: to be submitted under separate cover.

SHPA Compliance

Water Conservation Program Form: per agreement with DEC, this component consists of DEP's 2006 Water Conservation Program Report, not the Water Conservation Program Form.

Attachment B

Other Permit Application Information

1) **Name and location of a suitable place in which to hold a public hearing should one prove necessary**

The City will determine the number and specific location of one or more sites to hold public hearings in consultation with NYS DEC as the permit review process unfolds.

2) **Applicant's Attorney**

Robin Levine
General Counsel, NYC DEP
59-17 Junction Boulevard, 19th Floor
Flushing, NY 11373
(718) 595-6586

3) **Applicant's Engineer**

Paul V. Rush, P.E.
Deputy Commissioner, NYC DEP Bureau of Water Supply
P.O. Box 358
Grahamsville, NY 12740
(845) 985-2275

4) **Other Consultants**

The applicant has retained the services of Appleseed, Inc. as its consultant for the environmental review connected with this application. Their contact information is as follows:

Appleseed, Inc.
Hugh O'Neill, President
80 Broad Street, 13th Floor
New York, NY 10004
(212) 964-9711

JOINT APPLICATION FORM - INSTRUCTIONS

For Permits/Determinations to undertake activities affecting streams, waterways, waterbodies, wetlands, coastal areas and sources of water supply.

New York State
Department of Environmental Conservation (DEC)
Office of General Services (OGS)
Department of State (DOS)

US Army Corps of Engineers (USACE)
New York District
Buffalo District

Type or print clearly in ink. Incomplete or inaccurate information may delay processing and a final decision on your application. Individual Agencies may request that you submit additional information to complete your application.

PERMITS REQUESTED Check all Permits/Determinations requested from all the listed Agencies.

Separate authorizations or determinations of no permit required must be received from each Agency in accordance with their jurisdiction prior to initiation of work.

The applicant is responsible for obtaining any other federal, state or local permits or other approvals.

APPLICANT / OWNER / CONTACT INFORMATION AND SIGNATURES Signatures of the Applicant, Owner and Agent, where applicable, are required.

Applications by a Corporation must be signed by a member of the board of directors or a "high managerial agent" of the corporation as that term is defined in the § 20.20 of the Penal Law; a Partnership by a general partner; a Sole Proprietorship by the proprietor; a Limited Liability Company by member or manager in accordance with the LLC's articles of organization as filed with the Secretary of State.

Applications by a State Agency must be signed by a person duly designated by the commissioner or other agency head. Applications by Municipalities (counties, cities, towns and villages) and Public Corporations must be signed by the chief executive officer, the head of a subordinate agency or department, or a person duly designated by the chief executive officer.

Construction or work contractors may serve as a contact/agent on behalf of the applicant, but cannot be identified as the applicant or prospective permittee should a permit be issued.

PROJECT / FACILITY LOCATION INFORMATION Location Coordinates are expressed in New York Transverse Mercator (NYTM) units (i.e., UTM Zone 18 expanded to encompass the entire state) based on the North American Datum 1983, or Latitude and Longitude. If you are able to supply accurate coordinates, please do so. Coordinates may be obtained from DEC's online Environmental Resource Mapper (www.dec.ny.gov/animals/38801.html), using the Identify i tool.

PROJECT DESCRIPTION AND PURPOSE Provide a complete narrative description of the proposed work and its purpose. Attach additional page(s) if necessary.

REQUIRED APPLICATION ATTACHMENTS

Attach and submit the following to each involved Agency:

1) **LOCATION MAP** A US Geological Survey (USGS) Quadrangle Map, or equivalent identifying the project location. The map should include wetlands, seasonally wet streams and ditches. An acceptable location map may be obtained from DEC's online Environmental Resource Mapper (www.dec.ny.gov/animals/38801.html), using the Printer tool.

2) **PROJECT PLANS** A sketch plan view and cross-section drawn to scale with dimensions given, or engineering drawings showing location and extent of work. Note from which direction the photographs required in (3) are taken.

3) **PHOTOGRAPHS** At least 3 color photographs, taken from multiple directions, that clearly depict the site of the proposed activity, including any existing structures on the site, and the area surrounding that site. Indicate the time and date when taken.

OTHER REQUIREMENTS

For NY State Agencies - State Environmental Quality Review Act regulations (SEQR), 6 NYCRR Part 617 (www.dec.ny.gov/regs/4490.html) -

a) If the project is an Unlisted Action, submit a completed Part 1 of a Short Environmental Assessment Form. *
b) If the project is a Type I Action, submit a completed Part 1 of a Full Environmental Assessment Form. *

For NYS DEC Only - Complete the **Permission to Inspect Property Supplement** * to provide consent for DEC inspection. Failure to grant consent can be grounds for, and may result in, permit denial.

For USACE/NYS DOS - If the project requires a federal permit and lies within or affects the Coastal Zone (see the DOS Coastal Area Maps at www.nyswaterfronts.com/maps_regions.asp), submit a completed Federal Consistency Assessment Form (available at www.nyswaterfronts.com/consistency_federal.asp) to NYS DOS with a copy to USACE.

For USACE Section 404 Clean Water Act permits and specific Nationwide permits - a 401 Water Quality Certification must be obtained from NYS DEC.

For Adirondack Park - If the project is within the Adirondack Park, to determine permitting applicability contact -
NYS Adirondack Park Agency, 1133 NYS Rte 86, PO Box 99, Ray Brook, NY 12977 (518) 891-4050 www.apa.state.ny.us

SPECIAL SUPPLEMENTS AND REQUIREMENTS FOR SPECIFIC PERMIT APPLICATIONS

Applications for . . .	must be accompanied by . . .
• **Dams and Impoundment Structures**	Supplement D-1 *
• **Docks and Moorings**	Supplement D-2 *
• **Water Supply**	Supplement W-1 *
• **Long Island Well**	Regional specific supplement *
• **Wild, Scenic and Recreational River Systems**	Supplement WSR-1 *
• **Aquatic Vegetation, Aquatic Insect, and Fish Control**	Category specific form available at NYS DEC offices and at www.dec.ny.gov/chemical/8530.html. Submit applications to the NYS DEC regional office, Attn: Bureau of Pesticides.

• **USACE Section 404 Clean Water Act**, and **DEC Freshwater Wetlands** and **Tidal Wetlands** . . . Applications to disturb a wetland or waterway by placing fill or performing mechanized land clearing, ditching, channelization, dredging, or excavation activities should provide a discussion of practicable alternatives considered to avoid, minimize and/or mitigate the proposed project impacts. Particular justification should be given as to why the alternatives are not suitable.

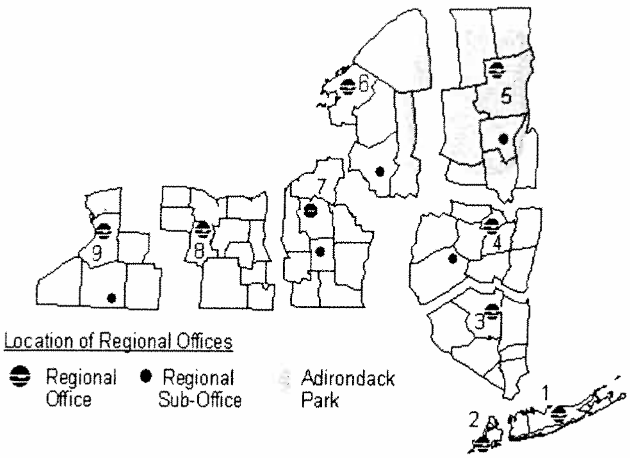
* Forms are available at NYS DEC offices and at www.dec.ny.gov/permits/6222.html

SUBMISSION OF APPLICATION FORMS AND ATTACHMENTS

Separately mail the completed application to each involved Agency based on project location and permit(s) requested.
For DEC - Mail **3 copies** of Pages 1 and 2 of the Application Form and **3 copies** of all required attachments.
For Other Agencies - Mail **1 copy** of Pages 1 and 2 of the Application Form and **1 copy** of all required attachments.

AGENCY CONTACT INFORMATION

NYS Department of Environmental Conservation
www.dec.ny.gov



NYS DEC REGION 4 Sub-Office
Regional Permit Administrator
65561 State Hwy 10
Stamford, NY 12167-9503
(607) 652-7741
email: r4dep@gw.dec.state.ny.us

NYS DEC REGION 7
Regional Permit Administrator
615 Erie Blvd West
Syracuse, NY 13204-2400
(315) 426-7438
email: r7dep@gw.dec.state.ny.us

NYS DEC REGION 5
Regional Permit Administrator
PO Box 296
1115 Route 86
Ray Brook, NY 12977-0296
(518) 897-1234
email: r5dep@gw.dec.state.ny.us

NYS DEC REGION 7 Sub-Office
Regional Permit Administrator
1285 Fisher Avenue
Cortland, NY 13045-1090
(607) 753-3095
email: r7dep@gw.dec.state.ny.us

NYS DEC REGION 5 Sub-Office
Regional Permit Administrator
PO Box 220
232 Golf Course Rd
Warrensburg, NY 12885-0220
(518) 623-1281
email: r5dep@gw.dec.state.ny.us

NYS DEC REGION 8
Regional Permit Administrator
6274 E. Avon - Lima Road
Avon, NY 14414-9519
(585) 226-5400
email: r8dep@gw.dec.state.ny.us

NYS DEC REGION 1
Regional Permit Administrator
SUNY @ Stony Brook
50 Circle Road
Stony Brook, NY 11790-3409
(631) 444-0365
email: r1dep@gw.dec.state.ny.us

NYS DEC REGION 3
Regional Permit Administrator
21 South Putt Corners Road
New Paltz, NY 12561-1620
(845) 256-3054
email: r3dep@gw.dec.state.ny.us

NYS DEC REGION 6
Regional Permit Administrator
317 Washington Street
Watertown, NY 13601-3787
(315) 785-2245
email: r6dep@gw.dec.state.ny.us

NYS DEC REGION 9
Regional Permit Administrator
270 Michigan Avenue
Buffalo, NY 14203-2915
(716) 851-7165
email: r9dep@gw.dec.state.ny.us

NYS DEC REGION 2
Regional Permit Administrator
1 Hunter's Point Plaza
47-40 21st Street
Long Island City, NY 11101-5407
(718) 482-4997
email: r2dep@gw.dec.state.ny.us

NYS DEC REGION 4
Regional Permit Administrator
1130 North Westcott Road
Schenectady, NY 12306-2014
(518) 357-2069
email: r4dep@gw.dec.state.ny.us

NYS DEC REGION 6 Sub-Office
Regional Permit Administrator
207 Genesee Street
Utica, NY 13501-2885
(315) 793-2555
email: r6dep@gw.dec.state.ny.us

NYS DEC REGION 9 Sub-Office
Regional Permit Administrator
182 East Union, Suite 3
Allegany, NY 14706-1328
(716) 372-0645
email: r9dep@gw.dec.state.ny.us

US Army Corps of Engineers
www.usace.army.mil

For DEC Regions 1, 2 and 3
US Army Corps of Engineers NY District
ATTN: Regulatory Branch
26 Federal Plaza, Room 1937
New York, NY 10278-0090
email: CENAN.PublicNotice@usace.army.mil
For DEC Regions 1, 2, Westchester County and Rockland County - (917) 790-8511
For the other counties of DEC Region 3 - (917) 790-8411

For DEC Regions 4, 5
Department of the Army
ATTN: CENAN-OP-R
NY District, Corps of Engineers
1 Buffington Street
Building 10, 3rd Floor
Watervliet, NY 12189-4000
(518) 266-6350 - Permits team
(518) 266-6360 - Compliance Team
email: cenan.rfo@usace.army.mil

For DEC Regions 6, 7, 8, 9
US Army Corps of Engineers
Buffalo District
ATTN: Regulatory Branch
1776 Niagara Street
Buffalo, NY 14207-3199
(716) 879-4330
email: LRB.Regulatory@usace.army.mil

Statewide
NYS Department of State
Division of Coastal Resources
Consistency Review Unit
One Commerce Plaza
99 Washington Ave, Suite 1010
Albany, NY 12231-00001
(518) 474-6000
www.nyswaterfronts.com

Statewide
NYS Office of General Services
Real Estate Development - Land Management
Corning Tower, 26th Floor
Empire State Plaza
Albany, NY 12242-0001
(518) 474-2195
www.ogs.state.ny.us

JOINT APPLICATION FORM

New York State

For Permits/Determinations to undertake activities affecting streams, waterways waterbodies, wetlands, coastal areas and sources of water supply.

Separate Permits/Determinations must be obtained from each involved agency prior to proceeding with work. Please read all instructions.

US Army Corps of Engineers (USACE)

1. Check All That Apply:

NYS Department of Environmental Conservation
- [ ] Stream Disturbance
- [ ] Excavation and Fill in Navigable Waters
- [ ] Docks, Moorings or Platforms
- [ ] Dams and Impoundment Structures
- [ ] 401 Water Quality Certification
- [ ] Freshwater Wetlands
- [ ] Tidal Wetlands
- [ ] Coastal Erosion Management
- [ ] Wild, Scenic and Recreational Rivers
- [x] Water Supply
- [ ] Long Island Well
- [ ] Aquatic Vegetation Control
- [ ] Aquatic Insect Control
- [ ] Fish Control

US Army Corps of Engineers
- [ ] Section 404 Clean Water Act
- [ ] Section 10 Rivers and Harbors Act
- [ ] Nationwide Permit(s) - Identify Number(s): ______
  Preconstruction Notification - [ ] Y / [ ] N

NYS Office of General Services (State Owned Lands Under Water)
- [ ] Utility Easement (pipelines, conduits, cables, etc.)
- [ ] Docks, Moorings or Platforms

NYS Department of State
- [ ] Coastal Consistency Concurrence

2. Name of Applicant (use full name): City of New York

Applicant must be (check all that apply): [x] Owner [x] Operator [ ] Lessee

Street Address: Dept. of Environmental Protection, 59-17 Junction Boulevard

Taxpayer ID (If applicant is NOT an individual): 13-6400434

Post Office City	State	Zip Code	Telephone (daytime)	Email
Flushing	NY	11373	718-595-6586	RobinL@dep.nyc.gov

3. Name of Facility or Property Owner, if different than Applicant

Street Address

Post Office City	State	Zip Code	Telephone (daytime)	Email

4. Contact/Agent Name: David Warne, Assistant Commissioner

Company Name: NYCDEP, Bureau of Water Supply

Street Address: 465 Columbus Avenue

Post Office City	State	Zip Code	Telephone (daytime)	Email
Valhalla	NY	10595	914-742-2099	dwarne@dep.nyc.gov

5. Project / Facility Name: New York City Watershed

Property Tax Map Section / Block / Lot Number

Project Location - Provide directions and distances to roads, bridges and bodies of waters: See Exhibits 2, 3a and 3b

Street Address, if applicable

Post Office City	State	Zip Code	Telephone, if applicable	Email
	NY			

Town / Village / City

County

Name of USGS Quadrangle Map

Stream/Water Body Name

Location Coordinates: Enter NYTMs in kilometers, **OR** Latitude/Longitude in degrees, minutes, seconds

NYTM-E	NYTM- N	Latitude	Longitude

6. If applicant is not the owner, both must sign the application. I hereby affirm that information provided on this form and all attachments submitted herewith is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law. Further, the applicant accepts full responsibility for all damage, direct or indirect, of whatever nature, and by whomever suffered, arising out of the project described herein and agrees to indemnify and save harmless the State from suits, actions, damages and costs of every name and description resulting from said project. In addition, Federal Law, 18 U.S.C., Section 1001 provides for a fine of not more than $10,000 or imprisonment for not more than 5 years, or both where an applicant knowingly and willingly falsifies, conceals, or covers up a material fact; or knowingly makes or uses a false, fictitious or fraudulent statement.

Signature of Applicant	Printed Name	Title	Date
[signature]	Caswell F. Holloway	Commissioner	01-19-10
Signature of Owner	Printed Name	Title	Date
Signature of Agent	Printed Name	Title	Date

For Agency Use Only DEC Application Number: USACE Number:

Reset

JOINT APPLICATION FORM - PAGE 2 OF 2

Submit this completed page as part of your Application.

7. **Project Description and Purpose:** Provide a complete narrative description of the proposed work and its purpose. Attach additional page(s) if necessary. Include: description of current site conditions and how the site will be modified by the proposed project; structures and fill materials to be installed; type and quantity of materials to be used (i.e., cubic yds or square ft of fill material below ordinary high water, or of structures below mean high water); area of excavation or dredging, volumes of material to be removed and location of dredged material disposal or use; work methods and type of equipment to be used; pollution control methods and mitigation activities proposed to compensate for resource impacts; and where applicable, the phasing of activities.

See Exhibits 7 & 11

Proposed Use: ☐ Private ☑ Public ☐ Commercial

Will Project Occupy Federal, State or Municipal Land? ☐ Yes ■ No
If yes, please specify.

Has Work Begun on Project? ■ Yes ☐ No If Yes, explain.

Proposed project is a continuation of the acquisition program authorized under WSP #0-9999-00051/00001

Proposed Start Date: January 21, 2012

Estimated Completion Date: January 20, 2022

8. List Previous Permit / Application Numbers (if any) and Dates:

Public Water Supply Permit #0-9999-00051/00001

9. Will this project require additional Federal, State, or Local Permits including zoning changes? ☐ Yes ■ No If Yes, please list:

10. Based on the permits and determinations requested and project location, check all the boxes corresponding to each of the Agencies and Offices to which you are filing an application. For Agency addresses and areas covered, refer to the Agency Contact Information on the Application Instructions - Page 2.

☐ **NYS Department of Environmental Conservation**

☐ REGION 1 Stony Brook
☐ REGION 2 Long Island City
☑ REGION 3 New Paltz
☑ REGION 4 Schenectady
☐ REGION 4 Stamford Sub-Office
☐ REGION 5 Ray Brook
☐ REGION 5 Warrensburg Sub-Office
☐ REGION 6 Watertown
☐ REGION 6 Utica Sub-Office
☐ REGION 7 Syracuse
☐ REGION 7 Cortland Sub-Office
☐ REGION 8 Avon
☐ REGION 9 Buffalo
☐ REGION 9 Allegany Sub-Office

☐ **US Army Corps of Engineers**

☐ NY District, NYC ☐ NY District, Watervliet ☐ Buffalo District

☐ **NYS Department of State**

☐ **NYS Office of General Services**

For Agency Use Only

DETERMINATION OF NO PERMIT REQUIRED

Agency Project Number ______________________

______________________ has determined that No Permit is required from this Agency for the project described in this application.
(Agency Name)

Agency Representative: Name (printed) ______________________ Title ______________________

Signature ______________________ Date ______________________

New York State
Department of Environmental Conservation

PERMISSION TO INSPECT PROPERTY

By signing this permission form for submission with an application for a permit(s) to the Department of Environmental Conservation ("DEC"), the signer consents to inspection by DEC staff of the project site or facility for which a permit is sought and, to the extent necessary, areas adjacent to the project site or facility. This consent allows DEC staff to enter upon and pass through such property in order to inspect the project site or facility, without prior notice, between the hours of 7:00 a.m. and 7:00 p.m., Monday through Friday. If DEC staff should wish to conduct an inspection at any other times, DEC staff will so notify the applicant and will obtain a separate consent for such an inspection.

Inspections may take place as part of the application review prior to a decision to grant or deny the permit(s) sought. By signing this consent form, the signer agrees that this consent remains in effect as long as the application is pending, and is effective regardless of whether the signer, applicant or an agent is present at the time of the inspection. In the event that the project site or facility is posted with any form of "posted" or "keep out" notices, or fenced in with an unlocked gate, this permission authorizes DEC staff to disregard such notices or unlocked gates at the time of inspection.

The signer further agrees that during an inspection, DEC staff may, among other things, take measurements, may analyze physical characteristics of the site including, but not limited to, soils and vegetation (taking samples for analysis), and may make drawings and take photographs.

Failure to grant consent for an inspection is grounds for, and may result in, denial of the permit(s) sought by the application.

Permission is granted for inspection of property located at the following address(es):

Any fee simple properties acquired pursuant to this permit

*By signing this form, I affirm under penalty of perjury that I am authorized to give consent to entry by DEC staff as described above. I understand that false statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.**

David S. Warne, Asst. Comm.	[signature]	1/20/10
Print Name and Title	Signature	Date

*The signer of this form must be an individual or authorized representative of a legal entity that:

- owns fee title and is in possession of the property identified above;
- maintains possessory interest in the property through a lease, rental agreement or other legally binding agreement; or
- is provided permission to act on behalf of an individual or legal entity possessing fee title or other possessory interest in the property for the purpose of consenting to inspection of such property.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK, 12233-0001

WATER SUPPLY APPLICATION
Supplement W-1 for Public Water Supply Permit

READ THE INSTRUCTIONS ON PAGE 2 BEFORE COMPLETING THIS FORM

FOR DEPARTMENT USE ONLY
APPLICATION NUMBER
WSA NUMBER

PLEASE TYPE OR PRINT CLEARLY IN INK

1. PROJECT DESCRIPTION (INCLUDE LOCATION - for multiple well heads, identify and attach additional coordinates)
Land Acquisition in the watershed of the New York City water supply system - See Exhibits 7 and 11

COORDINATES
NYTM-E ________
NYTM-N ________

2. PROJECT PURPOSE
Protection of the New York City water supply - See Exhibit 11

3. THIS PROJECT INVOLVES: (Check all that apply and, for each item checked, provide a brief description or identification)

- [x] ACQUISITION of existing facilities — Acquisition of land and conservation easements in the watershed of the New York City water supply system
- [ ] INSTALLATION of new facilities
- [ ] CHANGES in capacities of existing facilities
- [ ] ABANDONMENT of existing facilities ________

4. This project will involve the taking of up to 0 gallons of water [ ] (per minute) [ ] (per day) from ________ (Name of source)
Figure given represents [ ] increase in taking, [ ] total taking.

5. If certain exhibits are omitted or reduced in scope because of reference to documents submitted with prior applications, list the exhibits so affected, identify the prior application (by Water Supply Application Number and name of applicant) and specify the document(s) to be referenced.

EXHIBIT	WSA NO.	APPLICANT'S NAME	REFERENCED DOCUMENT(S)

Not applicable

6. PROJECT AUTHORIZATION
This application must be accompanied by proof of adequate authorization for the proposed project. List below all exhibits documenting such authorization, such as resolutions, certificates of incorporation, contracts, referendum results, etc. (See *Public Water Supply Program, Applicant's Guide* for further details.)

See Exhibit 1

7. PROJECT JUSTIFICATION
By the act of signing this application, the applicant certifies that each of the following statutory conditions is or will be satisfied, AND that a proper justification for each is given in the specified exhibits attached to this application:

A. The proposed project is justified by the public necessity .... See Exhibit(s) 11 for items 7a through 7h
B. The proposed project takes proper consideration of other sources of supply that are or may become available .... See Exhibit(s) ________
C. All work and construction connected with the proposed project will be proper and safe .... See Exhibit(s) ________
D. The supply will be adequate .... See Exhibit(s) ________
E. There will be proper protection of the supply and watershed or proper treatment of any additional supply .... See Exhibit(s) ________
F. The proposed project is just and equitable to all affected municipalities and their inhabitants and in particular with regard to their present and future needs for sources of water supply .... See Exhibit(s) ________
G. There is provision for fair and equitable determinations of and payments of any direct and indirect legal damages to persons or property that will result from the acquisition of any lands in connection with the proposed project or from the execution of the proposed project .... See Exhibit(s) ________
H. The applicant has developed and implemented a water conservation program in accordance with local water resource needs and conditions .... See Exhibit(s) ________

8. SEQR STATUS
A draft environmental analysis is being submitted under separate cover to DEC on January 21, 2010

9. SIGNATURE [signature]

10. DATE 01-19-10.

INSTRUCTIONS

1. **Before** completing this form, review carefully the *Public Water Supply Program Applicants' Guide.* If more room is needed to complete any item, an additional sheet may be used.

2. **Four (4) copies** of this form (*WATER SUPPLY APPLICATION: Supplement W-1 for Public Water Supply Permit*) **and** four (4) copies of Form 95-19-3 (*JOINT APPLICATION FOR PERMIT*) must be completed, signed, and submitted with all Water Supply Applications.

3. Applications must be in the name of the owner (or, in the case of acquisitions, the prospective owner) of the water supply system involved; except that applications from town or county water districts (or equivalents) should show the name of the **district** as the applicant. (See the detailed instructions for completing Supplement W-1 in the *Applicants' Guide.)*

4. For applications submitted by counties, cities, towns, and villages, forms must be signed by the Chief Executive Officer thereof or by a specifically authorized deputy.

5. All Water Supply Applications must include a completed *Water Conservation Program Form* demonstrating that the applicant has developed and implemented a **water conservation program** in accordance with local water resource needs and conditions.

6. Locate and describe all facilities and service areas on appropriate maps and plans. If your application involves groundwater wellhead(s) and/or surface water intake(s), record the coordinates in Item No.1 of this form. Include coordinates for as many wellheads or intakes as will exist. Location coordinates are expressed in New York Transverse Mercator units, or NYTMs (UTM Zone 18 expanded to encompass the entire state). These are based on the North American Datum 1983. If you are unable to supply accurate coordinates, attach a separate location map with this application. Choose a scale for this location map that allows you to accurately define the wellhead or intake position, and permits you to identify the overall project area within the county or township.

7. All facts and opinions expressed in the application must be documented in appropriate legal, engineering, or other papers attached as **exhibits**.

8. In a separate **transmittal letter**, the following information must be provided:

   a) Name and location of a suitable place in which to hold a public hearing should one prove necessary.

   b) Names, titles, mailing addresses, and phone numbers of other concerned officials, including at least:
      1. Applicant's attorney;
      2. Applicant's engineer;
      3. Other consultants (planners, geologists, etc.) serving the applicant;
      4. For non-municipal projects, the Chief Executive Officer of the municipality in which the project is located; and
      5. For projects taking a supply of water from another water system, an appropriate contact official for that system.

   c) A list of all maps and exhibits accompanying the application

9. **Copies** of the required water conservation program (See No. 5), maps (See No. 6), exhibits (See No. 7), and transmittal letter (See No. 8) shall be submitted as follows:

   a) Municipal applicants -- 3 copies

   b) Non-municipal applicants -- 4 copies

   c) EXCEPTION: Municipality applying to acquire existing non-municipal system -- 4 copies.

Exhibit 1

Project Authorization:

Cities in New York State have statutory authority to purchase and hold real property, both within and outside their city limits, pursuant to Section 20.2 of the New York State General City Law. More specifically, in a series of laws starting in 1834, the New York State Legislature has granted NYCDEP (and its predecessor entities) authority to acquire real property for water supply purposes, including for "preserving… the supply of pure and wholesome water for the use of the city, or for the purpose of preventing the contamination or pollution of the same." This authority is currently codified at Title 5, Section 354 of the New York City Administrative Code ("Ad. Code"). It derives from Chapter 256, § 12 of the Laws of 1834 (relating to acquisition of land for creation of the Croton system), Chapter 56, § 2 of the Laws of 1871 and Chapter 445, § 1 of the Laws of 1877 (relating to acquisition of land for expansion of the Croton system), and Chapter 466, Section 484 of the Laws of 1901 (granting the commissioner of water supply, gas and electricity power to acquire land for water supply throughout the state), among other legislative acts.

In order to acquire an interest in real property, the Commissioner of DEP must prepare a map of the real estate to be acquired and submit it to the Mayor's office for review, modification, or approval. "Interested persons" must be given the opportunity to comment or voice concerns about the proposed acquisitions at a hearing (Ad. Code § 5-356). Notice of the hearing is published in the City Record and in two newspapers in the counties of the proposed acquisition. Id. *After approval and filing of the maps, DEP may acquire the property.* Id.

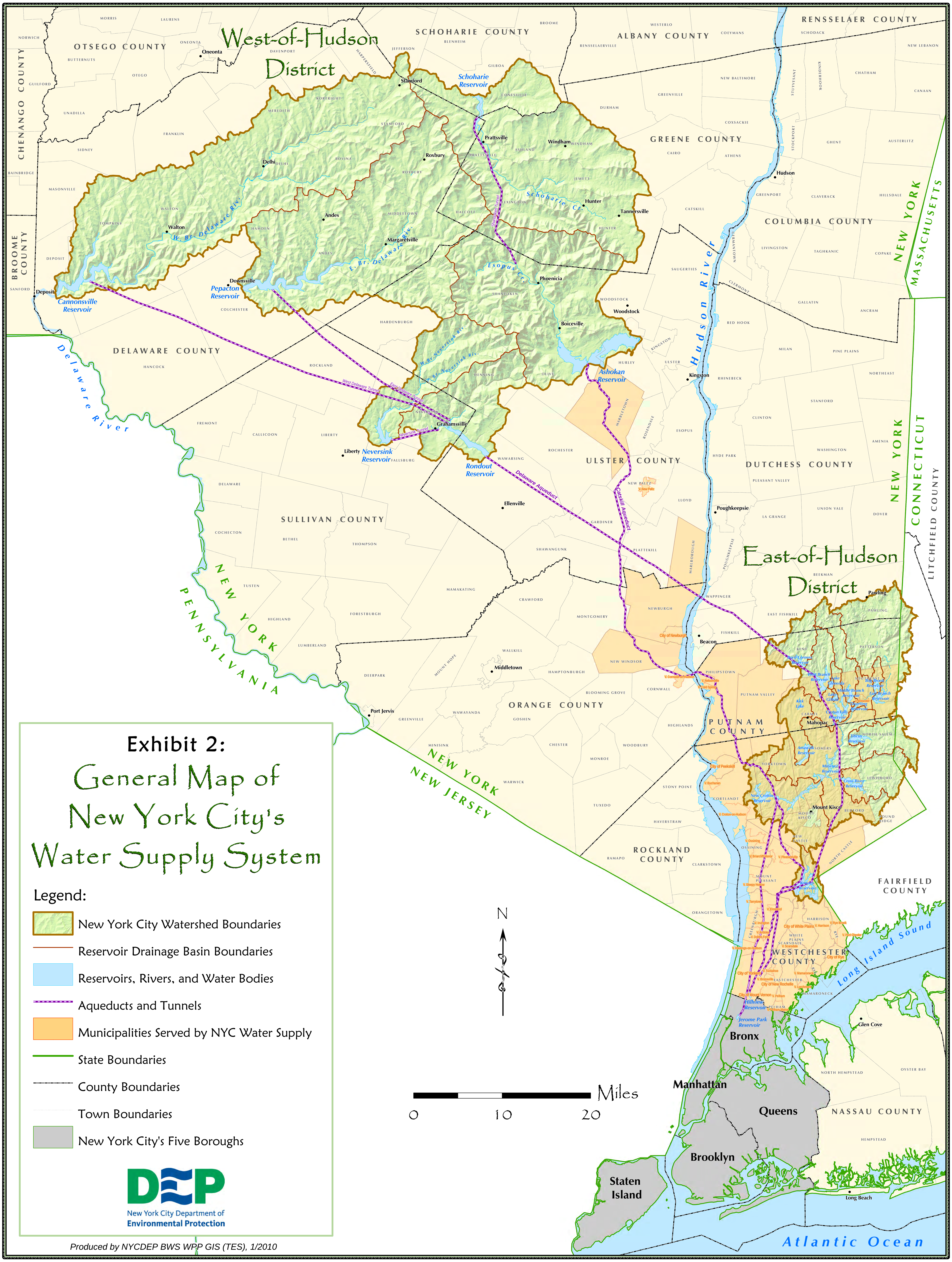
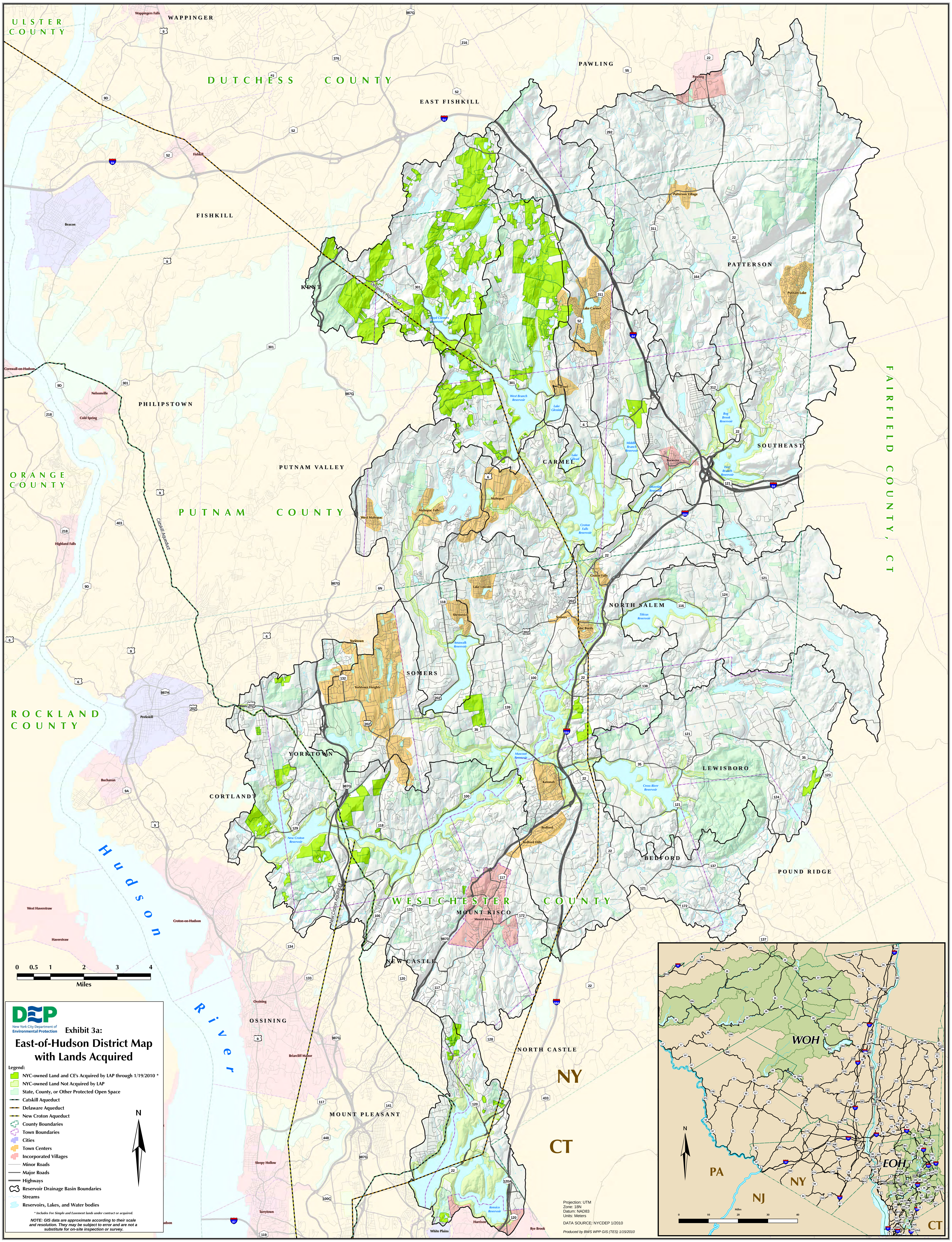


Exhibit 2: General Map of New York City's Water Supply System



DEP
New York City Department of Environmental Protection
Exhibit 3a:
East-of-Hudson District Map with Lands Acquired
Legend:
NYC-owned Land and CE's Acquired by LAP through 1/19/2010 *
NYC-owned Land Not Acquired by LAP
State, County, or Other Protected Open Space
Catskill Aqueduct
Delaware Aqueduct
New Croton Aqueduct
County Boundaries
Town Boundaries
Cities
Town Centers
Incorporated Villages
Minor Roads
Major Roads
Highways
Reservoir Drainage Basin Boundaries
Streams
Reservoirs, Lakes, and Water bodies
* Includes Fee Simple and Easement lands under contract or acquired.
NOTE: GIS data are approximate according to their scale and resolution. They may be subject to error and are not a substitute for on-site inspection or survey.
N
0 0.5 1 2 3 4
Miles
ULSTER COUNTY
DUTCHESS COUNTY
PUTNAM COUNTY
WESTCHESTER COUNTY
ORANGE COUNTY
ROCKLAND COUNTY
FAIRFIELD COUNTY, CT
Hudson River
NY
CT
WAPPINGER
PAWLING
EAST FISHKILL
FISHKILL
KENT
PATTERSON
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
NORTH SALEM
SOMERS
YORKTOWN
CORTLANDT
LEWISBORO
BEDFORD
POUND RIDGE
MOUNT KISCO
NEW CASTLE
OSSINING
NORTH CASTLE
MOUNT PLEASANT
Projection: UTM
Zone: 18N
Datum: NAD83
Units: Meters
DATA SOURCE: NYCDEP 1/2010
Produced by BWS WPP GIS (TES) 1/15/2010
WOH
EOH
PA
NJ

CONTRACT FOR SALE OF REAL PROPERTY

THIS CONTRACT, made this _____ day of __________________________, 2010, is between _______, (address) ("Seller"), and the City of New York, a municipal corporation organized and existing under the laws of the State of New York, acting by and through its Commissioner of the Department of Environmental Protection, having its principal offices at 59-17 Junction Boulevard, Flushing, NY 11373-5108 (the "City").

THE PARTIES HEREBY AGREE AS FOLLOWS:

1. Premises. The Seller agrees to convey and the City agrees to purchase the "Premises", which is all that certain plot, piece and/or parcel of land, situate, lying and being within the County of __, in the Town of __, indicated on the __County Tax Map as Section __, Block(s) _, Lot(s) _, consisting of +/- __ acres based on the aforementioned Tax Map, being more particularly bounded and described in a deed recorded on __at the __County Clerk's Office, in Liber __ of Deeds at page __, a copy of which is annexed hereto and made a part hereof as Schedule "A", excepting a portion approximately +/- __acres in size surrounding the existing structure(s) as depicted in the map attached as Schedule "B". The Premises are to be conveyed together with all improvements on the Premises except those listed on Schedule "C" attached hereto, all right, title and interest of Seller of, in and to the beds of any creeks, streams, rivers, ponds, lakes, waterways, marshes, or bays running through or lying adjacent to the Premises, and any and all rights of ingress and egress over and across any private drives, lands, waterways, or roads leading from any highway, road or street to the Premises.

2. Price and Payment Obligations

A. Purchase Price. The purchase price for the Premises is [$x,xxx.xx] per acre. Based on the City's initial assumption of +/- [yy.yy] acres, the "Preliminary Purchase Price" is [$zz,zzz.zz]. Prior to Closing the Preliminary Purchase Price shall be adjusted (the "Adjusted Purchase Price") to reflect the actual acreage of the Premises as determined by a boundary survey to be provided by an independent licensed professional land surveyor hired by the City.

B. Payment. Within 60 days of the date of this Contract, the City shall pay Seller [$vv,vvv.vv] (the "Down Payment"), representing ten percent (10%) of the Preliminary Purchase Price. At Closing, the City shall pay Seller the Adjusted Purchase Price less the Down Payment and less any reduction pursuant to Paragraph 3A(c)2.

C. Other Costs

(a) The cost of preparing and executing the deed shall be borne by Seller. The cost of recording the deed shall be borne by the City.

(b) Seller is required to pay any applicable income tax, gains and/or recording tax which may become due by reason of the delivery of the deed. Seller shall either pay any such tax prior to Closing or shall provide to the City payment for such tax in the form of a certified or official bank check payable to the order of the appropriate State, City or County officer, together with any required tax returns, forms, and/or affidavits duly executed and sworn to.

(c) All costs incurred in connection with any subdivision process, including the preparation, approval and filing of the preliminary and final subdivision plats and survey, shall be borne by Seller, except that the City agrees to pay for up to $5,000 in reasonable costs incurred by the Seller to a surveyor licensed by the State of New York relating to the subdivision to create the Premises, provided that the subdivision is agreed to by the parties to this contract in accordance with Paragraph 5(c) herein and provided the Seller has timely complied in good faith with all terms and conditions of this contract.

3. Physical Condition of Premises

A. Hazardous Materials

(a) Contract Rescission. In the event petroleum, hazardous, radioactive and/or toxic substances, each such term as defined by Federal, State and/or local law and regulations ("Hazardous Materials") are found on the Premises at any time prior to or at Closing, the City may rescind this Contract by notice of such to Seller, in which case Seller must within 30 days' receipt of such notice refund the Down Payment to the City.

(b) Removal:

(1) As an alternative to rescission, the City may demand that Seller remove the Hazardous Materials from the Premises no later than 90 days prior to the Closing Date, which would include mitigating any damage to the Premises resulting from such Materials (the removal and mitigation together referred to hereafter as "Removal"). Seller must then promptly, at his/her/its sole expense, comply with the demand in accordance with Federal, State, and/or local law and regulations, and must provide to the City proper documentation of such compliance.

(2) The City may permit Seller to complete any Removal after Closing, in which case it may require that Seller post an appropriate performance bond or sum in escrow to guarantee that such Removal is completed.

(c) Seller's Option. In the event the City elects to require Removal and the cost of such Removal exceeds 20% of the Adjusted Purchase Price, Seller may elect to not comply with the City's Removal demand. In order to make this election, Seller must provide notice to the City within 30 days of receipt of the City's Removal demand, such notice to include written determination by a licensed hazardous material remediation firm that the cost of Removal would exceed 20% of the Adjusted Purchase Price. Upon receipt of such notice from Seller, the City may at its option either:

(1) Rescind this Contract by notice of such to Seller, in which case Seller must refund the Down Payment to the City within 30 days' of Seller's receipt of such rescission notice; or

(2) Purchase the Premises at Closing with a 20% reduction in the Adjusted Purchase Price.

(d) All notices or demands sent under this Paragraph 3A shall be in writing and sent by certified or registered mail, return receipt requested, to the addresses listed in Paragraph 14(g).

(e) Nothing in this Paragraph 3A shall relieve any obligation of Seller with respect to the Premises that arises, either before or after Closing, under Federal, State, and/or local laws and regulations.

B. Non-Hazardous Materials**.** Seller shall remove all refuse not covered by Paragraph 3A, including but not limited to abandoned cars, appliances, tires, and construction waste, at Seller's expense at least 90 days prior to the Closing Date.

C**.** Modification to Premises. Seller shall not cut or remove from the Premises any trees or vegetation, except:

(a) To remove dangerous conditions;

(b) To maintain existing rights-of-way, interior roads or trails in use, or utilities on the Premises, in each case as of the date of this Contract;

(c) On lands where agricultural activities are already being conducted, Seller may continue to conduct farming, including preparing soil for planting, nutrient management, harvesting crops, and maintaining livestock. Any tilling that takes place after the date of this Contract shall provide for a 50-foot wide vegetated buffer of undisturbed land adjacent to any streams or watercourses. For row crops, including but not limited to corn and/or soybeans, the Seller shall plant a cover crop no later than November 1st of the applicable growing season. The contract term may be extended up to 90 days in order to allow Seller to complete the harvest and install the cover crop; or

(d) In compliance with any management plans approved by the New York State Department of Environmental Conservation pursuant to Paragraph 480-A of the New York State Real Property Tax Law.

D. Improvements and Fixtures. All improvements and fixtures on the Premises, including but not limited to those listed in Schedule C, shall be removed by Seller in a manner approved by the City in writing at least 90 days prior to the Closing Date, except that the City agrees that the following need not be removed: [N/A].

4. Liens, Encumbrances, Taxes and Violations

A. Liens and Encumbrances. Except as provided in Paragraph 4D, Seller must satisfy, remove and/or release any and all mortgages, liens, encumbrances, encroachments, claims, title defects, boundary line discrepancies or judgments of any kind or nature whatsoever on or against the Premises at least 90 days prior to the Closing Date.

B. Property Taxes. Except as provided in Paragraph 4D, Seller must pay all taxes with interest and penalties thereon which if unpaid would be liens against the Premises at least fourteen (14) days prior to the Closing Date.

(a) A tax that is levied on the Premises prior to the Closing Date, even if there is the option to pay any portion of the tax over time on an installment basis, is deemed for purposes of this Contract to be due and payable in its entirety on the date of levy and as such must be paid in its entirety at least fourteen (14) days prior to the Closing Date.

(b) Apportionment of taxes:

(1) Any taxes, water and/or sewer charges, and any other municipal or utility charges assessed on the Premises, shall be apportioned as of midnight of the day before the Closing Date on the basis of the fiscal period for which assessed.

(2) If Closing occurs before a new tax rate is fixed, the apportionment of taxes shall be based upon the tax rate for the immediately preceding fiscal period applied to the latest assessed valuation.

(3) Any errors or omissions in computing apportionments at Closing shall be corrected within a reasonable time following Closing.

C. Violations. Except as provided in Paragraph 4D, Seller must remove any outstanding notices of violations of law or municipal ordinances affecting the Premises at least 90 days prior to the Closing Date.

D. Subject to the City's approval, requested no less than 90 days prior to the Closing Date, Seller may use any portion of the balance of the Adjusted Purchase Price to satisfy any liens, remove encumbrances or cure violations on the Premises, other than real property tax liens, which must be paid and satisfied prior to the Closing Date.

5. Conditions to Closing. The City's obligation to purchase the Premises is subject to and conditioned upon fulfillment, before the Closing Date unless otherwise indicated, of the following conditions:

(a) All necessary governmental approvals, including approval by the Mayor of the City of New York in accordance with the New York City Administrative Code, to acquire the Premises.

(b) Delivery at Closing by Seller to the City of a Bargain and Sale Deed with covenant against grantor's acts, (i) in a form approved by the City at least two (2) weeks prior to the Closing Date and (ii) duly executed and acknowledged by Seller so as to convey the Premises to the City in fee simple, free and clear of all liens, encumbrances and violations, except as expressly permitted in this Contract.

(c) Submission of a preliminary subdivision plat for the City's review and approval before submission of such plat for any other governmental approvals, and delivery to the City of a survey and subdivision plat, prepared by a licensed, professional land surveyor and fully approved and signed by any and all necessary governmental entities so as to create from the Premises a legal and fully approved lot as approximately depicted in Schedule B, within six (6) months of the date of this Contract.

(d) The accuracy as of Closing of the Seller's representations and warranties made in Paragraph 7 (Seller's Representations).

(e) Satisfaction of Seller's obligations under Paragraph 3 (Physical Condition of Premises).

(f) Satisfaction of Seller's obligations under Paragraph 4 (Liens, Encumbrances, Taxes and Violations).

(g) If Seller is not an individual, delivery to the City of any necessary approvals, in forms approved by the City at least two (2) weeks prior to the Closing Date, authorizing the sale of the Premises and delivery of the deed.

(h) Timely delivery by Seller of all other receipts, papers, documents and affidavits which the City may reasonably demand from Seller in order to effect conveyance of the Premises.

6. Closing

A. The Closing shall take place within eighteen months from the date of this Contract, except that it may be beyond the eighteen-month period:

(a) In the event Seller has not satisfied his/her/its obligations under this Contract and the City elects to grant Seller an additional period of time in which to comply;

(b) If due to Seller's delay in satisfying the terms of the Contract, the City itself requires additional time to prepare for Closing; or

(c) An act of God or act of war impedes the City's ability to Close.

B. The City shall set the date and time of Closing (the "Closing Date") in accordance with the above upon reasonable notice to Seller.

C. The Closing shall take place at offices of the City in Kingston.

7. Seller's Representations. Seller hereby acknowledges, represents, warrants and agrees that:

(a) Seller is the sole owner of the Premises and has the full right, title and authority to convey the Premises and the improvements thereon.

(b) Seller will not sell, alter, improve, encumber or otherwise dispose of the Premises or part thereof without the express written prior approval of the City.

(c) All improvements and fixtures attached or appurtenant to or used in connection with the operation of the Premises are owned by the Seller, free from all liens and encumbrances.

(d) The Premises abut or have a legal and enforceable right of access to a public road.

(e) If Seller is not an individual, Seller is duly formed and is validly existing under the laws of the state in which it is organized and has all the requisite authority to enter into and perform all acts required under this Contract. Further, this Contract has been duly authorized, executed and delivered by Seller, and constitutes a valid, legal and binding agreement of Seller and is enforceable against it in accordance with its terms.

8. Permitted Exceptions. The Premises are to be conveyed subject to:

(a) Zoning regulations of the municipality in which the Premises are located which are not violated by existing structures or present uses; and

(b) Legally enforceable easements, covenants, restrictions of record, or other states of fact an accurate survey may show, provided same do not interfere with the intended use of the Premises and/or render title unmarketable.

9. Right of Entry. The City and its agents shall have the right to enter all areas of the Premises prior to Closing, from time to time during regular business hours, to conduct inspections, testing, surveys, and/or appraisals and/or to obtain such other information as the City shall deem necessary.

10. Possession of Premises. Upon delivery of the deed by Seller in accordance with the terms of this Contract, the Premises shall be vacant and the City shall take immediate possession.

11. The City's Failure to Purchase. In the event the City fails to purchase the Premises in breach of this Contract, the sole remedy of Seller shall be to retain the Down Payment as liquidated damages, it being agreed that Seller's damages might be impossible to ascertain and the Down Payment constitutes a fair and reasonable amount of damages under the circumstances and is not a penalty, whereupon this Contract shall be considered canceled.

12. Seller's Failure to Convey. If Seller fails to convey title to the Premises in accordance with the terms and provisions of this Contract, the City hereby reserves its right to either: (a) rescind the Contract, whereupon the sole liability of Seller shall be to refund the Down Payment; or (b) seek any other available legal remedy at law or in equity including, but not limited to, specific performance, and/or monetary damages.

13. Broker. The City hereby represents to Seller that it has not dealt with any real estate broker in connection with its purchase of the Premises other than ____N/A____, ("Broker") and Seller shall pay Broker any commission earned pursuant to a separate agreement between Seller and Broker.

14. Miscellaneous

(a) This Contract cannot be altered or amended except by a written instrument signed by both parties to this Contract;

(b) A waiver of any breach of this Contract must be set forth in writing signed by the party who has the right to enforce the breach. Any waiver of any breach shall not operate or be construed as a waiver of any subsequent breach.

(c) This Contract, including all Schedules hereto, constitutes the entire agreement between Seller and the City;

(d) This Contract may not be assigned by Seller without the prior consent of the City.

(e) This Contract or a memorandum thereof may be recorded at the discretion of the City. In the event that the parties mutually agree to terminate this Contract, the parties shall sign a Termination of Contract Agreement and a Memorandum of Termination of Contract Agreement. Either party may record such Memorandum of Termination of Contract Agreement.

(f) This Contract shall apply to, inure to the benefit of, and bind the parties, and their respective heirs, executors, administrators, successors and assigns.

(g) Except as provided in Paragraph 3A(d), all notices sent pursuant to this Contract shall be delivered personally or sent by facsimile or regular U.S. mail to the following addresses:

If to Seller:

John XXXXXXXXX
XJohn XXXXXXXX
XXXXXXXXX

If to the City:

Director of Land Acquisition
New York City Department of Environmental Protection
71 Smith Avenue, Kingston, N.Y. 12401
Fax: (845) 338-1260

(h) The headings in this Contract are for convenience only and shall not be used to interpret or construe its provisions.

(i) This Contract shall be governed by the laws of the State of New York.

(j) The parties agree to cooperate with each other in providing additional documentation or in taking whatever steps reasonably necessary to fulfill the objectives of this Contract.

(k) The following provisions shall survive Closing or, if Closing does not occur for any reason, the termination of this Contract: 2C(b), 3A(b)(2), 3A(e), 14(c), 14(e), 14(f) 14(j), and this 14(k).

IN WITNESS WHEREOF, the parties have caused this Contract to be executed the day and year first written above.

Dated: ____________________

____
Seller's Name

____
Daytime Phone Number

The City of New York

Dated: _____________________ by: _________________________
Robin M. Levine
General Counsel, NYCDEP

Approved as to form - Standard Type of Class:

____
Assistant Corporation Counsel
Dated: ______________________

ACKNOWLEDGMENTS:

STATE OF NEW YORK)
) ss.:
COUNTY OF QUEENS)

On the _____ day of ______________ in the year 2010, before me, the undersigned, a Notary Public in and for the said State, personally appeared **Robin M. Levine,** personally known to me or proved to me on the basis of satisfactory evidence to be General Counsel for **Department of Environmental Protection, of the CITY OF NEW YORK**, a municipal corporation of the State of New York, the individual whose name is subscribed to the within instrument and acknowledged to me that she executed the same in her capacity, and that by her signature on the instrument, the individual, or the person upon behalf of whom the individual acted, executed the instrument.

____
NOTARY PUBLIC

STATE OF)
) ss.:
COUNTY OF)

On the _____ day of ______________ in the year 2010, before me, the undersigned, a Notary Public in and for the said State, personally appeared ___________________________, personally known to me or proved to me on the basis of satisfactory evidence to be the individual whose name is subscribed to the within instrument and acknowledged to me that she/he executed the same in her/his capacity, and that by her/his signature on the instrument, the individual, or the person upon behalf of whom the individual acted, executed the instrument.

____
NOTARY PUBLIC

[Seller] to NYC
Schedule A
Deed

[Seller] to NYC
Schedule B
Map

[Seller] to NYC
Schedule C
List of Improvements to be Removed

Any Undisclosed Improvements

CONTRACT FOR SALE OF CONSERVATION EASEMENT
NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION

THIS CONTRACT, made this _____ day of ___________________________, 20___, is between _______, (address) ("Seller"), and ________ (Escrow Agent), and the City of New York, a municipal corporation organized and existing under the laws of the State of New York, acting by and through its Commissioner of the Department of Environmental Protection, having its principal offices at 59-17 Junction Boulevard, Flushing, NY 11373-5108 (the "City").

THE PARTIES HEREBY AGREE AS FOLLOWS:

1. Property. Seller hereby warrants and represents that Seller is the owner of a certain plot, pieces(s) and/or parcel(s) of land, situate, lying and being within the County of __, in the Town of __, indicated on the __County Tax Map as Section __, Block(s) _, Lot(s) _, consisting of +/-__ acres, based on the aforementioned Tax Map, being more particularly bounded and described in a deed recorded on __at the __County Clerk's Office, in Liber __ of Deeds at page __, a copy of which is annexed hereto and made a part hereof as Schedule "A", and as shown on the map annexed hereto and made a part hereof as Schedule "B" (collectively the "Property").

2. Conservation Easement

A. Seller agrees to convey and the City agrees to purchase a Conservation Easement ("Conservation Easement") under the terms and conditions attached hereto as Schedule "C", in and on the Property , subject to the terms and conditions set forth in this Contract.

B. At Closing the Conservation Easement shall include a baseline report (the "Baseline Documentation") that shall describe and/or depict the condition of the Property as of the date the Baseline Documentation is executed. The Baseline Documentation may include photographs of or maps depicting the location and condition of watercourses or wetlands, the size and location of structures and the extent of Impervious Surfaces, if applicable, Building Envelope(s) as defined in the Conservation Easement attached hereto, the location of significant roads, parking areas and driveways, and the extent of open fields. Both parties shall sign the Baseline Documentation indicating their agreement with the descriptions and depictions contained therein at least two (2) weeks prior to Closing. Seller shall not unreasonably withhold its agreement to the Baseline Documentation.

3. Price and Payment Obligations

A. Purchase Price. The purchase price for the Conservation Easement is [$x,xxx.xx] per acre. Based on the City's initial assumption of +/- [yy.yy] acres, the "Preliminary Purchase Price" is [$zz,zzz.zz]. Prior to Closing the Preliminary Purchase Price shall be adjusted (the "Adjusted Purchase Price") to reflect the actual acreage of the Property as determined by a boundary survey to be provided by an independent licensed professional land surveyor hired by the City.

B. Payment.

(a) Within 60 days of the date of this Contract, the City shall pay the Seller (through his/her attorney the "Escrow Agent") [$vv,vvv.vv] (the "Down Payment"), representing ten percent (10%) of the Preliminary Purchase Price.

(b) At Closing, the City shall pay Seller the Purchase Price less the Down Payment and less any reduction pursuant to Paragraph 4A(3)(b).

(c) The Escrow Agent shall deposit the Down Payment in a FDIC insured interest bearing account for the benefit of the parties at ______________________________(bank account), until Closing, or termination of this Contract, and shall disburse the Down Payment in accordance with the terms of this paragraph:

(1) Interest shall be paid to the party entitled to the Down Payment at the same time the Down Payment is disbursed and the party receiving the interest shall pay any income taxes thereon, if applicable.

(2) The Social Security or Federal Identification numbers of the parties shall be furnished to the Escrow Agent upon request.

(3) At Closing, the Down Payment shall be paid by the Escrow Agent to Seller. If for any reason Closing does not occur and either party gives Notice (as defined in paragraph 14(G)) to the Escrow Agent demanding the disbursement of the Down Payment, the Escrow Agent shall give prompt Notice to the other party of such demand. If the Escrow Agent does not receive Notice of objection from such other party to the proposed disbursement within 10 business days after the giving of such Notice, the Escrow Agent is hereby authorized and directed to make such disbursement. If the Escrow Agent does receive such Notice of objection within such 10 day period or if for any other reason the Escrow Agent in good faith shall elect not to make such disbursement, the Escrow Agent shall continue to hold such amount until otherwise directed by Notice from the parties to this Contract, or a final, non-appealable judgment, order, or court decree.

(4) The Escrow Agent shall have the right at any time to deposit the Down Payment and the interest thereon with the clerk of a court in the county in which the Property is located and shall give Notice of such deposit to Seller and the City.

(5) Upon such deposit or other disbursement in accordance with the terms of this paragraph, the Escrow Agent shall be relieved and discharged of all further obligations and responsibilities hereunder.

(6) The Escrow Agent is acting solely as a stakeholder at the request of the parties and for their convenience and the Escrow Agent shall not be liable to either party for any act or omission on its part unless taken or suffered in bad faith or in willful disregard of this Contract or involving gross negligence on the part of the Escrow Agent.

(7) Seller and the City jointly and severally agree to defend, indemnify and hold the Escrow Agent harmless from and against all costs, claims and expenses (including reasonable attorneys' fees) incurred in connection with the performance of the Escrow Agent's duties hereunder, except with respect to actions or omissions taken or suffered by the Escrow Agent in bad faith or in willful disregard of this Contract or involving gross negligence on the part of the Escrow Agent.

(8) Escrow Agent may act or refrain from acting in respect of any matter referred to herein in full reliance upon and with the advice of counsel which may be selected by it (including any member of its firm) and shall be fully protected in so acting or refraining from action upon the advice of such counsel.

(9) Escrow Agent acknowledges its agreement to receive the Down Payment and its agreement to the provisions of this paragraph by signing in the place indicated on the signature page of this Contract.

(10) The Escrow Agent or any member of its firm shall be permitted to act as counsel for Seller in any dispute as to the disbursement of the Down Payment or any other dispute between the parties whether or not the Escrow Agent is in possession of the Down Payment and continues to act as the Escrow Agent.

C. Tax Allocation and Apportionment

(1) Title 4-A of Article 5 of the Real Property Tax Law determines the allocation of taxes on the Property between the Seller (as owner of the fee) and the City (as holder of the Conservation Easement). Accordingly, the City shall pay a percentage of the taxes on the Property, this percentage to be calculated by use of a fraction of the numerator of which is the appraised value of the Conservation Easement ($___, based on $ _____per acre, assuming ___ acres) and the denominator of which is the appraised value of the Property without the Conservation Easement ($

___, based on $ ___ per acre, assuming ___ acres). This percentage shall be finally determined at Closing based on the actual acreage of the Property, as indicated by the survey referenced in Paragraph 3A herein. Seller and the City are both subject to the jurisdiction of the appropriate assessing entity, to which the City shall certify the allocation factor determined based upon the City's independent appraisal. The parties agree that the local assessing entity is charged with the responsibility of assessing and entering on the assessment roll that portion which is taxable to Seller as owner of the Property and that portion which is taxable to the City for the Conservation Easement.

(2) Any taxes previously paid by Seller and owed by the City to Seller for the remainder of the fiscal year in which the Conservation Easement is conveyed shall be paid by the City to Seller at Closing in accordance with Paragraph 5B(2) herein.

D. Other Costs

(1) The cost of preparing and recording the Conservation Easement, including the Baseline Documentation, shall be borne by the City.

(2) Seller is required to pay any applicable income tax, gains and/or recording tax which may become due by reason of the delivery of the Conservation Easement. Seller shall either pay any such tax prior to Closing or shall provide to the City payment for such tax in the form of a certified or official bank check payable to the order of the appropriate State, City or County officer, together with any required tax returns, forms, and/or affidavits duly executed and sworn to.

(3) All costs incurred in connection with any subdivision process, including the preparation, approval and filing of a preliminary and final subdivision plats and survey, shall be borne by Seller.

4. Physical Condition of Property

A. Hazardous Materials

(1) Contract Rescission. In the event petroleum, hazardous, radioactive and/or toxic substances, each such term as defined by Federal, State and/or local law and regulations ("Hazardous Materials") are found on the Property, and present a threat to the Property, at any time prior to or at Closing, the City may rescind this Contract by notice of such to Seller, in which case Seller must within 30 days' receipt of such notice refund the Down Payment to the City.

(2) Removal:

(a) As an alternative to rescission, the City may demand that Seller remove the Hazardous Materials from the Property no later than 90 days prior to the Closing

Date, which would include mitigating any damage to the Property resulting from such Materials (the removal and mitigation together referred to hereafter as "Removal"). Seller must then promptly, at his/her/its sole expense, comply with the demand in accordance with Federal, State, and/or local law and regulations, and must provide to the City proper documentation of such compliance.

(b) The City may permit Seller to complete any Removal after Closing, in which case it may require that Seller post an appropriate performance bond or sum in escrow to guarantee that such Removal is completed.

(3) Seller's Option. In the event the City elects to require Removal and the cost of such Removal exceeds 20% of the Purchase Price, Seller may elect to not comply with the City's Removal demand. In order to make this election, Seller must provide notice to the City within 30 days of receipt of the City's Removal demand, such notice to include written determination by a licensed hazardous material remediation firm that the cost of Removal would exceed 20% of the Purchase Price. Upon receipt of such notice from Seller, the City may at its option either:

(a) Rescind this Contract by notice of such to Seller, in which case Seller must refund the Down Payment to the City within 30 days' of Seller's receipt of such rescission notice; or

(b) Purchase the Conservation Easement at Closing with a 20% reduction in the Adjusted Purchase Price.

(4) All notices or demands sent under this Paragraph 4A shall be in writing and sent by certified or registered mail, return receipt requested, to the addresses listed in Paragraph 14(g) herein.

(5) Nothing in this Paragraph 4A shall relieve any obligation of Seller with respect to the Property that arises, either before or after Closing, under Federal, State, and/or local laws and regulations.

(6) This Paragraph shall not prohibit the storage of petroleum products in accordance with Federal, State and/or local law or regulations in conjunction with residential or other uses of the Property that are permitted under the terms and conditions of the Conservation Easement attached hereto.

B. Non-Hazardous Materials**.** Seller shall remove all refuse from the Property, not covered by

Paragraph 4A, including but not limited to abandoned cars, appliances, tires, abandoned or collapsed structures, and construction waste, at Seller's expense at least 90 days prior to the Closing Date. Seller is not obligated to remove refuse located within the Building Envelope[s]. The Building Envelope[s] is [are] delineated in Schedule "B" attached hereto.

C. Physical Modification to Property. Seller may physically modify the Property only as specified below:

(1) In any way that is permissible under the terms and conditions of the Conservation Easement attached hereto as Schedule C, subject to the same terms and conditions applicable to that activity in the Conservation Easement.

(2) In any way that is in compliance with a management plan approved by the New York State Department of Environmental Conservation pursuant to Paragraph 480-A of the New York State Real Property Tax Law, upon prior notification to the City.

5. Liens, Encumbrances, Taxes and Violations

A. Liens and Encumbrances.

(1) Except as provided in (B) below and in Paragraph 5D, Seller must satisfy, remove and/or release any and all mortgages, liens, encumbrances, encroachments, claims, title defects, boundary line discrepancies or judgments of any kind or nature whatsoever on or against the Property at least 90 days prior to the Closing Date.

(2) Subject to the approval of the City, the Property may have a mortgage, lien or other encumbrance at Closing provided the holder of such encumbrance enters into a written agreement with Seller (a "Subordination Agreement") to subordinate the encumbrance to the Conservation Easement. Each such Subordination Agreement shall be submitted to the City at least 180 days prior to Closing for approval by the City and the title company hired by the City to insure title to the Conservation Easement. An executed, acknowledged and recordable version of the approved Subordination Agreement shall then be delivered for recording at Closing. All costs associated with drafting, executing and recording any Subordination Agreement are to be borne by Seller.

B. Property Taxes. Except as provided in Paragraph 5D, Seller must pay at least fourteen (14) days prior to the Closing Date all taxes with interest and penalties thereon which if unpaid would be liens against the Property.

(1) A tax that is levied on the Property prior to the Closing Date, even if there is the option to pay any portion of the tax over time on an installment basis, is deemed for purposes of this Contract to be due and payable in its entirety on the date of levy and as such must be paid in its entirety at least fourteen (14) days prior to the Closing Date.

(2) Apportionment of taxes:

(a) Any real property taxes assessed on the Property, shall be apportioned as of midnight of the day before the Closing Date on the basis of the fiscal period for which it is assessed.

(b) If Closing occurs before a new tax rate is fixed, the apportionment of taxes shall be based upon the tax rate for the immediately preceding fiscal period applied to the latest assessed valuation.

(c) Any errors or omissions in computing apportionments at Closing shall be corrected within a reasonable time following Closing.

C. Violations. Except as provided in Paragraph 5D, Seller must remove any outstanding notices of violations of law or municipal ordinances affecting the Property at least 90 days prior to the Closing Date.

D. Subject to the City's approval, requested no less than 90 days prior to the Closing Date, Seller may, upon notification of the Closing Date, request to use any portion of the balance in the Adjusted Purchase Price to satisfy any liens, remove encumbrances, cure violations, satisfy outstanding tax assessments or arrears on the Property, other than real property tax liens, which must be paid and satisfied at least fourteen (14) days prior to the Closing Date.

6. Conditions to Closing. The City's obligation to purchase the Conservation Easement is subject to and conditioned upon fulfillment, before the Closing Date unless otherwise indicated, of the following conditions:

A. All necessary governmental approvals, including approval by the Mayor of the City of New York in accordance with the New York City Administrative Code, to acquire the Conservation

Easement.

B. Delivery by Seller to the City at Closing of the Conservation Easement in the form attached hereto as Schedule “C”.

C. Delivery by Seller of the Baseline Documentation Certification agreed to between the parties, duly executed and acknowledged by Seller, at least eight (8) weeks prior to the Closing Date.

D. If the parties agree to a subdivision of the Property prior to Closing, submission of a preliminary subdivision plat for the City’s review and approval before submission of such plat for any other governmental approvals, and delivery to the City of a survey and subdivision plat, prepared by a licensed, professional land surveyor and fully approved and signed by any and all necessary governmental entities within six (6) months of the date of this Contract.

E. The accuracy as of Closing of the Seller’s representations and warranties made in Paragraph 8 (Seller’s Representations).

F. Satisfaction of Seller’s obligations under Paragraph 4 (Physical Condition of Property).

G. Satisfaction of Seller’s obligations under Paragraph 5 (Liens, Encumbrances, Taxes and Violations).

H. If Seller is not an individual, delivery to the City of any necessary approvals, in forms approved by the City at least two (2) weeks prior to the Closing Date, authorizing the sale of the Conservation Easement and delivery of the deed.

I. Timely delivery by Seller of all other receipts, papers, documents and affidavits which the City may reasonably demand from Seller in order to effect conveyance of the Conservation Easement.

7. Closing

A. The Closing shall take place within eighteen months from the date of this Contract, except that it may be postponed to a date beyond the eighteen-month period:

(1) In the event Seller has not satisfied his/her/its obligations under this Contract and

the City elects to grant Seller an additional period of time in which to comply;

(2) If due to Seller's delay in satisfying the terms of the Contract, the City itself requires additional time to prepare for Closing; or

(3) If an act of God, an act of war, any natural disasters or any acts or events beyond the control of the City impedes the City's ability to Close.

B. The City shall set the date and time of Closing (the "Closing Date") in accordance with the above upon reasonable notice to Seller.

C. The Closing shall take place at offices of the City in Kingston.

8. Seller's Representations. Seller hereby acknowledges, represents, warrants and agrees that:

A. Seller is the sole owner of the Property and has the full right, title and authority to convey the Conservation Easement on the Property.

B. Prior to Closing Seller will not sell, alter, improve, encumber or otherwise dispose of the Property or part thereof without the express written prior approval of the City except as permitted in Paragraph 4C.

C. The Property abuts or has a legal and enforceable right of access to a public road.

D. If Seller is not an individual, Seller is duly formed and is validly existing under the laws of the state in which it is organized and has all the requisite authority to enter into and perform all acts required under this Contract. Further, this Contract has been duly authorized, executed and delivered by Seller, and constitutes a valid, legal and binding agreement of Seller and is enforceable against it in accordance with its terms.

9. Permitted Exceptions. The Conservation Easement is to be conveyed subject to legally enforceable easements, covenants, restrictions of record, or other states of fact an accurate survey may show, provided same do not interfere with the intended use of the Property and/or render title unmarketable.

10. Right of Entry. The City and its agents shall have the right to enter all areas of the Property prior to Closing, from time to time during regular business hours, to conduct inspections, testing, surveys, and/or appraisals and/or to obtain such other information as the City shall deem necessary.

11. The City's Failure to Purchase. In the event the City fails to purchase the Conservation Easement in breach of this Contract, the sole remedy of Seller shall be to retain the Down Payment as liquidated damages, it being agreed that Seller's damages might be impossible to ascertain and the Down Payment constitutes a fair and reasonable amount of damages under the circumstances and is not a penalty, whereupon this Contract shall be considered canceled.

12. Seller's Failure to Convey. If Seller fails to convey the Conservation Easement in accordance with the terms and provisions of this Contract, the City hereby reserves its right to either: (a) rescind the Contract, whereupon the sole liability of Seller shall be to refund the Down Payment; or (b) seek any other available legal remedy at law or in equity including, but not limited to, specific performance and/or monetary damages.

13. Broker. The City hereby represents to Seller that it has not dealt with any real estate broker in connection with its purchase of the Conservation Easement other than ________, ("Broker") and Seller shall pay Broker any commission earned pursuant to a separate agreement between Seller and Broker.

14. Miscellaneous

A. This Contract, including the Conservation Easement attached hereto cannot be altered or amended except by a written instrument signed by both parties to this Contract;

B. A waiver of any breach of this Contract must be set forth in writing signed by the party who has the right to enforce the breach. Any waiver of any breach shall not operate or be construed as a waiver of any subsequent breach.

C. This Contract, including all Schedules hereto, constitutes the entire agreement between Seller and the City;

D. This Contract may not be assigned by Seller without the prior consent of the City;

E. This Contract or a memorandum thereof may be recorded at the discretion of the City. In the event that the parties mutually agree to terminate this Contract, the parties shall sign a Termination of Contract Agreement and a Memorandum of Termination of Contract Agreement. Either party may record such Memorandum of Termination of Contract Agreement.

F. This Contract shall apply to, inure to the benefit of, and bind the parties, and their respective heirs, executors, administrators, successors and assigns.

G. Except as provided in Paragraph 4A(4), all notices sent pursuant to this Contract shall be delivered personally or sent by facsimile or regular U.S. mail to the following addresses:

If to Seller:

XXXXXXXXX
XXXXXXXXX
XXXXXXXXX

If to the City:

Director of Land Acquisition
New York City Department of Environmental Protection
71 Smith Avenue, Kingston, N.Y. 12401
Fax: (845) 338-1260

H. The headings in this Contract are for convenience only and shall not be used to interpret or construe its provisions.

I. This Contract shall be governed by the laws of the State of New York and to the extent it does not contradict, the Administrative Code of the City of New York.

J. The parties agree to cooperate with each other in providing additional documentation or in taking whatever steps reasonably necessary to fulfill the objectives of this Contract.

K. The following provisions shall survive Closing or, if Closing does not occur for any reason, the termination of this Contract: 3C(2), 4A(2)(b), 4A(5), 14E, 14J, and this 14K.

IN WITNESS WHEREOF, the parties have caused this Contract to be executed the day and year first written above.

Dated: ____________________

____
Seller's Name

____
Daytime Phone Number

Dated: ____________________

____
Escrow Agent's Name

____
Daytime Phone Number

The City of New York

Dated: ____________________

by: ____________________
Robin M. Levine
General Counsel, NYCDEP

Approved as to form:

____
Acting Corporation Counsel

Dated: ____________________

ACKNOWLEDGMENTS:

STATE OF NEW YORK)
) ss.:
COUNTY OF QUEENS)

On the _____ day of ______________ in the year 20___, before me, the undersigned, a Notary Public in and for the said State, personally appeared **Robin M. Levine** personally known to me or proved to me on the basis of satisfactory evidence to be General Counsel of the **Department of Environmental Protection, of the CITY OF NEW YORK**, a municipal corporation of the State of New York, the individual whose name is subscribed to the within instrument and acknowledged to me that she executed the same in her capacity, and that by her signature on the instrument, the individual, or the person upon behalf of whom the individual acted, executed the instrument.

____
NOTARY PUBLIC

STATE OF)
) ss.:
COUNTY OF)

On the _____ day of ______________ in the year 20___, before me, the undersigned, a Notary Public in and for the said State, personally appeared __________________________, personally known to me or proved to me on the basis of satisfactory evidence to be the individual whose name is subscribed to the within instrument and acknowledged to me that she/he executed the same in her/his capacity, and that by her/his signature on the instrument, the individual, or the person upon behalf of whom the individual acted, executed the instrument.

____
NOTARY PUBLIC

STATE OF)
) ss.:
COUNTY OF)

On the _____ day of ______________ in the year 20___, before me, the undersigned, a Notary Public in and for the said State, personally appeared _______**ESCROW AGENT**____________, personally known to me or proved to me on the basis of satisfactory evidence to be the individual whose name is subscribed to the within instrument and acknowledged to me that she/he executed the same in her/his capacity, and that by her/his signature on the instrument, the individual, or the person upon behalf of whom the individual acted, executed the instrument.

____
NOTARY PUBLIC

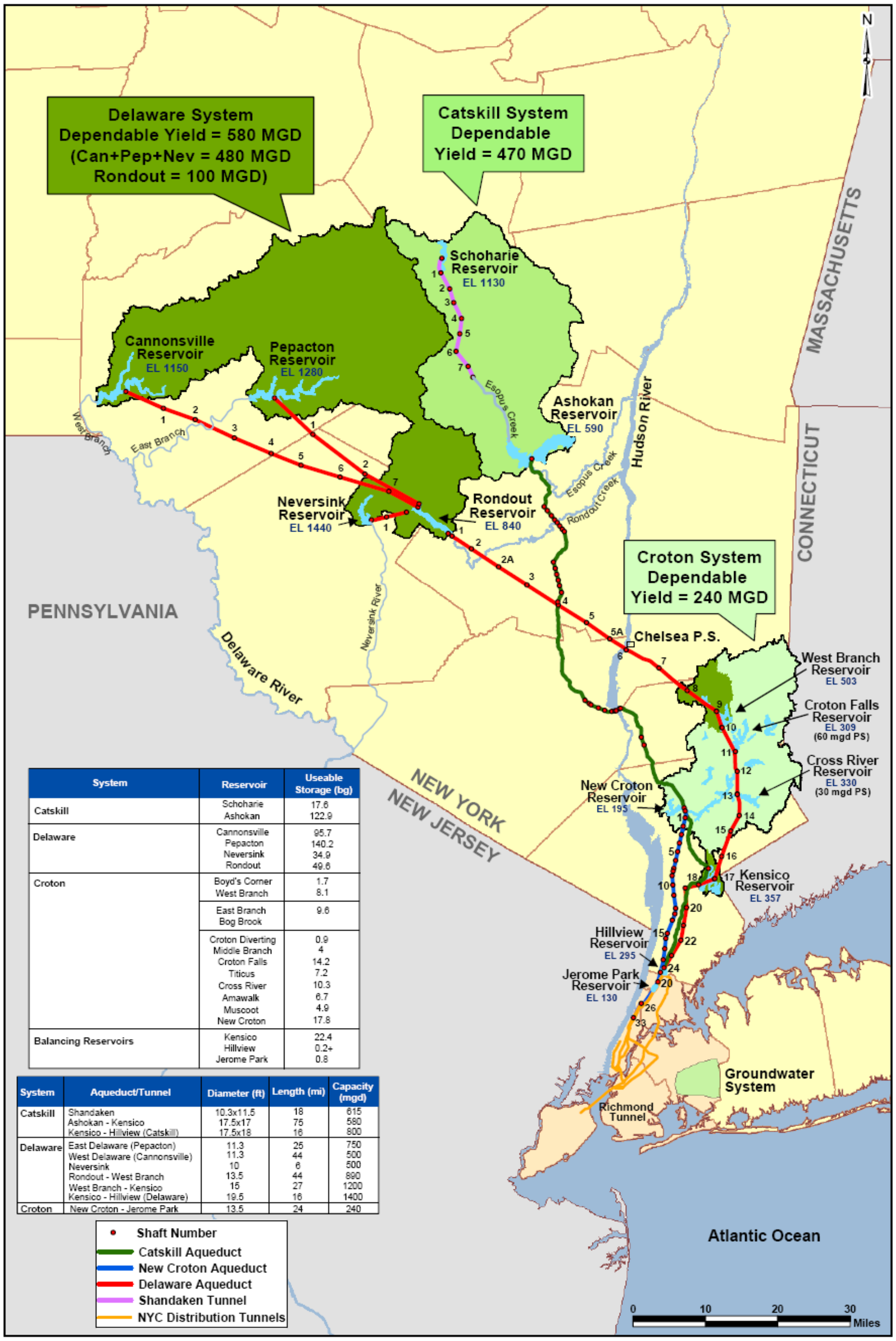
Schedule A (Deed)

Schedule (B) (Map)

Schedule C (Conservation Easement)

Exhibit 6: Engineer’s Report

New York City's water supply system is one of the most extensive municipal water systems in the world. The New York City Department of Environmental Protection manages the City’s water supply, providing over 1.1 billion gallons of water each day to meet the daily needs of more than eight million City residents, another one million users in four upstate counties bordering on the water supply system, and countless visitors via a complex network of nineteen reservoirs, three controlled lakes, 7000 miles of water pipes, tunnels, and aqueducts.



System	Reservoir	Useable Storage (bg)
Catskill	Schoharie Ashokan	17.6 122.9
Delaware	Cannonsville Pepacton Neversink Rondout	95.7 140.2 34.9 49.6
Croton	Boyd's Corner West Branch	1.7 8.1
	East Branch Bog Brook	9.6
	Croton Diverting Middle Branch Croton Falls Titicus Cross River Amawalk Muscoot New Croton	0.9 4 14.2 7.2 10.3 6.7 4.9 17.8
Balancing Reservoirs	Kensico Hillview Jerome Park	22.4 0.2+ 0.8

System	Aqueduct/Tunnel	Diameter (ft)	Length (mi)	Capacity (mgd)
Catskill	Shandaken Ashokan - Kensico Kensico - Hillview (Catskill)	10.3x11.5 17.5x17 17.5x18	18 75 16	615 580 800
Delaware	East Delaware (Pepacton) West Delaware (Cannonsville) Neversink Rondout - West Branch West Branch - Kensico Kensico - Hillview (Delaware)	11.3 11.3 10 13.5 15 19.5	25 44 6 44 27 16	750 500 500 890 1200 1400
Croton	New Croton - Jerome Park	13.5	24	240

Figure 1: NYC water supply systems, reservoirs, and aqueducts

Description of the Systems and Aqueducts:

The NYC surface water supply system stores nearly 580 billion gallons of water and is divided into three separate sub-systems

The Croton system is the oldest and smallest of the water supply systems. It was completed as a system prior to World War I and began service in 1842. The system holds approximately 95 billion gallons of water in 12 reservoirs and 3 controlled lakes and is located in Westchester and Putnam Counties. Croton System supplies an estimated 10% of the daily water consumption.

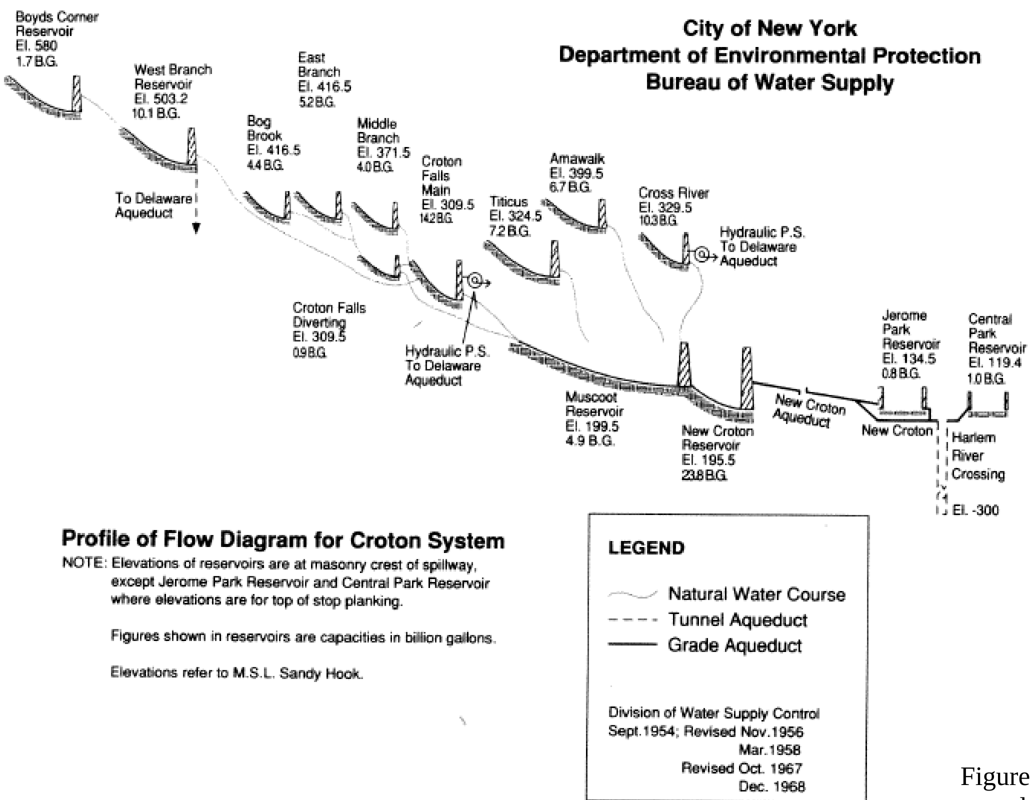


Figure 2: Flow Diagram of a complex network of reservoirs in the Croton system

Croton Aqueduct:

Croton water is delivered into the City via the New Croton aqueduct nearly 400 feet below grade. The aqueduct is divided into two sections:

Northern Section stretches 24 miles from New Croton reservoir to Jerome Park reservoir in the Bronx. The transmission capacity of the northern section tunnel is 290 MGD.

The tunnel is horseshoe shaped and brick lined and constructed in rock. It measures 13.5 feet high by 13.6 feet wide with a constant slope of approximately 0.7 feet per mile.

Southern Section from Jerome Park Reservoir gatehouse to Shaft 33 is approximately 9 miles long and 12.25 feet in diameter. It's a pressurized brick lined tunnel. The transmission capacity of the southern section tunnel is 250 MGD.

The Catskill system, built decades after the Croton system is significantly larger than the Croton. In the early years of the 20th century, the city and New York State designated thousands of acres of land in the eastern Catskill Mountains to build two reservoirs that more than doubled the City's water supply capacity. Construction of the Catskill water supply was accomplished in two stages:

Ashokan Reservoir, located in Ulster County, about 14 miles west from the City of Kingston, was formed by impounding the Esopus Creek. In an effort to control the turbidity of the water stored in the Ashokan Reservoir, the reservoir basin is divided into two sections known as the west basin and the east basin. The City has the ability to draw water from either basin to maximize the water quality during Catskill turbidity events. The two basins hold nearly 128 Billion gallons of water.

Schoharie Reservoir, a 20 billion gallon reservoir was formed by impounding the Schoharie creek. The 18.1 mile Shandaken tunnel was built to deliver the Schoharie Reservoir's waters into the channel of the Esopus creek, which leads into the Ashokan Reservoir. Schoharie Reservoir is 120 miles away from New York City and is the furthest reservoir in the New York City water supply system.

In total, the Catskill reservoirs hold approximately 148 Billion Gallons of water and on average supplies 40% of the daily water consumption.

Catskill Aqueduct:
Catskill system water is delivered into the City via the Catskill aqueduct built in 1915. Catskill water flows via the aqueduct into Kensico Reservoir and then into Hillview Reservoir just north of the City line. From there, City tunnel number 1 and number 2 deliver the water to the distribution system.

The aqueduct is built in four distinct types of construction that were adopted to meet the varying physiographic features of the path it travels.

Type 1, Cut-and-cover: Most of the aqueduct is 17 foot high by 17.5 foot wide, non-pressurized, horseshoe-shaped, concrete conduit, with an approximate slope of 1.1 feet per mile. The size increases to 17.5 by 18 feet between Kensico and Hillview Reservoir.

Type 2, Grade Tunnel: 24 tunnels approximately 14 miles in length, horseshoe shaped, Un-reinforced concrete conduits, 17 feet high by 13.33 feet wide, with a steeper than 1.1 feet per mile slope.

Type 3, Pressure Tunnel: 7 tunnels approximately 17 miles long with diameters varying from 14 to 16.58 feet used to cross small valleys or where sound rock was encountered. Circular, lined with un-reinforced concrete, designed to withstand internal hydrostatic pressures. A 14 foot diameter, 3022-foot long tunnel goes under the Hudson River and is approx. 1100 feet below sea level (the lowest level of any tunnel in the City water supply system).

Type 4, Steel Pipe Siphons: Used to cross small valleys or where the rock was not suitable for a pressure tunnel. 14 "Inverted" siphons, consisting of three steel pipes, encased in concrete and lined with cement mortar, from 9 to 11 feet in diameter, covering 6 miles of terrain.

The Catskill aqueduct is divided into two sections. Ashokan to Kensico section is 75 miles long with transmission capacity of 590 MGD. Kensico to Hillview section is 17 miles long with transmission capacity of up to 800 MGD.

The Delaware system, The city expanded its water supply system after World War II, tapping the east and west branches of the Delaware River, as well as other tributaries of the Delaware and Hudson rivers to create the newest and largest of its three systems, the Delaware system. The system includes four reservoirs, Cannonsville, Pepacton, Neversink, and Rondout and was completed in 1967. The system holds approximately 320 billion gallons of water, which provides around 50 % of the city's daily water supply.

Cannonsville Reservoir was formed by impounding the West Branch of the Delaware River. It is the westernmost of New York City's reservoirs. Placed in service in 1964, it is the most recently constructed New York City-owned reservoir. With a drainage area of 455 square miles, Cannonsville has the largest watershed of all of the NYC reservoirs. The reservoir's capacity is approximately 98 billion gallons. The water diversions from Cannonsville Reservoir flow through the West Delaware Tunnel in Tompkins, NY in to the Rondout Reservoir.

Pepacton Reservoir was formed by impounding the East Branch of the Delaware River. New York City purchased the land in 1942. The Downsville Dam, located at Downsville, NY, was finished in 1954, and the reservoir was filled by 1955. The reservoir is a narrow, winding reservoir that is 15 miles long and about 0.7 miles across at its widest point. The reservoir contains approximately 148 billion gallons of water at full capacity, and is over 160 feet (43.2 m) deep at maximum. This makes it New York City's biggest reservoir by volume. The water diversions from Pepacton Reservoir flow through the East Delaware Tunnel into the Rondout Reservoir.

Neversink Reservoir was formed by impounding the Neversink River, the longest tributary of the Delaware River. Neversink Reservoir has the highest quality of water among the Delaware Basin reservoirs. The reservoir is at the highest elevation (Spillway elevation is 1440 feet above the sea level) in the Delaware system. Neversink Reservoir holds approximately 35 Billion Gallons of water and has a watershed area of 93 square miles. The reservoir is 5 miles long and over 175 feet deep.

Rondout Reservoir was formed by impounding the Rondout creek. Although geographically in the Hudson River basin, Rondout is operationally part of the City's Delaware water system. Rondout Reservoir is the collection point for the city's Delaware system. Built in 1954, it was the first out of four Delaware reservoirs to be built. The reservoir is 6.5 miles long and holds a total of 50 Billion gallons.

An important set of operation restrictions on the Delaware System is the Supreme Court Decree of 1954, as supplemented by the Good Faith Agreement of the 1982. The decree and the agreement specify limits on the City diversions from the Delaware River Basin, and prescribe certain releases from the City’s Delaware Reservoirs to prevent salt intrusion and for other purposes in the lower Delaware River. These releases are related to flow measurements at Montague, NY and Trenton, NJ. In addition, agreements made between the City and the NYS DEC made in 1980 provides that the City shall supply augmented conservation releases during normal hydrologic conditions from its Delaware Basin reservoirs, and conservation releases from Rondout and Croton System.

The Delaware system reservoirs are significant factors in the local economy of upstate New York, as thousands of visitors, especially trout fishermen, travel to the area for recreation every year.

Delaware Aqueduct:

Water from the three Delaware Basin reservoirs is transferred to the Rondout reservoir by gravity from the West Delaware tunnel, 44 miles long, The East Delaware tunnel, 25 miles long, and the Neversink tunnel, 6 miles long. The water then enters the 85-mile Delaware Aqueduct at Rondout reservoir.

The Aqueduct is a circular concrete lined pressurized bedrock tunnel with a 13.5 to 19.5 feet finished diameter. The aqueduct passes under the Hudson River at the depth of approximately 600 feet below sea level. The Delaware Aqueduct then continues through the West Branch Reservoir to the Kensico Reservoir in Westchester and Putnam counties north of the city. The Delaware aqueduct continues further south through the Hillview Reservoir in Yonkers.

The aqueduct is divided into three sections:
Rondout to West Branch reservoir section is 44.2 miles long and can carry up to 890 MGD.
West Branch to Kensico reservoir section is 27.2 miles long and can carry up to 1045 MGD.
Kensico to Hillview reservoir section is 13.6 miles long and can carry up to 1450 MGD.
Gatehouses and valve chambers, some underground, contain the gates, valves, meters, etc. for controlling and measuring the flow of water into and out of the aqueduct.

Other Reservoirs:

Kensico Reservoir is a terminal reservoir located in Valhalla, NY. Kensico reservoir is part of the Catskill/Delaware water systems operation. It was put into service in 1915. Kensico reservoir was formed by impounding the Bronx River, but receives most of its water from Delaware and Catskill aqueducts. Along with the West Branch Reservoir, it is one of only two reservoirs within the Catskill/Delaware Watersheds that is not in the Catskill Mountains region.
Kensico reservoir holds approximately 30 Billion gallons of water and has a watershed area of 13.3 square miles.

Hillview Reservoir is a 900 million gallon storage reservoir in southeastern Yonkers, NY. The reservoir itself does not impound a river, and is held up by four walls. Hillview reservoir completed in 1915 was designed to receive water from the Catskill Aqueduct, through Kensico Reservoir. Water from the reservoir is sent to distribution system through New York City Water Tunnels No. 1 and No. 2. New York City Water Tunnel No. 3, which is still under construction, is planned to take water from the Kensico Reservoir, and immediately send it into the Hillview Reservoir, and then into the rest of New York City.

Jerome Park Reservoir is an 800 million gallon storage reservoir in north Bronx. The reservoir itself does not impound a river, and is held up by four walls. It was built in 1906 to receive the waters of the New Croton Aqueduct.

In the 1990s, residents fought to stop the City from converting the site to a water treatment plant. It was thought that the noise, chemicals, and unsightly construction would decrease the quality of life for area residents. The treatment plant is being built in another part of the Bronx, minutes away in the middle of Van Cortlandt Park.

A major advantage of the New York City water supply system is that of the nearly 1.1 billion gallons a day of water supplied to the City, 95% of the total is delivered by gravity. The other 5% requires pumping to maintain pressure. This percentage is sometimes increased in times of drought when the reservoirs are at lower than normal levels.

The furthest water supply reservoir is 120 miles away from central Manhattan. Long travel time for the water from the source to the City, results in most of the contaminations and microbes dying naturally and in superior water quality which meets all health related State and federal drinking water standards. With the exception of color, an aesthetic condition in the Croton and Groundwater Systems, that may exceed the standard on a seasonal basis.

All City water is treated with chlorine to meet disinfection standards, with fluoride (one part per million) to help prevent tooth decay, and with orthophosphate to create a protective film on pipes and reduce the release of metals, such as copper and lead, from household plumbing. Sodium hydroxide is added to Catskill/Delaware water to raise the PH and reduce corrosivity. For more information about the water quality please refer to *annual Water Quality reports.*

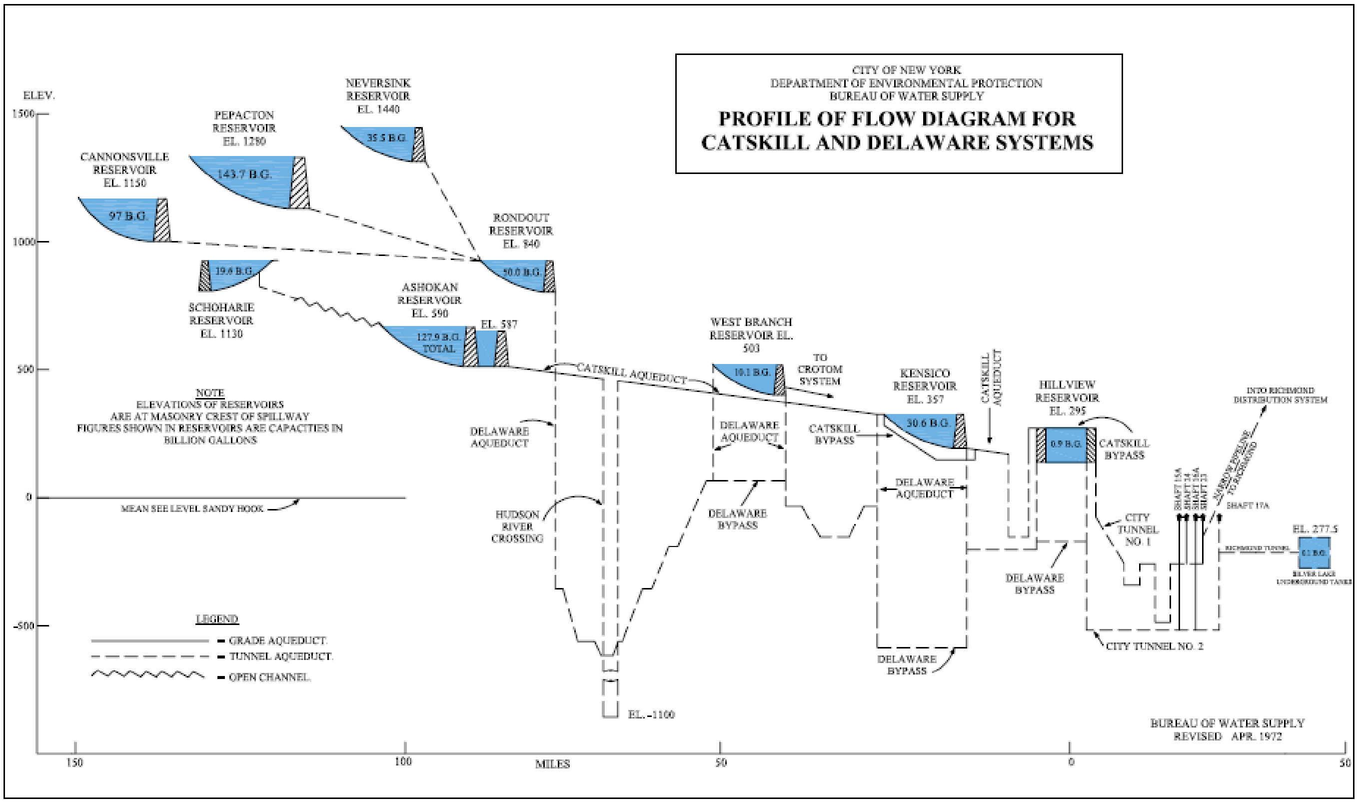


Figure 3: Flow diagram for Delaware and Catskill systems

New York City Water Supply Distribution System

Water from the New York City reservoirs supplies all of the New York City. In addition, upstate municipal corporations and water districts in the counties (except Dutchess County) in which the City has water supply facilities have certain legal entitlements to provide connections to the system and to take water, at a price set by the New York State DEC in quantities no greater than their populations times the City's per capita use. As such, the City system supplies nearly 85% of the water used in Westchester County and 5 to 10% of the water used in Orange, Putnam, and Ulster Counties. There are also upstate communities that do not regularly use water from the City system but are connected to it for emergency use.

New York City Water Tunnels:

New York City Water Tunnel No. 1 was completed in 1917. It runs from the Hillview Reservoir under the central Bronx, Harlem River, West Side, Midtown and Lower East Side of Manhattan, and under the East River to Brooklyn where it connects to Tunnel 2. It is expected to undergo extensive repairs upon completion of Tunnel No. 3 in 2012.

New York City Water Tunnel No. 2 was completed in 1935. It runs from Hillview Reservoir under the central Bronx, East River, and western Queens to Brooklyn where it connects to Tunnel 1 and the Richmond Tunnel to Staten Island.

New York City Water Tunnel No. 3 is the largest capital construction project in New York City's history. It is intended to provide the city with a critical third connection to its Upstate New York water supply system. The tunnel will eventually be more than 60 miles (97 km) long. Construction on the tunnel began in 1970 and the next phase of the tunnel is expected to be completed in 2012 with final completion date of 2020 or beyond.

In addition to the complex network of aqueducts, tunnels and approximately 7,000 miles of water pipes, New York City has almost 140,000 catch basins, 114,000 hydrants, 90,000 valves, 14 gatehouses, 68 groundwater wells, a 100 million gallon underground storage tank and 7,000 miles each of sanitary sewers. The responsibility of maintaining these vast networks falls under the Department of Environmental Protection's Bureau of Water and Sewer Operations.

City-sponsored conservation measures have cut average daily water consumption by almost 20% since the late 1980s. Steps to improve water use efficiency include metering 660,000 residential properties; installing low-flow plumbing fixtures in hundreds of thousands of houses and apartments; replacing most of the City's 114,000 fire hydrants with tamper-proof models; and providing free water use audits to homeowners, apartment managers and business operators.

Figure 4: New York City Tunnels

Current Projects:

Catskill/Delaware UV Facility

In preparation for the new EPA Long Term 2 Enhanced Surface Water Treatment Rule, LT2ESWTR, which was first proposed in August 2003, New York City designed an ultraviolet (UV) light disinfection plant for the Catskill/Delaware System. In January 2008 facility construction started. The facility is expected to begin operation in 2012. The Catskill/Delaware facility will consist of fifty-six 40-million gallon per day UV Disinfection Units and is designed to disinfect a maximum of 2.4 billion gallons of water per day. The plant will provide an additional barrier of microbiological protection by inactivating potentially harmful organisms such as Cryptosporidium and Giardia. This treatment will supplement DEP's existing microbial disinfection programs.

Croton Filtration Plant

The 400-square-mile Croton watershed is more densely populated and has more development than the City's 1,600-square-mile Catskill/Delaware watershed, leading the water quality to be lower than Catskill/Delaware water. The City's goal is to ensure that Croton system water is at all times protected against microbiological contamination, is aesthetically pleasing, and meets all drinking water quality standards. The City, therefore is constructing a filtration plant for Croton system water, pursuant to the terms of a November 1998 federal court Consent Decree, entered into with the United States and the State of New York. The facility is expected to reduce color levels in the Croton system water, reduce the risk of microbiological contamination, reduce disinfection by-product levels and ensure compliance with stricter water quality standards.

Restoration of the original elevation at New Croton Reservoir

The New Croton Reservoir was originally designed to store more water under normal conditions than it currently impounds. Due to damages sustained from a series of storms in 1955, flashboards were removed and portions of the fixed spillway weir crest were lowered resulting in a six foot drop in the elevation of the normal pool, and decreasing water storage capacity of the reservoir. In connection with significant modifications to the spillway that are required to meet current NYC DEC guidelines for dam safety, NYCDEP intends to restore the fixed spillway crest four feet and return the water level to an elevation closer to what was maintained prior to 1955, thereby restoring a portion of the storage capacity of the Reservoir. The resulting increased capacity is an important part of efforts to lessen the impact of future droughts on availability of potable water to New York City and the other municipalities the Croton System serves. It should be noted that New York City DEP is not seeking to acquire land in connection with restoring the capacity of the New Croton Reservoir.

Exhibit 7: "Maps showing all land to be acquired in connection with the project"

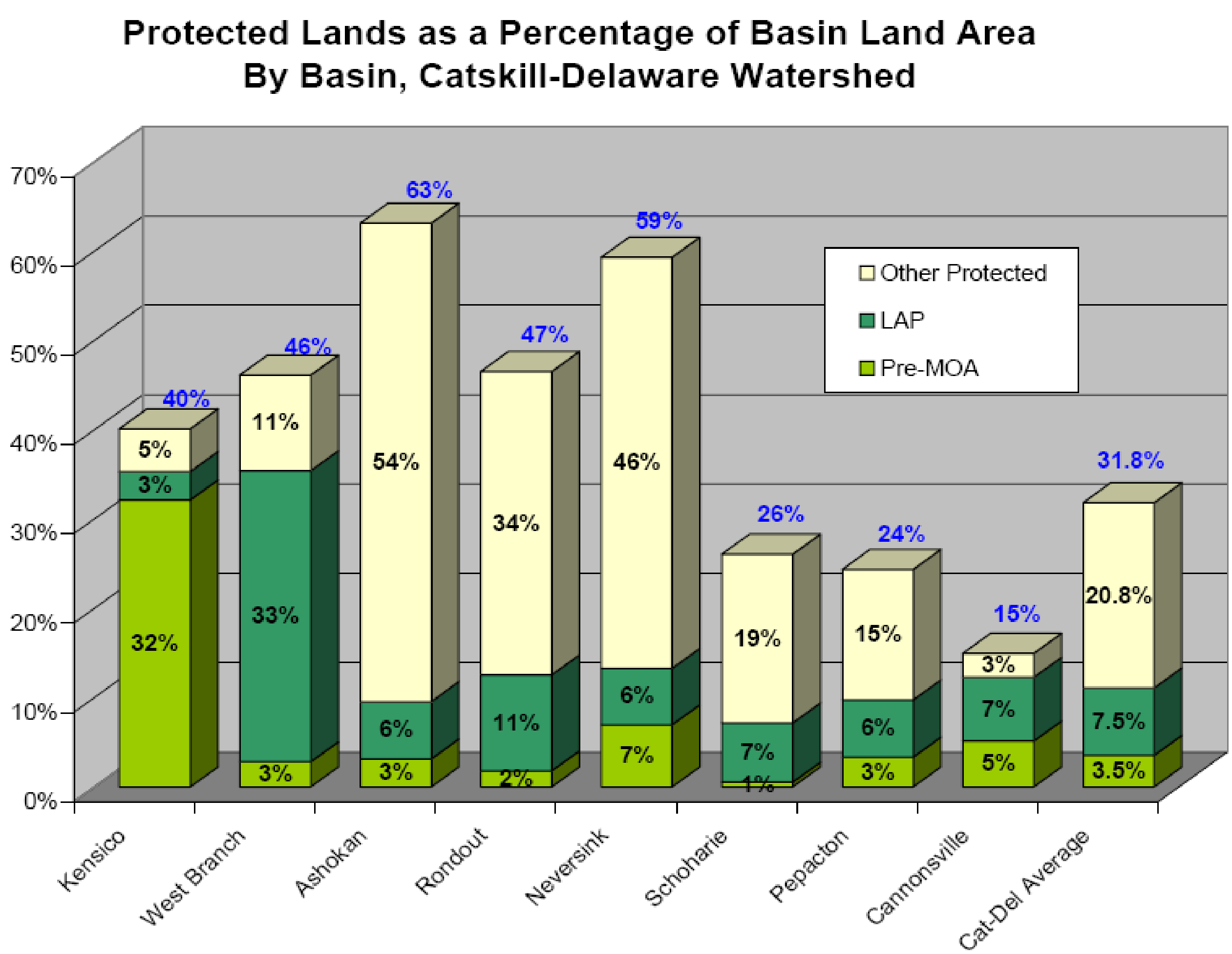
See Exhibits 3a and 3b for maps of the watershed showing protected lands as of January, 2010. These maps provide an overall view of the success of the Land Acquisition Program since 1997. It is not possible to provide maps of expected or future land acquisitions, given that the City will acquire properties only from willing sellers and location of these properties cannot be forecast. However, based on program requirements, history, and existing plans, it is possible to describe in general the types of properties to be solicited and the geographic regions of focus for future work.

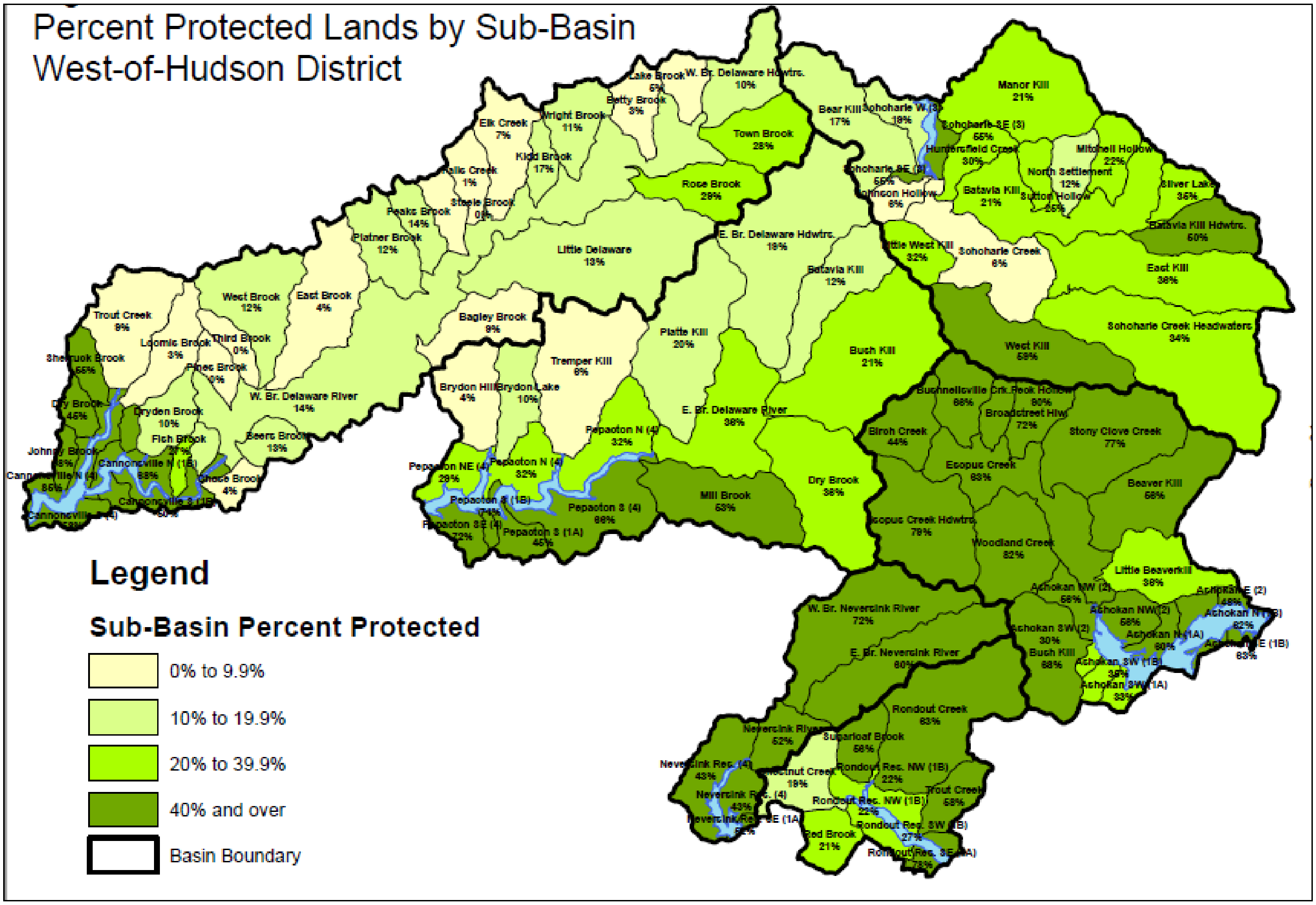
Program Requirements

The City acquires land subject to requirements set forth in the 1997 Watershed Memorandum of Agreement ("MOA"), the 1997 and 2007 Filtration Avoidance Determinations ("FAD"), and of course the existing (1997) Water Supply Permit (WSP). These documents establish the types of property interests that the City can acquire under the Program, conditions relating to the acquisition process, and requirements for the City once it acquires property, including maintaining property for watershed protection and payment of taxes. As discussed in detail further below, these documents also establish limits on the locations, types and size of properties that can be acquired.

History

Since 1997, the City and WAC have together secured over 100,000 acres of real property interests in the Catskill – Delaware System. This acreage is distributed as shown in Exhibits 3a and 3b. Considering land protected permanently by the City and by other entities such as New York State, a number of basins exhibit relatively high levels of overall permanent protected status, as shown in the chart and map below:





The percentage of lands under permanent protection is thus quite high in high priority basins such as Kensico (1A/B), West Branch Boyd's (1A/B), Rondout (1A/B), and Ashokan (1A/B and 2). In addition, the entire Neversink basin and certain sub-basins in Schoharie, Pepacton and Cannonsville are protected at levels well over 40%.

<u>Long-Term Plan for Acquisitions under the 2012 Water Supply Permit</u>

As required pursuant to the 2007 Filtration Avoidance Determination, in September 2009, the City prepared the Long-Term Land Acquisition Plan: 2012-2012 ("Long-Term Plan"), a copy of which is attached to this Exhibit. The Long-Term Plan identifies five key goals for the LAP over the term of the 2012 Water Supply Permit:

- Continue the proven real estate methods that have guided the program since 1997;
- Increase the percentage of protected lands in the Cat-Del System as a whole, with a particular emphasis on non-terminal reservoir basins with less than 30 percent protected lands, specific sub-basins with a low percentage of protected lands, and reservoir basins that are expected to provide a large contribution to future water supply;
- Continue to refine parcel selection procedures to maximize the water quality benefit of acquisitions;
- Build on our existing programs to promote City lands as a working landscape in partnership with local communities; and
- Develop strategies to promote the wise use of acquisition resources over the long-term.

The Long-Term Plan identifies regional Areas of Focus based primarily on the current level of protection in a sub-basin or basin as a mechanism for focusing the City's solicitation efforts and resources on acquisition in those areas where the LAP can maximize water quality benefit.

Since the added protective benefits of acquiring all but the largest properties in these basins is marginal, and the costs can be high (particularly east-of-Hudson), the City does not expect to continue the same intensity of solicitation in the basins and sub-basins where the proportion of permanently protected land is already high, nor to acquire many properties in these areas with the exception of those that are compelling.

In addition, farms are concentrated substantially in Cannonsville, with some in Pepacton and Schoharie but few elsewhere; thus WAC will be continuing to focus its resources in these three basins. For these and other reasons outlined in the Long-Term Plan, the City expects to focus its solicitation efforts in areas of Schoharie, Pepacton and Cannonsville that are currently at relatively low levels of protection. The lion's share of acreage in future acquisitions by both DEP and WAC can thus be expected in these areas.

Limits on Acquisitions and Potential Modifications

The City has been involved in negotiations with key watershed stakeholders over concerns raised by the watershed communities in connection with the expansion of the LAP under the 2007 FAD. These negotiations have focused on modifications to existing limitations on the City's solicitations and acquisitions under the MOA and the 1997 Water Supply Permit, and may lead to revisions of the City's solicitation plans and acquisition conditions. While we cannot at this time foresee exactly what these revisions will ultimately look like, they will likely include the following revisions that would influence the pattern of acquisitions:

1. **Hamlet designation.** Under the MOA (see Section 68 and Attachment R), a list of specific tax parcels totaling 6,852 acres were designated west-of-Hudson, which towns and incorporated villages could then elect to prohibit the City from acquiring in fee simple. Conservation easements could be acquired regardless, by either DEP or WAC. The MOA stipulated windows of opportunity for towns and villages to revise their decisions in regard to this process in 1997, 2001, and 2006. As part of negotiations in 2008-9 with FAD regulators and stakeholders on the shape of the Land Acquisition Program (LAP) for the period of the 2012-2022 WSP, to address local economic development concerns, the parties have agreed to new hamlet expansion (LAP exclusion zones) opportunities. Of the 32 towns west-of-Hudson, 15 elected not to revise their existing hamlet designations and 17 requested to add designated parcels to such 'hamlets'. The proposed additional parcels are de minimus in some towns and moderate in most others. If agreed to, these 17 towns (in addition to all other towns and villages with existing designated hamlets) would be given new opportunities every five years – immediately following issuance of the 2012 Water Supply Permit – to elect whether or not to exclude DEP and WAC from acquiring any real property interests, whether fee simple or conservation easements, in the designated hamlet areas as revised. Throughout the negotiations, the City has made clear that it will agree to expanded hamlet areas only if it determines that the expansions proposed by a town will not impair the City's ability to run a robust Land Acquisition Program, consistent with the requirements and goals established under the MOA and the FAD. Moreover, we have agreed that any modifications to the hamlets require the consent of the FAD regulators.

2. **Natural features criteria.** The Coalition of Watershed Towns has requested to revise solicitation guidelines such that only properties containing the following numeric thresholds for the natural features criteria would be solicited or acquired under the new WSP:

   Water features: properties must contain a minimum of 10% surface area, as determined by DEP's geographic information system, that is covered with watercourses, water bodies, wetlands, reservoirs, or 300-foot buffers to any of those features. Properties that contain less than 10% of water features in surface area must have a minimum of 60% surface area covered by slopes that are 15% or steeper. The Coalition has proposed that properties that do not meet one or both of these thresholds cannot be acquired by the City.

The City has tentatively agreed to adopt thresholds for natural features criteria, although it has proposed somewhat lower thresholds, and has also proposed that the thresholds should not apply if land abutting a property under consideration is already owned by the City or the State. As with the proposal to expand hamlet areas, the City has made clear that it will agree to natural features thresholds only if it determines that they will not impair the City's ability to run a robust Land Acquisition Program, consistent with the requirements and goals established under the MOA and the FAD. Moreover, we recognize that any modifications to the natural features criteria require the consent of the FAD regulators.

3. **Riparian Buffer Conservation Easement Program.** NYS has proposed that the City fund a program through which one or more local land trusts might acquire conservation easements on riparian buffers. The City has agreed in principle to such a program, and expects to meet with stakeholders during 2010 to establish the goals and parameters of such a program. If such program is to be implemented, it is expected to begin as a pilot program, probably in Greene County, and involve acquisitions of relatively small (under 20-acre) easements, and might require a modification to the minimum size thresholds or other criteria established under the MOA and the 1997 Water Supply Permit.

Exhibit 8: Cost Estimate

The MOA, 1997 FAD, and 1997 WSP required or authorized the City to commit up to $300 million toward the acquisition of real property interests in the Catskill / Delaware systems. These funds have been fully spent (in the case of DEP acquisitions) or committed (in the case of the WAC Farm Easement Program). The 2007 FAD required the City to commit an additional $241 million to the program, bringing the City's total commitment for land acquisition to $541 million.

As of the submission date for this Water Supply Permit application, roughly $173 million of the $541 million remains uncommitted. The overall breakdown of program costs to this point, and estimated costs through the term of the current FAD, are as follows:

Actual (Past) and Estimated (Future) Land Acquisition Program Costs, 1997 - 2017

Timeframe (Calendar Years)	Signed Contracts	Soft Costs	WAC Farm CEs*	WAC Forest CEs*	Riparian CEs*	Totals
1997 to 2009	$295.0	$26.2	$47.0	*N.A.*	*N.A.*	$368.2
2010 to 2017	$126.8	$12.0	$23.0	$6.0	$5.0	$172.8
Totals	**$421.8**	**$38.2**	**$70.0**	**$6.0**	**$5.0**	**$541.0**
% of Total:	78%	7%	13%	1%	1%	100%

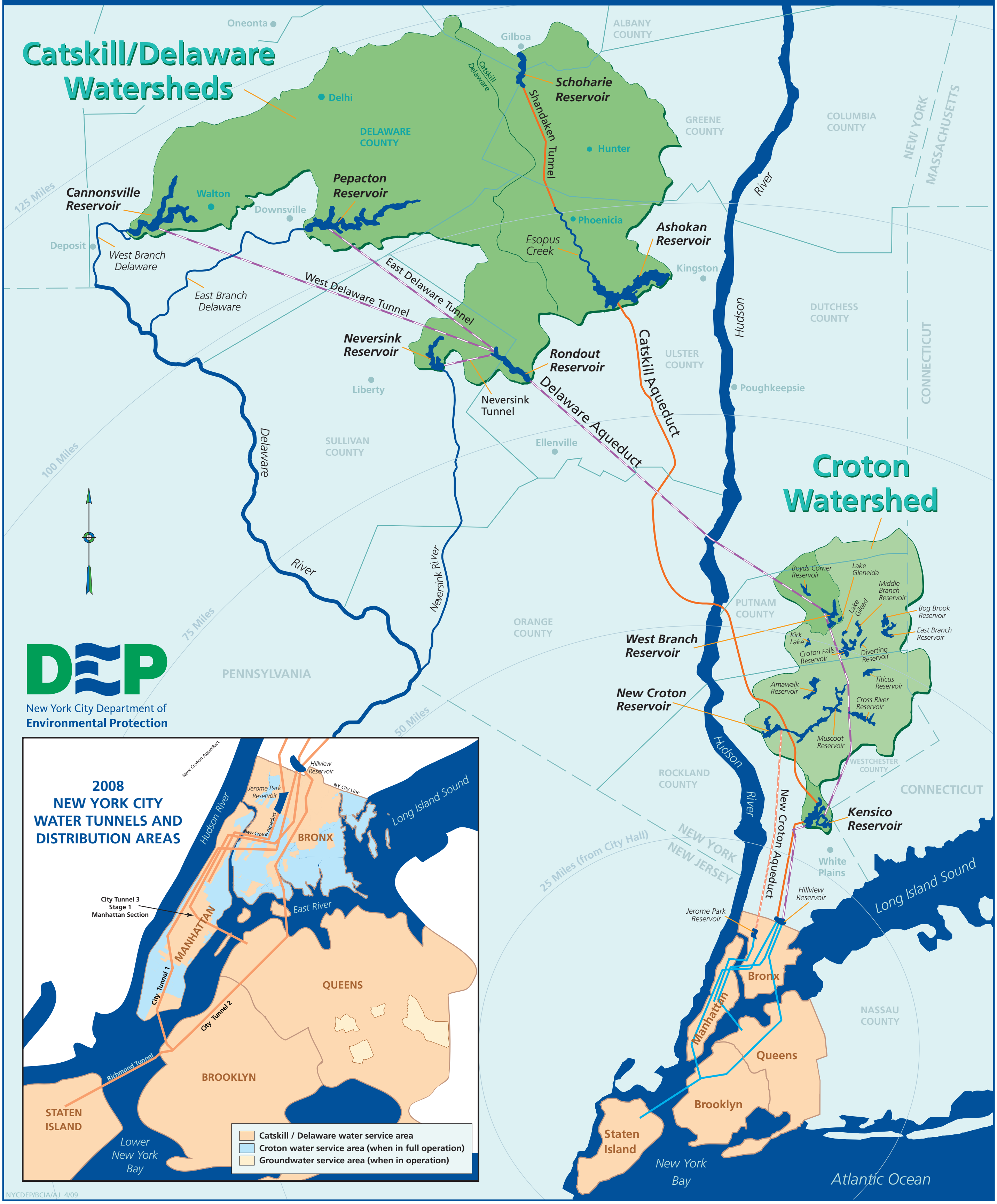
*The costs allocated for WAC farm and forest CEs, and for riparian CEs, include the soft costs associated with those programs.

New York City 2008 Drinking Water Supply and Quality Report

New York City Department of
Environmental Protection

Michael R. Bloomberg, Mayor
Steven W. Lawitts, Acting Commissioner

New York City's Water Supply System



New York City Department of
Environmental Protection

59-17 Junction Boulevard
Flushing, NY 11373

Steven W. Lawitts
Acting Commissioner

Dear Water Customer:

New York City's water supply system delivers more than 1 billion gallons of fresh, clean water daily to 9 million customers throughout the five boroughs and upstate. Consisting of 19 reservoirs, 3 controlled lakes, and more than 6,000 miles of pipes, aqueducts, and tunnels – our system is a green machine that runs almost entirely by gravity and, for the most part, doesn't require filtration.

Though our City and our Department face economic challenges that are very much influencing the way we do business, under Mayor Bloomberg's leadership DEP is presiding over one of the most important periods of revitalization for New York City's water and wastewater infrastructure since the creation of the Delaware Water Supply system in the 1950s and the post-1970s transformation of our Wastewater Treatment System. City Water Tunnel No. 3, the Croton Water Filtration Plant, the Catskill/Delaware Ultraviolet Light Disinfection Facility, land acquisition and infrastructure support for the Filtration Avoidance Determination (FAD), sweeping changes to the Newtown Creek Wastewater Treatment Plant, and preparation to fix the Delaware Aqueduct are just a few of the agency's significant ongoing projects.

These projects are ambitious and forward thinking. They are in the best tradition of the engineers who, more than 150 years ago, began building one of the greatest water supply systems in the world, and will ensure that – consistent with the Mayor's PlaNYC vision – this system can support an additional population of 1 million people by 2030 and remain viable for generations to come.

In addition to safeguarding and modernizing our infrastructure, DEP has made tremendous headway in revamping its Bureau of Customer Services. This year, DEP initiated the implementation of a citywide automated meter reading (AMR) network. AMR leverages the City's wireless network capabilities, and will provide our 833,000 customers with more accurate billing information. It will also eliminate estimated bills and the need for door-to-door meter reading.

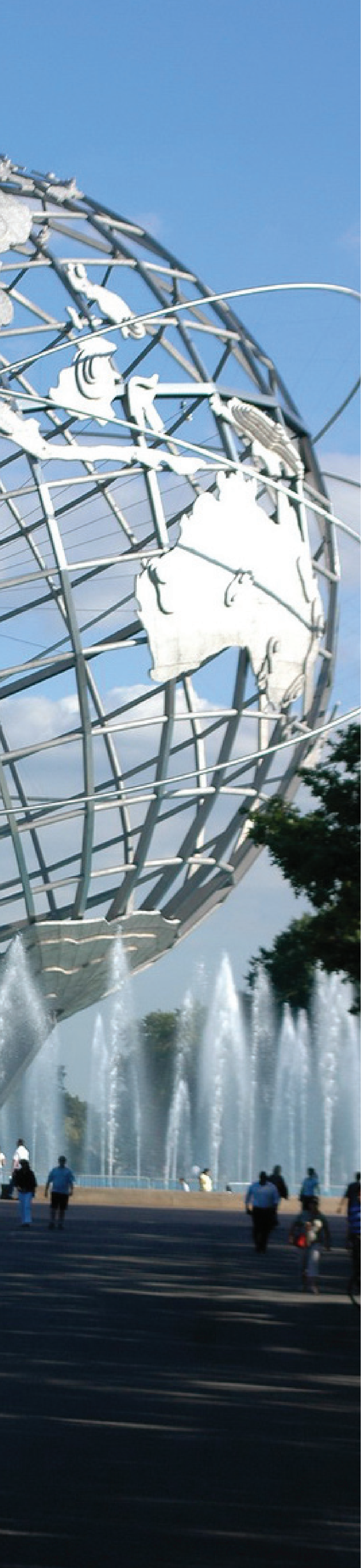
Soon, DEP will launch NYC Water, a campaign to promote our delicious tap water, which is among the highest-quality and best-tasting in the world. With no carbohydrates, sugar, or calories, NYC Water is not only good for your health; it's healthier for your wallet. Drinking two liters of NYC Water each day costs just 50¢ a year, while drinking two liters of bottled water a day can cost more than $1,400 a year.

In addition to being economically prudent, it is also environmentally responsible to drink tap water. Forty-seven million gallons of fossil fuels are used to produce all the plastic bottles Americans use each year, which results in one billion pounds of CO_2 added to the atmosphere. By drinking NYC Water, instead of bottled water, you can help protect our environment and minimize the likely impacts of climate change on our water supply system.

With your help, we can continue to promote NYC Water so that all of our customers, in addition to the millions of people who commute to or visit the City each year, know to reach for the tap instead of a bottled drink the next time they're thirsty.

Sincerely,

Steven W. Lawitts



NEW YORK CITY 2008 DRINKING WATER SUPPLY AND QUALITY REPORT

The New York City Department of Environmental Protection (DEP) is pleased to present its 2008 Annual Water Quality Report. This report was prepared in accordance with Part 5-1.72 of the New York State Sanitary Code (10NYCRR), and the National Primary Drinking Water Regulations, 40 CFR Part 141 Subpart O, of the United States Environmental Protection Agency (EPA), which require all drinking water suppliers to provide the public with an annual statement describing the water supply and the quality of its water.

New York City's Water Supply

The New York City surface (reservoir) water supply system provides approximately 1.0 billion gallons of safe drinking water daily to over 8 million residents of New York City, and to one million people living in Westchester, Putnam, Ulster, and Orange counties, as well as the millions of tourists and commuters who visit the City throughout the year. In addition to our surface water supplies, fewer than 100,000 people in southeastern Queens may receive groundwater or a blend of groundwater and surface water. In all, the City system supplies nearly half the population of New York State with high quality water.

Source of New York City's Drinking Water

New York City's surface water is supplied from a network of 19 reservoirs and three controlled lakes in a 1,972 square-mile watershed that extends 125 miles north and west of New York City. Due to the City's ongoing efforts to maintain the appropriate volume and high quality of water in the distribution system, there is some rotation in the water sources used by DEP. In 2008, 98.3% of our water came from the Catskill/Delaware System (Public Water System Identification Number – PWSID NY7003493), located in Delaware, Greene, Schoharie, Sullivan, and Ulster counties, west of the Hudson River. The Croton System (PWSID NY7003666), the City's original upstate supply, provided, on average, 1.6% of the daily supply to the City from 12 reservoir basins in Putnam, Westchester, and Dutchess counties. New York City's Groundwater System (PWSID NY7011735) in southeastern Queens was off-line for the entire 2008 calendar year.

Regulation of Drinking Water

The sources of drinking water worldwide (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material and can pick up substances resulting from the presence of animals or from human activities. Contaminants that may be present in source water include: microbial contaminants, inorganic contaminants, pesticides and herbicides, organic chemical contaminants, and radioactive contaminants.

In order to ensure that tap water is safe to drink, the New York State Department of Health (NYSDOH) and EPA prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. The State Health Department's and the federal Food and Drug Administration's (FDA) regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline at (800) 426-4791.

Ensuring a Safe, Reliable and Sufficient Water Supply

Source Water Assessment Program

The Safe Drinking Water Act (SDWA) Amendments of 1996 required states to develop and implement Source Water Assessment Programs (SWAP) to: identify the areas that supply public tap water; inventory contaminants, and assess water system susceptibility to contamination; and inform the public of the results. The SDWA gave states a great deal of flexibility on how to implement SWAP. These assessments were to be created using available information, and to help estimate the potential for source water contamination. Elevated susceptibility ratings do not mean that source water contamination has or will occur in the water supply, but instead indicate the need for water suppliers to implement additional precautionary measures.

Starting in 1993, and culminating in 1997 with the historic watershed agreement and Filtration Avoidance Determination (FAD), New York City began implementation of a series of programs to reduce the susceptibility of the surface water supply to contamination from a variety of sources. These programs, which are still ongoing, operate under the close scrutiny of both the NYSDOH and the EPA. Due to these efforts, further detailed below, the SWAP methodologies applied to the rest of the state were not applied to the New York City water supply by NYSDOH.

Watershed Protection Programs

10-Year Filtration Avoidance Determination from EPA

2008 marked the first full year of DEP's implementation of the latest 10-year FAD, covering 2007 to 2017, issued by EPA in July of 2007. The FAD is based on the Long-term Watershed Protection Program DEP submitted in December, 2006, and describes enhancements to existing watershed protection programs as well as the development of several new efforts.

Land Acquisition

New York City buys real property interests from willing sellers only, with the goal of further protecting and buffering its 19 reservoirs and controlled lakes in the Catskill/Delaware and Croton watersheds. Surrounding these reservoirs are 1.2 million acres of land, of which the City owned 45,000 acres in 1997. Since the Land Acquisition Program began in 1997, the City and its partner, the Watershed Agricultural Council (WAC), have secured over 92,000 acres in fee simple or conservation easements. In all, the City now owns more than 137,000 acres, land which is now protected from development and managed pro-actively to protect water quality. DEP solicits parcels for acquisition based on the presence of critical natural, topographical features, such as streams and wetlands and/or proximity to reservoirs, as well as potential for development. During 2008, DEP continued to solicit – and re-solicit – owners of such sensitive watershed properties.

Land Management

With the City's acquisition of land over the past 11 years, it has become one of the largest single landowners in the watershed region. These properties must be managed to ensure that water quality is protected. To achieve this critical objective, DEP has developed and implemented land management programs that identify specific beneficial uses and projects for the City's water supply lands that include opening properties for recreational use.

Since 1997, DEP has increased the acreage of land open for recreation every year, and 51,538 acres are now available for fishing, hiking, hunting, trapping, cross-country skiing and other passive activities. New in 2008 were Public Access Areas, where recreation users can enter City lands without a DEP Access Permit or Hunt tag. An additional 4,337 recreation Access Permits were issued in 2008, for a total of more than 114,085 valid permits.

Partnership Programs
Many of the City's watershed protection programs west of the Hudson River are administered by the Catskill Watershed Corporation (CWC), a non-profit corporation formed for this purpose. Together, the CWC and DEP have repaired, replaced or managed more than 2,800 failing septic systems and authorized the construction of approximately 70 stormwater control measures to address existing stormwater runoff.

The Community Wastewater Management Program (CWMP), funded by the City and administered by CWC, enables the planning, design and construction of community septic systems or septic maintenance districts in hamlets west-of-Hudson. CWMP projects have been completed in the hamlets of Bovina and DeLancey and are underway in Hamden, Bloomville, Boiceville, and Ashland.

DEP also works with communities to address the issue of septic systems that are failing or likely to fail. Through its New Infrastructure Program, DEP is financing the construction of new wastewater treatment plants in areas with problem septic systems. Roxbury, Andes, Windham, Hunter, Fleischmanns, and Prattsville have completed construction of wastewater treatment facilities. DEP's sewer extension program connects new sewer lines to City-owned treatment plants west-of-Hudson. The projects in Grahamsville, Tannersville, Margaretville, Grand Gorge, and Pine Hill are either in design or under construction.

Wastewater Treatment Plant (WTP) Upgrades
More than 100 non-City-owned WTPs in the upstate watershed are being upgraded to provide state-of-the-art treatment of pathogens and substantially reduce nutrients in their waste streams. Under this City-funded effort, plants generating 98% of the west-of-Hudson WTP flow have been upgraded. In the Croton Watershed, plants producing 81% of the flow have been fully upgraded; facilities accounting for another 9% of the flow are in the construction phase; while another 22 plants (generating 10% of the flow) are now in the design phase.

Stream Management Program
Stream Management Program (SMP) is a partnership program founded to encourage the long-term stewardship of streams and floodplains in the west-of-Hudson watershed. The SMP and its partners work to address the challenges associated with living in the Catskill Mountains that can affect water quality: damage to property and infrastructure, such as homes, roads, bridges and culverts; excessive stream-bank erosion; flooding hazards; and ecological and habitat degradation. Over the past several years the City has contracted with four county Soil and Water Conservation Districts and the Cornell Cooperative Extension of Ulster County to develop stream management plans that report the condition of stream corridors and provide a comprehensive set of recommendations for their protection, conservation, and enhancement.

Plans have been completed for the Esopus Creek, the Schoharie Creek and all of its major tributaries, and the main streams of the East and West Branches of the Delaware River. Over the past several years, the SMP and its partners have also demonstrated stream restoration techniques throughout the west-of-Hudson watershed, completing 53 projects and restoring natural channel stability to many miles of watershed streams. In 2008, DEP and its contractual partners began implementing the variety of recommendations made within these plans. The SMP along with our partners has established watershed councils for each major reservoir basin, with participating communities providing a leadership role in implementing the plans' recommendations.

New York City has committed $34 million to the Stream Management Program through the 2007 FAD, which is in addition to the $21 million funded under the 2002 FAD.

Watershed Agricultural Program and Forestry Program
The Watershed Agricultural Program and the Watershed Forestry Program combined function as collaborators between DEP and the local not-for-profit Watershed Agricultural Council (WAC) that supports and maintains well-managed family farms and working forests as beneficial land uses for water quality protection. In 2008, DEP and WAC completed negotiations on a 46-month contract that enables WAC to continue

administering and implementing the Watershed Agricultural and Forestry Programs through 2012. This new contract took effect January 1, 2009. It includes both actual and proposed federal matching fund commitments from the USDA Forest Service, Farm Service Agency, and Natural Resource Conservation Service, primarily through direct WAC grants, but also through the City/federal cost-sharing Conservation Reserve Enhancement Program (CREP) and the 2008 federal Food, Conservation and Energy Act.

Since 1992, the Watershed Agricultural Program has developed pollution prevention plans for more than 390 small and large farms in both the Catskill/Delaware and Croton watersheds, in addition to implementing thousands of best management practices (BMPs) that reduce agricultural pollution and protect water quality. In the Catskill/Delaware watersheds, approximately 96% of large commercial farms participate in the program.

Since 1997, the Watershed Forestry Program has developed more than 740 forest management plans covering 132,500 watershed acres, of which an estimated 103,800 acres are forested. It has also implemented 150 timber harvest road BMP projects and remediated 59 forest roads having erosion problems. Each year, the program also conducts dozens of forestry education and training programs for thousands of watershed landowners, foresters, loggers, teachers, students, forest industry professionals, local officials, and other upstate/downstate audiences.

Improved Reliability

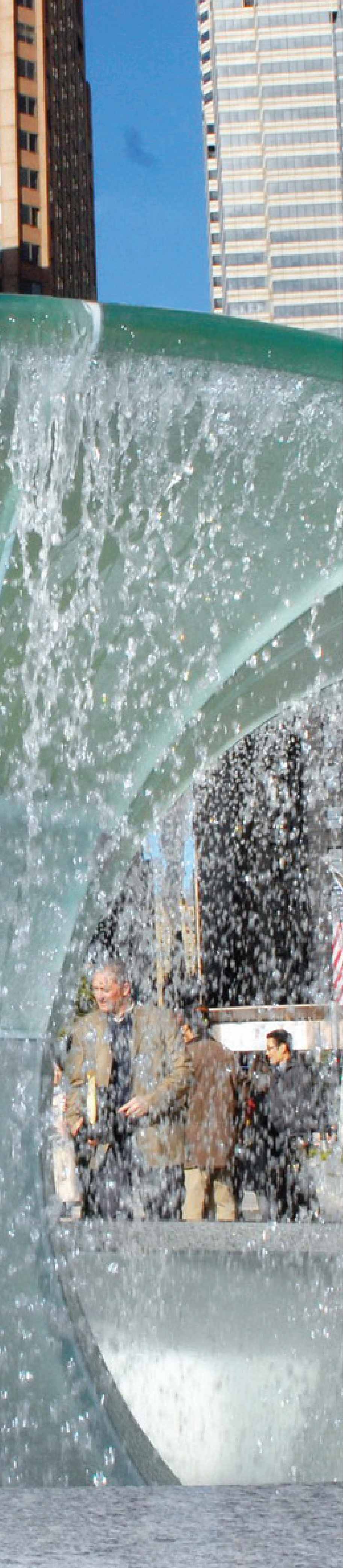
Catskill/Delaware UV Facility

EPA published new regulations in the Federal Register on January 5, 2006, including the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), to improve control of microbial pathogens. In preparation for the new rule, which was first proposed in August 2003, New York City designed an ultraviolet (UV) light disinfection plant for the Catskill/Delaware System. Construction of the facility began in 2008 and is expected to begin operation in 2012. The plant is located at the New York City-owned Eastview site, a 153-acre property situated in the towns of Mount Pleasant and Greenburgh in Westchester County, New York. The Catskill/Delaware facility will consist of fifty-six 40-million-gallon-per-day UV Disinfection Units and is designed to disinfect a maximum of 2.4 billion gallons of water per day. The plant will provide an additional barrier of microbiological protection by inactivating potentially harmful organisms, such as *Cryptosporidium* and *Giardia*. This treatment will supplement DEP's existing microbial disinfection programs.

Croton Water Filtration Plant

The City's goals are to ensure that water from all three of its water supply systems is at all times protected against microbiological contamination, is aesthetically pleasing, and meets all drinking water quality standards. With respect to the Croton System, the City is proceeding with the construction of a filtration plant for Croton System water, pursuant to the terms of a November 1998 federal court Consent Decree entered into with the United States and the State of New York. The filtration plant is expected to reduce color levels, the risk of microbiological contamination, and disinfection byproduct (DBP) levels in the Croton System water. The filtration plant will also ensure compliance with stricter water quality standards. In September 2004 the City issued a notice to proceed with the first phase of construction of the Croton Water Filtration Plant at the Mosholu Golf Course site. In August 2006 and August 2007 the second and third phases went forward. Construction work at the site continues to make progress: excavation of the two Treated Water Tunnels has been completed; placement of concrete for lining the Raw Water Tunnel is underway; and, concrete placement, installation of mechanical piping and electrical work at the site continue to advance. In addition, work off-site at the Treated Water Shafts at Jerome Park Reservoir continues. The Croton Water Filtration Plant is expected to be operational by 2012.

As part of an agreement between the City and the Parks Department, more than $200 million generated from water and sewer revenues are being spent on improvements to more than 70 Bronx Parks and recreational facilities. DEP also operates a community



outreach office adjacent to the Mosholu site. The office, located at 3660 Jerome Avenue, Bronx, New York is open Monday through Friday from 9 AM to 5 PM. For more information, the telephone number of the center is (718) 231-8470.

The City remains committed to maintaining a comprehensive watershed protection program for the Croton System. Until DEP begins to filter Croton water, we are required to make the following statement: *Inadequately treated water may contain disease-causing organisms. These organisms include bacteria, viruses, and parasites, which can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.*

City Water Tunnel No. 3

Construction of City Water Tunnel No. 3, one of the largest capital projects in New York City's history, began in 1970. City Water Tunnel No. 3 will enhance and improve the City's water delivery system, and allow for the inspection and repair of City Water Tunnels No. 1 and No. 2 for the first time since they were put into service, in 1917 and 1936, respectively. The 13-mile Stage 1 section went into service in August 1998. It runs from Hillview Reservoir in Yonkers, through the Bronx, down Manhattan across Central Park, and into Astoria, Queens. Stage 2 of City Water Tunnel No. 3 consists of the Brooklyn/Queens leg and the Manhattan leg. The Brooklyn/Queens leg is a 5.5-mile section in Brooklyn that connects to a 5-mile section in Queens. These sections were completed in May of 2001. It is anticipated that the Brooklyn/Queens section, which will deliver water to Staten Island, Brooklyn and Queens, will be activated by 2013. Tunneling on the Manhattan portion of Stage 2 began in 2003 and was completed in 2008. Almost 9 miles were excavated and lined with concrete. In addition, ten new supply shafts have been constructed on the Manhattan leg that will integrate the new tunnel section with the existing distribution system. Work on the distribution chambers, which are underground facilities atop the shafts, continues and should be completed in 2013 at which time the Manhattan leg is expected to begin water delivery. Facility planning for Stage 3 of the tunnel is ongoing, with a final facility plan and conceptual design expected by 2011. Stage 3, referred to as the Kensico-City Tunnel (KCT) involves construction of a 16-mile section that extends from the Kensico Reservoir to a valve chamber in the Bronx. When completed, the KCT will be able to deliver water directly from Kensico Reservoir to City Water Tunnel No. 3. In total, City Water Tunnel No. 3 will span 60 miles. Construction is expected to be completed by 2025.

Hillview Reservoir

Due to violations of the Total Coliform Rule (TCR) in the distribution system in 1993 and 1994 that were attributed to conditions at Hillview Reservoir, DEP entered into a 1996 Administrative Order (AO) with NYSDOH, which was amended in 1997 and again in 1999, requiring DEP to complete four activities: 1) remove sediment from the Hillview Reservoir sediments; 2) undertake a biofilm research study of the distribution system; 3) investigate the integrity of the Hillview Reservoir dividing wall; and 4) install a cover over the Hillview Reservoir. DEP completed all of the action items stipulated in the AO except for item 4, the covering of the Hillview Reservoir. However, DEP instituted an improvements program comprised of facility and operational modifications designed to prevent a recurrence of the TCR violations. The improvements include: increasing the chlorine residual in the basins of Hillview Reservoir, developing and updating Standard Operating Procedures, and initiating an avian (bird) deterrent program. Significant capital projects were also completed, including improvements to chemical addition facilities and site security. Other capital projects are planned which exceed the requirements of the AO. Because DEP did not meet the AO milestone for commencing construction of a cover (April 30, 2002), nor for completing construction of a cover (December 31, 2005), NYSDOH and DEP negotiated to amend the terms of the AO, and reached an agreement to modify the AO and extend the covering milestone. The final AO was signed in February 2008. It requires DEP to complete the cover over the East Basin by June 2014, and the cover over the West Basin, by October 2016.

Groundwater System Enhancements

In the late 1990s, after purchasing the wells in southeastern Queens and assuming responsibility for the delivery of drinking water from those wells to the adjacent communities, DEP embarked upon a broad program to integrate New York City's surface water supply with the groundwater supplied by the aquifer system below southeastern Queens. As part of the Brooklyn-Queens Aquifer Feasibility Study, DEP continues to investigate the use of the deep aquifers for water storage and to develop plans for a treatment plant at Station 6 in Jamaica.

Station 6 Groundwater Treatment Plant

DEP continues to develop plans for a new groundwater treatment plant to replace DEP's existing facility located at Station 6 in Jamaica, Queens. This proposed state-of-the-art facility, whose final design is expected to be completed in 2012 and construction projected for 2014, will produce high quality drinking water and control groundwater flooding. Once built, Station 6 will provide between 10 and 12 million gallons per day of drinking water. As part of the Station 6 project, DEP has implemented a comprehensive community outreach program. This program includes small group meetings, large public forums, distribution of informational materials, and a Citizens Advisory Committee. More information about the Groundwater System can be found at www.nyc.gov/dep/groundwater.

Aquifer Storage and Recovery

In addition to improving the quality of groundwater from Queens' aquifers through treatment, DEP is investigating the possibility of improving the groundwater supply by using the deep aquifers (Magothy and Lloyd) to provide additional storage for surface water. Working with regional agencies, DEP is developing an Aquifer Storage and Recovery (ASR) project. Currently, the Lloyd Aquifer's resources are depleting, mainly due to rate of consumption by Long Island communities that is greater than the aquifer's natural rate of recharge. ASR would help to replenish the Lloyd Aquifer by injecting surplus water from New York City's upstate surface water reservoirs into the aquifer. This water would be stored in both deep aquifers and, when necessary, the City could extract a portion of this potable water to supplement its drinking water supply.

This process will benefit both the City and communities on Long Island. New York City will benefit from a new in-City drinking water supply -- created without many of the attendant construction costs and community disturbances involved in traditional capital projects. Most importantly, the City would also gain a temporary alternate water supply in case of an emergency, such as a drought or the need to shut down one of the City's three aqueducts. The injection process will have an added benefit in that it will recharge the aquifer. This recharging process would help to guard the aquifer against saltwater intrusion, protecting Long Island beach communities' underground drinking water from salinization, which is a long-term threat to their supply.

The West Side Corporation Site

The West Side Corporation (WSC), located at 107-10 180th Street in Jamaica, was a dry cleaning storage and distribution center that handled large amounts of the chemical tetrachloroethylene (also known as "PERC" or PCE) between 1969 and 1982. When the business closed, it left behind spills and storage tank leaks that resulted in the seepage of hazardous chemicals, including PERC, through the soil and into the groundwater. Today, DEP and the DEC are working together to clean up both the soil and the groundwater contamination caused by the spills.

Water Conservation

The average single family household in New York City uses approximately 100,000 gallons of water each year, at a cost of $2.02 per 100 cubic feet of water (748 gallons), or about $270 each year (based on the FY2008 water rate). Since virtually all City residences are connected to the public sewer system and, therefore, receive wastewater collection and treatment services as well, the combined annual water and sewer charge for the typical NYC household using 100,000 gallons per year is $699 consisting of $270 for water service and $429 for wastewater services. New York City is fortunate to have reasonably priced drinking water; however, everyone should do their part to conserve this precious resource. All New Yorkers are encouraged to observe good water conservation habits, and are required to obey the City's year-round water use

restrictions, which include a prohibition on watering sidewalks and lawns between November 1 and March 31, and between 11 AM to 7 PM from April 1 to October 31. It is illegal to open fire hydrants at any time. You can help save water by ordering a Home or Apartment Water Saving Kit by calling the City's helpline, 311. If you are an apartment building owner/manager or a homeowner, you can also obtain a free leak survey by calling DEP's Leak survey contractor at (718) 326-9426 for information. You can also go to www.nyc.gov/dep, click on "more services" in the Customer Services Box, and fill-in these order forms to send to the person listed.

Water Treatment

All surface water and groundwater entering New York City's distribution system is treated with chlorine, fluoride, food grade phosphoric acid and, in some cases, sodium hydroxide. New York City uses chlorine to meet the New York State Sanitary Code and federal Safe Drinking Water Act (SDWA) disinfection requirements. Fluoride, added since 1966, at a concentration of one part per million, in accordance with the New York City Health Code, helps prevent tooth decay. Phosphoric acid is added to create a protective film on pipes that reduces the release of metals such as lead from household plumbing. Sodium hydroxide is added to Catskill/Delaware water to raise the pH and reduce corrosivity.

In the Groundwater System, DEP has the ability to apply a sequestering agent at several wells to prevent the precipitation of naturally occurring minerals, mostly iron and manganese, in the distribution mains and customers' household piping. Air stripper facilities can be operated at several wells to remove volatile organic chemicals. For the entire 2008 calendar year there were no wells in operation.

Fluoride

DEP is one of the many drinking water systems in New York State that provides drinking water with a controlled, low level of fluoride for consumer dental health protection. According to the United States Centers for Disease Control and Prevention (CDC), fluoride is very effective in preventing cavities when present in drinking water at an optimal range of 0.8 to 1.2 mg/L. The New York City Health Code requires a fluoride concentration of approximately 1.0 mg/L, with an acceptable range of 0.9 to 1.1 mg/L. To ensure that the fluoride supplement in your water provides optimal dental protection, NYSDOH requires that we monitor fluoride levels on a daily basis. During 2008, none of the monitoring results showed fluoride at levels that approach the 2.2 mg/L MCL for fluoride.

During 2008, fluoride was not continuously supplied in the Catskill/Delaware System due to upgrades and repair work on the fluoride feed system. Fluoridation facilities for the Catskill System were off-line over 7% of the time, with the longest period of fluoridation interruption being approximately two days, from 2/22/08 through 2/24/08. Fluoridation facilities for the Delaware System were off-line over 9% of the time, with the longest period of fluoridation interruption being five days, from 6/14/08 through 6/19/08. NYSDOH Bureau of Dental Health has indicated that a brief interruption of fluoridation to the Catskill/Delaware System is not expected to have a significant impact on dental health. Interruption of fluoridation in 2008 did not require public notification.

Operational Changes

As part of a multi-year program to inspect and rehabilitate the New Croton Aqueduct, the Croton System was removed from service on October 12, 2007. On October 15, 2008, the Croton System was activated and began supplying water into distribution through December 12, 2008 when the Mosholu Pump Station was shut down. Croton water was not fed into distribution for the remainder of the year.

For the Groundwater System, there were no wells in operation for the entire 2008 calendar year. Operational information for the Groundwater System can be found at www.nyc.gov/dep/groundwater. The map on the inside front cover represents the Catskill/Delaware, Croton, and Groundwater service areas. This map depicts the Croton and Groundwater service areas when in operation.

Drinking Water Quality

DEP's water quality monitoring program -- far more extensive than required by law -- demonstrates that the quality of New York City's drinking water remains high and meets all health-related State and federal drinking water standards.

Drinking Water Monitoring

DEP monitors the water in the distribution system, the upstate reservoirs and feeder streams, and the wells that are the sources for the City's supply. Certain water quality parameters are monitored continuously as the water enters the distribution system, and water quality is regularly tested at sampling points throughout the entire City. DEP conducts analyses for a broad spectrum of microbiological, chemical, and physical measures of quality. In 2008, DEP collected more than 29,800 samples from the City's distribution system and performed more than 381,300 analyses.

DEP conducts most of its distribution water quality monitoring at approximately 1,000 fixed sampling stations throughout the City. These stations, visible in many neighborhoods, allow DEP to collect water samples throughout the distribution system in an efficient and sanitary manner. The approximate boundaries of the service areas for all three City Systems are displayed in the map on the inside of the front cover.

Test Results

The results of the tests conducted in 2008 on distribution water samples under DEP's Distribution System Monitoring Program are summarized in the tables in this Report. These tables reflect the compliance monitoring results for all regulated and nonregulated parameters. The tables present both the federal and State standard for each parameter (if applicable), the number of samples collected, the range of values detected, the average of the values detected, and the possible sources of the parameters. The monitoring frequency of each parameter varies and is parameter specific. Data are presented separately for the Catskill/Delaware and Croton Systems. (There are no data presented for the Groundwater System since it was not in service in 2008.) Whether a particular user received water from the Catskill/Delaware or Croton supplies, or a mixture of the two, depends on location, system operations, and consumer demand. Those parameters monitored, but not detected in any sample, are presented in a separate box. The State requires monitoring for some parameters less than once per year because the concentrations of these parameters do not change frequently. Accordingly, some of these data, though representative, are more than one year old. For specific information about water quality in your area, New York City residents should call the City of New York's 24-hour helpline at 311.

Sampling

DEP is required to monitor drinking water for various parameters on a regular basis. Results of regular monitoring are an indicator of whether or not drinking water meets health standards. DEP collects samples at a frequency prescribed by the State. In 2008, DEP met all State and federal sampling requirements.

Color

The Croton System experiences seasonal water quality problems associated with elevated color levels, resulting from naturally occurring minerals and organic matter present in the water. In the Croton System, there was one violation of the color MCL in October 2008 at the Croton System entry point Site 37 on 10/30/2008. In November 2008, there were a total of seven color MCL violations at the Croton System entry points: three color MCL violations at entry point Site 1SC21 (11/2/2008, 11/18/2008, and 11/27/2008), three color MCL violations at Site 37 (11/2/08, 11/6/08, 11/9/08), and one color MCL violation at Site 12900 (11/18/2008). In December 2008, there was one color MCL violation at the Croton System entry point Site 1SC21 on 12/9/2008, and one color MCL violation at the Croton System entry point Site 37 on 12/11/2008. In each case, the average of two consecutive samples from the same site exceeded the MCL of 15 apparent units. Color has no health effects unless detected in very high concentrations. In some instances, color may be objectionable to some people at as low as 5 apparent units. The presence of elevated color levels is aesthetically objectionable and suggests that the water may need additional treatment.

Turbidity

For the month of November 2008, the Croton System's monthly average daily entry point turbidity was 1.52 NTU, which violated the MCL of 1 NTU.

On 10/30/2008 there was a Croton System entry point turbidity reading of 1.66 NTU at Site 1SC21. If the daily entry point analysis exceeds 1 NTU, a repeat sample must be taken within one hour. DEP failed to collect a repeat sample on 10/30/2008 and was issued a Tier 3 monitoring violation by NYSDOH.

On 11/1/2008, there was a Croton System entry point turbidity reading of 1.94 NTU at Site 37. DEP failed to collect the repeat sample on 11/1/2008 and was issued a Tier 3 monitoring violation by NYSDOH.

Turbidity has no health effect. However, turbidity can interfere with disinfection and provide a medium for microbial growth. Turbidity may indicate the presence of disease-causing organisms. These organisms include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated headaches. Please pay special attention to the additional statement in this document regarding Cryptosporidium.

Lead in Drinking Water

New York City water is virtually lead-free when it is delivered from the City's upstate reservoir system, but water can absorb lead from solder, fixtures, and pipes found in the plumbing of some buildings or homes. Under the federal Lead and Copper Rule (LCR), mandated at-the-tap lead monitoring is conducted at selected households located throughout the City. Based on the results of this monitoring, in 2008, the 90^{th} percentile did not exceed 15 µg/L, the established standard or Action Level (AL) for lead. The at-the-tap monitoring results are also presented in a separate table in the Report.

In 2004, NYSDOH issued a NOV asserting violations of the LCR. This NOV was in relation to DEP's reporting of past data collected under the LCR, specifically a failure to report all results, a failure to utilize all results to determine the 90^{th} percentile concentrations, and a failure to collect samples during the period of June 1 to September 30, 2004. In 2005, under the NOV, DEP re-instituted a lead public education program, returned to semi-annual at-the-tap monitoring in the distribution system, began monitoring the surface and groundwater systems separately for lead, and established a program to replace City-owned lead service lines (LSLs). In 2007, because the at-the-tap lead results in 2005 and 2006 met the Action Level for lead of 15 µg/L, NYSDOH gave DEP permission to monitor at-the-tap lead and copper levels annually. To fulfill the requirement to replace LSLs, DEP worked with other City agencies through an inter-Agency Task Force, and 55 LSLs were replaced in 2005, 1 was replaced in 2006, and 16 were replaced in 2008. As a result of these efforts, in 2008, NYSDOH agreed that DEP had satisfied the requirements of the NOV in order to reassume its compliance with the LCR. The NOV was formally closed on October 6, 2008.

The data reported by DEP under the LCR reflect that since the program began in 1992, the 90^{th} percentile values for lead levels at-the-tap, at locations sampled for Rule compliance, have decreased from levels as high as 55 µg/L to approximately 11 µg/L in the surface water systems.

DEP offers a Free Residential Lead Testing Program which allows all New York City residents to have their tap water tested at no cost. The Free Residential Testing Program is the largest of its kind in the Nation: Over 75,000 sample collection kits have been distributed since the start of the program in 1992.

Infants and young children are typically more vulnerable to lead in drinking water than the general population. It is possible that lead levels at your home may be higher than at other homes in the community as a result of materials used in your home's plumbing. If you are concerned about elevated lead levels in your home's water, you may wish to have your water tested, and also flush your tap for 30 seconds to 2 minutes before using tap water. Additional information is available from the EPA's Safe Drinking Water Hotline (800) 426-4791. To request a free kit to test for lead in your drinking water, call the City of New York's 24-hour helpline at 311 or (212) NEW-YORK.

Monitoring for Cryptosporidium and Giardia

In 1992, the City started a comprehensive program to monitor its source waters and watersheds for the presence of *Cryptosporidium* and *Giardia*. Since then, samples have been collected weekly from the effluents of the Kensico and New Croton Reservoirs, before water is first chlorinated in the Catskill/Delaware and Croton Systems, respectively. Since 1992, DEP has modified its laboratory protocols twice to improve the Department's ability to detect both *Cryptosporidium* oocysts and *Giardia* cysts. These test methods, however, are limited in that they do not allow DEP to determine if organisms identified are alive or capable of causing disease.

From January 1 to December 31, 2008, a total of 104 routine samples were collected and analyzed for *Cryptosporidium* oocysts and *Giardia* cysts at the Kensico Reservoir effluents, and 52 routine samples were collected at the New Croton Reservoir effluent. Samples were analyzed using Method 1623 HV (US EPA). Of the 104 routine Kensico Reservoir effluent samples, 11 were positive for *Cryptosporidium* (0 to 2 oocysts 50L^{-1}), and 85 were positive for *Giardia* (0 to 8 cysts 50L^{-1}). No enhanced samples were collected at the Kensico effluents in 2008. Of the 52 routine New Croton Reservoir effluent samples, seven were positive for *Cryptosporidium* (0 to 3 oocysts 50L^{-1}), and 26 were positive for *Giardia* (0 to 4 cysts 50L^{-1}). Four enhanced samples were collected from the New Croton Reservoir effluent in 2008 in response to a laboratory issue and not a water quality issue. Nevertheless, data from the enhanced samples resulted in no detection of *Cryptosporidium* oocysts and only one detection of a *Giardia* cyst. DEP's *Cryptosporidium* and *Giardia* data from 1992 to the present, along with weekly updates, can be viewed on our web site at: www.nyc.gov/html/dep/html/drinking_water/pathogen.shtml. As stated above, detecting the presence of *Cryptosporidium* oocysts and *Giardia* cysts does not indicate whether these organisms are alive or potentially infectious.

While there is no evidence of the illnesses cryptosporidiosis or giardiasis related to the New York City water supply, federal and New York State law requires all water suppliers to notify their customers about the potential risks of *Cryptosporidium* and *Giardia*. Cryptosporidiosis and giardiasis are intestinal illnesses caused by microscopic pathogens, which can be waterborne. Symptoms of infection include nausea, diarrhea, and abdominal cramps. Most healthy individuals can overcome both of these illnesses within a few weeks. DEP's Waterborne Disease Risk Assessment Program conducts active surveillance for cryptosporidiosis and giardiasis to track the incidence of illness and determine all possible causes, including tap water consumption. No cryptosporidiosis or giardiasis outbreaks have been attributed to tap water consumption in New York City.

According to the EPA and the CDC, it is unclear how most cases of cryptosporidiosis or giardiasis in the United States are contracted. The relative importance of various risk factors is unknown. Risk factors include eating contaminated food, swallowing contaminated recreational water while swimming or camping, contact with animals, contact with human waste, certain sexual practices, and drinking contaminated water. Individuals who think they may have cryptosporidiosis or giardiasis should contact their health care provider.

Some people may be more vulnerable to disease-causing microorganisms or pathogens in drinking water than the general population. Immuno-compromised persons, such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants, can be particularly at risk from infections. These people should seek advice from their health care providers about their drinking water.

EPA/CDC guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium*, *Giardia* and other microbial contaminants are available from the EPA's Safe Drinking Water Hotline at (800) 426-4791.

New York City Drinking Water Quality
Testing Results 2008

Detected Parameters

PARAMETERS	NYSDOH MCL	USEPA MCLG	CATSKILL/DELAWARE SYSTEM # SAMPLES	CATSKILL/DELAWARE SYSTEM RANGE	CATSKILL/DELAWARE SYSTEM AVERAGE	CROTON SYSTEM # SAMPLES	CROTON SYSTEM RANGE	CROTON SYSTEM AVERAGE	SOURCES IN DRINKING WATER
CONVENTIONAL PHYSICAL AND CHEMICAL PARAMETERS									
Alkalinity (mg/L $CaCO_3$)	-		325	9.3 - 33.7	12.9	12	38.3 - 60	54.9	Erosion of natural deposits
Aluminum (µg/L)	50 - 200 [1]		317	9 - 97	21	13	5 - 28	14	Erosion of natural deposits
Barium (mg/L)	2	2	317	0.012 - 0.025	0.017	13	0.026 - 0.038	0.031	Erosion of natural deposits
Calcium (mg/L)	-		325	4.8 - 12.9	5.6	13	14.4 - 25.2	21.8	Erosion of natural deposits
Chloride (mg/L)	250		316	8 - 28	10	12	37 - 63	56	Naturally occurring; road salt
Chlorine Residual, free (mg/L)	4 [2]		10978	0.00 - 1.38	0.72	319	0.09 - 1.37	0.81	Water additive for disinfection
Color - distribution system (color units - apparent)	-		9885	4 - 112	6	172	6 - 74	12	Presence of iron, manganese, and organics in water
Color - entry points (color units - apparent)	15 [3]		1098	4 - 12	6	148	**7 - 20**	13	Presence of iron, manganese, and organics in water
Copper (mg/L)	1.3 [4]	1.3	325	0.003 - 0.096	0.008	14	0.001 - 0.018	0.009	Corrosion of household plumbing systems; erosion of natural deposits; leaching from wood preservatives
Corrosivity (Langelier index)	0 [1, 5]		315	-2.82 to -1.78	-2.41	12	-1.47 to -1.18	-1.26	
Fluoride (mg/L)	2.2 [3]	4.0	1447	ND - 1.38	1	170	ND - 1.16	0.88	Erosion of natural deposits; water additive which promotes strong teeth; runoff from fertilizer
Hardness (mg/L $CaCO_3$)	-		317	16 - 47	19	13	54 - 96	83	Erosion of natural deposits
Hardness (grains/gallon[US]$CaCO_3$)[6]	-		317	0.9 - 2.7	1.1	13	3.1 - 5.5	4.8	Erosion of natural deposits
Iron (µg/L)	300 [7]		317	20 - 280	40	15	70 - 170	110	Naturally occurring
Lead (µg/L)	15 [4]	0	325	ND - 8	0.5	15	ND	ND	Corrosion of household plumbing systems; erosion of natural deposits
Magnesium (mg/L)	-		317	1.1 - 3.7	1.2	13	4.4 - 8.1	7	Erosion of natural deposits
Manganese (µg/L)	300 [7]		317	8 - 221	18	14	28 - 163	89	Naturally occurring
Nitrate (mg/L nitrogen)	10	10	316	0.12 - 0.31	0.21	12	0.11 - 0.22	0.16	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
Nitrite (mg/L nitrogen)	1	1	316	ND - 0.001	ND	12	ND	ND	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
pH (pH units)[8]	6.5 - 8.5 [1]		10935	6.5 - 8	7.2	320	6.8 - 7.7	7.1	
Phosphate, Ortho- (mg/L)	-		10979	0.7 - 2.82	2.02	319	0.00 - 4.33	1.56	Water additive for corrosion control
Potassium (mg/L)	-		317	0.5 - 1.2	0.6	13	1.4 - 2.4	2.1	Erosion of natural deposits
Silica [silicon oxide] (mg/L)	-		316	1.6 - 3.5	2.5	12	3.8 - 6	5.2	Erosion of natural deposits
Sodium (mg/L)	NDL[9]		317	7 - 17	9	13	21 - 32	28	Naturally occurring; road salt; water softeners; animal waste
Specific Conductance (µS/cm)	-		10983	73 - 211	85	320	224 - 390	340	
Strontium (µg/L)	-		317	17 - 40	20	13	45 - 78	68	Erosion of natural deposits
Sulfate (mg/L)	250		316	4.6 - 6.4	5.0	12	7.2 - 9.8	9.1	Naturally occurring
Temperature (°F)	-		10981	36 - 78	54	320	44 - 60	51	
Total Dissolved Solids (mg/L)	500 [1]		316	38 - 104	51	12	133 - 204	182	Metals and salts naturally occurring in the soil; organic matter
Total Organic Carbon (mg/L carbon)	-		316	1.3 - 2	1.4	12	1.9 - 3	2.7	Organic matter naturally present in the environment
Turbidity[10] - distribution system (NTU)	5 [11]		9885	0.48 - 19.2	1.8	172	0.73 - 23.2	2.2	Soil runoff
Turbidity[10] - entry points (NTU)	1 [12]		-	-	-	148	-	**1.5**	Soil runoff
Turbidity[10] - source water (NTU)	5 [13]		4356	-	4.0	552	-	2.1	Soil runoff
UV 254 Absorbency (cm^{-1})	-		316	0.02 - 0.038	0.027	12	0.044 - 0.066	0.060	Organic matter naturally present in the environment
Zinc (mg/L)	5		317	ND - 0.018	0.004	15	ND - 0.004	0.002	Naturally occurring

PARAMETERS	NYSDOH MCL	USEPA MCLG	CATSKILL/DELAWARE SYSTEM			CROTON SYSTEM			SOURCES IN DRINKING WATER
			# SAMPLES	RANGE	AVERAGE	# SAMPLES	RANGE	AVERAGE	
ORGANIC CONTAMINANTS									
Disinfection Byproducts detected:									
Bromochloroacetic acid (µg/L)	50		246	ND - 2	1	10	1 - 3	2	Byproduct of drinking water chlorination
Chloral Hydrate (µg/L)	50		16	1.7 - 9.3	5.1	2	5.8 - 7.2	6.5	Byproduct of drinking water chlorination
Chloropicrin (µg/L)	50		16	0.3 - 0.7	0.5	2	0.4 - 0.5	0.5	Byproduct of drinking water chlorination
Chloromethane (µg/L)	50		777	ND - 1.36 (14)	ND	12	ND	ND	Byproduct of drinking water chlorination
Haloacetonitriles (HANs) (µg/L)	50		16	1.8 - 3.9	2.8	2	3.3 - 5.8	4.5	Byproduct of drinking water chlorination
Halogenated ketones (HKs) (µg/L)	50		16	1.3 - 3.6	2.5	2	3.0 - 4.5	3.7	Byproduct of drinking water chlorination
Total Organic Halogen (µg/L)	-		289	80 - 221	149	12	215 - 318	264	Byproduct of drinking water chlorination
Specified Organic Chemicals detected:									
Hexachlorocyclopentadiene (µg/L)	50		12	ND	ND	3	ND - 0.12	0.1	Discharge from chemical factories
Unspecified Organic Chemicals detected:									
Acetone (µg/L)	50		777	ND - 12	ND	16	ND	ND	Occurs naturally and is used in the production of paints, varnishes, plastics, adhesives, organic chemicals and alcohol. Also used to clean and dry parts of precision equipment

PARAMETERS	NYSDOH MCL	USEPA MCLG	CATSKILL-DELAWARE SERVICE AREA			CROTON SERVICE AREA			GROUNDWATER SERVICE AREA			SOURCES IN DRINKING WATER
			# SAMPLES	RANGE	RAA	# SAMPLES	RANGE	RAA	# SAMPLES	RANGE	RAA	
Disinfection Byproducts detected:												
Haloacetic acid 5 (HAA5) (µg/L)	60 (15)		203	17 - 62	49	33	21 - 65	56	20	14 - 41	39	Byproduct of drinking water chlorination
Total Trihalomethanes (µg/L)	80 (15)		217	12 - 66	46	56	20 - 70	62	520	14 - 47	33	Byproduct of drinking water chlorination

MICROBIAL PARAMETERS								
PARAMETERS	NYSDOH MCL	USEPA MCLG	CITYWIDE DISTRIBUTION					SOURCES IN DRINKING WATER
			# SAMPLES	RANGE	# SAMPLES POSITIVE	AVERAGE	HIGHEST MONTH % POSITIVE	
Total Coliform Bacteria (% of samples positive/month)	5%	0	10056	-	14	-	0.5%	Naturally present in the environment
E. coli (CFU/100mL)	(16)	0	10056	-	0	-	0.0%	Human and animal fecal waste
Heterotrophic Plate Count (CFU/mL)	TT	-	4576	ND - 375	418	2	-	Naturally present in the environment

LEAD AND COPPER RULE SAMPLING AT RESIDENTIAL WATER TAPS: JANUARY TO DECEMBER 2008											
PARAMETERS	NYS DOH AL	US EPA MCLG	Surface Water Service Area				Groundwater Service Area				SOURCES IN DRINKING WATER
			# SAMPLES	RANGE	90th PERCENTILE VALUES	# SAMPLES EXCEEDING AL	# SAMPLES	RANGE	90th PERCENTILE VALUES	# SAMPLES EXCEEDING AL	
Copper (mg/L)	1.3	1.3	185	0.008 - 0.567	0.194	0	93	0.009 - 2.596	0.200	2	Corrosion of household plumbing systems
Lead (µg/L)	15	0	185	ND - 942.4	11	14	93	ND - 6408.0	8	6	Corrosion of household plumbing systems

New York City Drinking Water Quality

Testing Results 2008 *(Continued)*

Undetected Parameters

UNDETECTED CONVENTIONAL PHYSICAL AND CHEMICAL PARAMETERS
Antimony, Arsenic, Asbestos (17), Beryllium, Cadmium, Chromium, Cyanide, Foaming Agents, Lithium, Mercury, Nickel, Selenium, Silver, Thallium, Gross Alpha, Gross Beta, Radium 228
UNDETECTED ORGANIC CONTAMINANTS
Principal Organic Contaminants not detected:
Benzene, Bromobenzene, Bromochloromethane, Bromomethane, n-Butylbenzene, sec-Butylbenzene, tert-Butylbenzene, Carbon Tetrachloride, Chlorobenzene, Chloroethane, Chloromethane, 2-Chlorotoluene, 4-Chlorotoluene, Dalapon, Dibromomethane, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, Dichlorodifluoromethane, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,1-Dichloroethene, cis-1,2-Dichloroethylene, trans-1,2-Dichloroethylene, 1,2-Dichloropropane, 1,3-Dichloropropane, 2,2-Dichloropropane, 1,1-Dichloropropene, cis-1,3-Dichloropropene, trans-1,3-Dichloropropene, Ethylbenzene, Hexachlorobutadiene, Isopropylbenzene, p-Isopropyltoluene, Methylene chloride, n-Propylbenzene, Styrene, 1,1,1,2-Tetrachloroethane, 1,1,2,2-Tetrachloroethane, Tetrachloroethylene, Toluene, 1,2,3-Trichlorobenzene, 1,2,4-Trichlorobenzene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, Trichloroethene, Trichlorofluoromethane, 1,2,3-Trichloropropane, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene, m-Xylene, o-Xylene, p-Xylene
Specified Organic Contaminants not detected:
Alachlor, Aldicarb (Temik), Aldicarb sulfone, Aldicarb sulfoxide, Aldrin, Atrazine, Benzo(a)pyrene, Butachlor, Carbaryl, Carbofuran (Furadan), Chlordane, 2,4-D, 1,2-Dibromo-3-chloropropane, Dicamba, Dieldrin, Di(2-ethylhexyl)adipate, Di(2-ethylhexyl)phthalate, Dinoseb, Diquat, Endothall, Endrin, Ethylene dibromide (EDB), Glyphosate, Heptachlor, Heptachlor epoxide, Hexachlorobenzene, 3-Hydroxycarbofuran, Lindane, Methomyl, Methoxychlor, Methy-tertiary-butyl-ether (MTBE), Metolachlor, Metribuzin, Oxamyl (Vydate), Pentachlorophenol, Picloram, Polychlorinated biphenyls [PCBs], Propachlor, Simazine, Toxaphene, 2,4,5-TP (Silvex), 2,3,7,8-TCDD (Dioxin), Vinyl chloride
Unspecified Organic Chemicals not detected:
Acenaphthene, Acenaphthylene, Acetochlor, Acifluorfen, Anthracene, Bentazon, Benzo[a]anthracene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[g,h,i]perylene, a-BHC, b-BHC, d-BHC, Bromacil, Butylbenzylphthalate, a-Chlordane, g-Chlordane, Chlorobenzilate, Chloroneb, Chlorothalonil (Draconil, Bravo), Chlorpyrifos (Dursban), Chrysene, 2,4-DB, DCPA (total mono & diacid degradate), p,p'DDD, p,p'DDE, p,p'DDT, Diazinon, Dibenz[a,h]anthracene, Di-n-Butylphthalate, 3,5-Dichlorobenzoic acid, Dichlorprop, Dichlorvos (DDVP), Diethylphthalate, Dimethoate, Dimethylphthalate, 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, Di-N-octylphthalate, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin aldehyde, EPTC, Fluoranthene, Fluorene, Heptachlor epoxide (isomer B), Indeno[1,2,3-cd] pyrene, Isophorone, Malathion, Methiocarb, Molinate, Naphthalene, cis-Nonachlor, trans-Nonachlor, Paraquat, Parathion, Pendimethalin, Permethrin, Phenanthrene, Propoxur (Baygon), Pyrene, 2,4,5-T, Terbacil, Terbuthylazine, Thiobencarb, Trifluralin

Footnotes

(1) USEPA Secondary MCL: NYSDOH has not set an MCL for this parameter.

(2) Value represents MRDL, which is a level of disinfectant added for water treatment that may not be exceeded at the consumer's tap without an unacceptable possibility of adverse health effects. The MRDL is enforceable in the same manner as an MCL and is the calculated running annual average. Data presented are the range of individual sampling results and the highest of the 4 quarterly running annual averages.

(3) Determination of MCL violation: If a sample exceeds the MCL, a second sample must be collected from the same location within 2 weeks. If the average of the two results exceeds the MCL, then an MCL violation has occurred.

(4) Action Level (not an MCL) measured at the tap. The data presented in this table were collected from sampling stations at the street curb. For at-the-tap monitoring, see the following table.

(5) A Langelier Index of less than zero indicates corrosive tendencies.

(6) Hardness of up to 3 grains per gallon is considered soft water; between 3 and 9 is moderately hard water.

(7) If iron and manganese are present, the total concentration of both should not exceed 500 µg/L.

(8) The average for pH is the median value.

(9) Water containing more than 20 mg/L of sodium should not be used for drinking by people on severely restricted sodium diets. Water containing more than 270 mg/L of sodium should not be used for drinking by people on moderately restricted sodium diets.

(10) Turbidity is a measure of cloudiness of the water. Turbidity is monitored because it is a good indicator of water quality and can hinder the effectiveness of disinfection.

(11) This MCL for turbidity is the monthly average rounded off to the nearest whole number. Data presented are the range of individual sampling results and the highest monthly average from distribution sites.

(12) This MCL for turbidity only applies to the Croton System. The value presented is the highest monthly average for the Croton distribution entry points.

(13) This MCL for turbidity is on individual readings taken every 4 hours at the source water entry point. Data presented are the highest individual sampling result for each system.

(14) Only one sample collected from site 39650 on 11/5/2008 had a detection of 1.36 µg/L.

(15) USEPA MCLs for HAA5 and TTHMs are the calculated quarterly running annual average. Data presented are the range of individual sampling results and the highest quarterly running average.

(16) If a sample and its repeat sample are both positive for coliform bacteria and one of the two samples is positive for *E. coli*, then an MCL violation has occurred.

(17) NYSDOH has issued a waiver for asbestos monitoring in the Groundwater System since no asbestos cement pipes are used anywhere in the distribution system.

Highlighted and **bolded** value indicates a violation or exceedence occurred.

Definitions

Action Level (AL):
The concentration of a contaminant, which if exceeded, triggers treatment or other requirements that a water system must follow. An exceedence occurs if more than 10% of the samples exceed the Action Level.

Maximum Contaminant Level Goal (MCLG):
The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

Maximum Contaminant Level (MCL):
The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible, using the best available treatment technology.

Maximum Residual Disinfectant Level (MRDL):
The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Maximum Residual Disinfectant Level Goal (MRDLG):
The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.

Treatment Technique (TT):
A required process intended to reduce the level of a contaminant in drinking water.

90th Percentile Value:
The values reported for lead and copper represent the 90th percentile. A percentile is a value on a scale of 100 that indicates the percent of a distribution that is equal to or below the value. The 90th percentile is equal to or greater than 90% of the lead and copper values detected at your water system.

Abbreviations

CFU/mL = colony forming units per milliliter

mg/L = milligrams per liter (10^{-3} grams per liter)

NA = Not Applicable

ND = Lab analysis indicates parameter is not present

NDL = No Designated Limit

NTU = Nephelometric Turbidity Units

µS/cm = microsiemens per centimeter

µg/L = micrograms per liter (10^{-6} grams per liter)

µmho/cm = micromhos per centimeter

pCi/L = picocuries per liter

Cover Art: “Water is the Life of NYC”

© Groundswell Community Mural Project (2008)
Lead Artist: Nicole Schulman; Assistant Artist: Crystal Bruno
Community Partners: NYC Department of Environmental Protection
Youth Artists: Stephon Samuel, Samuel Walker, Federico Tenorio, Christina Cacioppo, Dwight Vacciana, Lilyana Lucero, Zane Smith, Epigmenio JR Sosa, Johnathan Marrero, Ernessa De Rose, Geoffrey Kixmiller
The project was made possible with a grant from the StratREAL Foundation USA with additional support from: Winifred Johnson Clive Foundation, Assemblywoman Joan Milman, Brooklyn Borough President’s Office, Councilwoman Sara Gonzalez, National Endowment for the Arts, NYC Department of Cultural Affairs, the Park Slope Civic Council.
Location: 209 4th Avenue (at Sackett Street), Brooklyn

Photographs of ornamental fountains courtesy of the New York City Department of Parks and Recreation. All other photographs by the New York City DEP.

Frequently Asked Questions

Is New York City's water "hard"?

Hardness is a measure of dissolved calcium and magnesium in the water. The less calcium and magnesium in the water ("soft" water), the easier it is to create lather and suds. Depending upon location, the hardness can be 1.0 grain/gallon ($CaCO_3$) for the Catskill/Delaware System, and 5 grains/gallon for the Croton System. New York City's water is predominantly "soft."

At times, my drinking water looks "milky" when first taken from a faucet, but then clears up. Why?

Air becomes trapped in the water as it makes its long trip from the upstate reservoirs to the City. As a result, bubbles of air can sometimes cause water to appear cloudy or milky. This condition is not a public health concern. The cloudiness is temporary and clears quickly after the water is drawn from the tap and the excess air is released.

At times I can detect chlorine odors in tap water. What can I do about it?

Chlorine odors may be more noticeable when the weather is warmer. Chlorine is a disinfectant and is added to the water to kill germs. The following are ways you can remove the chlorine and its odor from your drinking water:

- Fill a pitcher and let it stand in the refrigerator overnight. (This is the best way.)
- Fill a glass or jar with water and let it stand in sunlight for 30 minutes.
- Pour water from one container to another about 10 times.
- Heat the water to about 100 degrees Fahrenheit.
- Once you remove the chlorine, be sure to refrigerate the water to limit bacterial regrowth.

Does my drinking water contain fluoride?

Yes, all New York City tap water contains fluoride. In accordance with Article 141.08 of the New York City Health Code, DEP, as the New York City water supplier, adds a fluoride compound that provides our water supply with a concentration of approximately 1.0 part per million (ppm) fluoride. Fluoridation began in 1966.

The faucet aerators in my home are clogging with pieces of a small, whitish material. What is causing this to occur?

This problem may be accompanied by a significant drop in water pressure at the affected faucet in addition to a decrease in your hot water supply. The culprit is the hot water heater's "dip-tube." This is a long internal tube that delivers cold water to the bottom of the hot water heater tank. The tube, which is composed of polypropylene, may disintegrate. The problem affects approximately 16 million water heaters manufactured between 1993 and 1996.

Sometimes my water is a rusty brown color. What causes this?

Brown water is commonly associated with plumbing corrosion problems inside buildings and from rusting hot water heaters. If you have an ongoing problem with brown water, it is probably due to rusty pipes. It is recommended that you run your cold water for 2-3 minutes, if it has not been used for an extended period of time. This will flush the line. You can avoid wasting water by catching your "flush" water in a container and using it to water plants or for other purposes. Brown water can also result from street construction or water main work being done in the area. Any disturbance to the main, including the opening of a fire hydrant, can cause pipe sediment to shift, resulting in brown water. The settling time will vary, depending on the size of the water main.

Should I buy bottled water?

You do not need to buy bottled water for health reasons in New York City, since our water meets all federal and State health-based drinking water standards. Also, bottled water costs up to 1,000 times more per year than the City's drinking water. When purchasing bottled water, consumers should look for the NYSHD CERT#. Consumers can access additional information on New York State certified bottled water facilities within the entire United States that can be sold within New York State at www.health.state.ny.us/environmental/water/drinking/bulk_bottle/bottled.htm. As an alternative to purchasing bottled water, use a reusable bottle and fill it with New York City tap water.

Automated Meter Reading (AMR)

Improving customer service to its 833,000 account holders remains a top priority for DEP. This important work continues with the launch of Automated Meter Reading (AMR). AMR technology will end the use of estimated water bills, giving homeowners and small businesses more accurate and timely records of usage – increasing their ability to identify how they can conserve water and reduce water bills.

What is AMR?

The installation of a citywide automated meter reading (AMR) network is an important next step in the New York City Department of Environmental Protection's comprehensive transformation of its Bureau of Customer Services. AMR systems consist of small, low-power radio transmitters connected to individual water meters that send readings to a network of rooftop receivers throughout the city. DEP's system will leverage DoITT's New York City Wireless Network (NYCWiN).

How does AMR work?

DEP will attach a small device to your meter that automatically transmits readings to electronic data receivers throughout the city. These receivers will provide DEP with all relevant billing information and eliminate the need for meter readers to visit your property.

How does AMR benefit me?

- AMR eliminates, with rare exceptions, the need to estimate your bill.
- AMR tracks consumption and can alert you to costly leaks.
- AMR eliminates the need for a meter reader to visit your premises.
- AMR ensures that you receive a more accurate bill each month.

How will AMR affect my bill?

AMR will eliminate estimated bills and increase billing accuracy. AMR can also help alert you to household leaks so you are able to fix them before they become costly problems. You will continue to receive your water and sewer bills in the mail in accordance with your normal billing schedule, though DEP is also finalizing a new, customer-friendly bill that will explain consumption data in a clear, easy to read format. We anticipate that you will begin receiving these bills in 2009.

When will an AMR transmitter be installed on my meter?

DEP contractors are performing transmitter installation door-to-door beginning in the winter of 2009. Installing transmitters on all 833,000 meters in New York City will take approximately three years. Installations will occur first in Brooklyn and Queens, then in the Bronx and Manhattan, and then in Staten Island. You will receive notification from DEP when AMR installation contractors are in your neighborhood. In addition, you may call 311 at any time to schedule a transmitter installation – performed by DEP contractors – for your property.

Will DEP need access to my home?

DEP may need to enter your home, depending on where your current meter is installed; and we may need to shut off your water. In addition, a very small number of old meters may need to be replaced before an AMR transmitter can be properly installed. DEP will pay for these replacements.

How long will the installation take?

Installation of the transmitter will take around 30 minutes.

What are the benefits of AMR to DEP?

- AMR increases customer satisfaction by ensuring that bills are based on actual usage.
- AMR allows DEP to more closely monitor citywide consumption and more effectively manage the city's water supply systems.
- AMR is a less expensive way to read meters. It is efficient, accurate and can reduce costs.

Does AMR equipment meet industry and Federal standards?

Yes. AMR technology is designed to function at very low power levels and is in widespread use throughout the utility industry. We will use AMR equipment that has been tested and is compliant with American National Standards Institute (ANSI) and Federal Communication Commission (FCC) standards. Similar systems are already used by many other major cities, including Dallas, Detroit and Washington, D.C.

Will AMR interfere with TV, personal computers, or other electronic equipment?

AMR equipment operates on a low-power frequency band reserved specifically for this purpose. It is highly unlikely to interfere with the operation of any other electronic equipment.

Where can I find more information about DEP's AMR system?

More information is available on DEP's website at nyc.gov/dep. Additional information is also available by calling 311.

New York City Department of
Environmental Protection
59-17 Junction Boulevard
Flushing, New York 11373-5108

Please share this information with all the other people who drink NYC water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

Contact Us

For a copy of this report, to report unusual water characteristics, or to request a free kit to test for lead in your drinking water, call 311, or from outside NYC, call (212) New-York. TTY services are available by calling (212) 504-4115.

For more information on *Cryptosporidium* and *Giardia*, please contact the Bureau of Communicable Diseases of the New York City Department of Health and Mental Hygiene (DOHMH) at (212) 788-9830 or call 311.

To contact DOHMH about other water supply health-related questions, call 311, or call NYSDOH Bureau of Water Supply Protection at (518) 402-7650.

To report any pollution, crime or terrorism activity occurring both in-City and in the watershed, call (888) H2O-SHED (426-7433).

To view this 2008 Statement, announcements of public hearings, or other information, visit DEP's Web site at:

www.nyc.gov/dep

Este reporte contiene información muy importante sobre el agua que usted toma. Haga que se la traduzcan o hable con alguien que la entienda.

Ce rapport contient des informations importantes sur votre eau potable. Traduisez-le ou parlez en avec quelqu'un qui le comprend bien.

Questo documento contiene informazioni importanti sulla vostra acqua potabile. Traducete il documento, or parlatene con qualcuno che lo puó comprendere.

Rapò sa a gen enfòmasyon ki enpòtan anpil sou dlo w'ap bwè a. Fè tradwi-l pou ou, oswa pale ak yon moun ki konprann sa ki ekri ladan-l.

Ten raport zawiera bardzo istotną informacje o twojej wodzie pitnej. Przetłumacz go albo porozmawiaj z kimś kto go rozumie.

В этом материале содержится важная информация относительно вашей питьевой воды. Переведите его или поговорите с кем-нибудь из тех, кто понимает его содержание.

這個報告中包含有關你的飲用水的重要信息。
請將此報告翻譯成你的語言，或者詢問懂得這份報告的人。

이 보고서는 귀하의 식수에 관한 매우 중요한 정보를 포함하고 있습니다.
이 정보에 대해 이해하는 사람에게 그 정보를 번역하거나 통역해 받으십시오.

New York City
Department of Environmental Protection
Bureau of Water Supply

2008 Watershed Water Quality Annual Report

July 2009

Table of Contents

List of Tables

List of Figures

Acknowledgements

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Leading authorship roles were taken by the members of Watershed Water Quality Science and Research Division. Dr. Lorraine Janus was responsible for overall organization of the report and Chapter 1. Mr. James Mayfield was responsible as lead author for Chapter 2 on hydrology. He was also responsible for oversight of Chapter 3 and Chapter 5. The lead authors of Chapter 3 were Mr. Gerry Marzec and Mr. Rich VanDreason. Ms. Kerri Alderisio, Section Chief of Pathogen Planning and Assessment was responsible for the direction of programs and as lead author for the pathogen research in Chapter 4, aided by Mr. Steve DiLonardo and Mr. Christian Pace. Mr. Bryce McCann took responsibility as lead author for the diverse aspects of watershed management in Chapter 5. Dr. Don Pierson, Dr. Elliot Schneiderman, and Mr. Mark Zion were authors of sections describing model development and applications in Chapter 6. Mr. Martin Rosenfeld was the primary author of future research described in Chapter 7. Ms. Pat Girard, Supervisor of Reporting and Publications, was responsible for desktop publishing of the report, aided by Mr. Martin Rosenfeld who applied his editing and proofreading skills to finalize the document in a polished form. Other contributors included: Tracy Lawrence, Andrew Bader, Christopher Nadareski, David Quentin, Ray Homolac, Michael Usai, Deborah Layton, Thomas Baudanza, Michael Meyer, Thomas Stalter, Eve Fox, Edward Blouin, Marilyn Shanahan, David Tobias, Terry Spies, Carla Paltridge, Sharon Neuman, Donald Kent, David Lounsbury, Kelly Seelbach, and Yucel Tokuz.

This report is intended to provide an accurate description of the scientific work conducted in 2008 to manage water quality for NYC, and at the same time to be engaging for a wide audience, from regulatory agencies to the general public. Its production required the scientific expertise, creativity, and cooperation of many staff members in WQD. All deserve special recognition and thanks for their willing participation in the many facets of the Directorate's work. This report would not exist without the extensive field work, laboratory analysis, scientific interpretation, and administrative work needed to keep the watershed programs of the Directorate operating. Therefore, thanks are due to: all the field and laboratory staff who collected and analyzed the thousands of samples emanating from the watershed monitoring programs; the administrative, computing, health and safety, and quality assurance staff who support them; and the scientific staff responsible for planning, interpreting, and documenting the results of our collective work. Although we could not name everyone, thanks go to all those who contributed to this report.

1. Introduction

1.1 What is the purpose and scope of this report?

Figure 1.1 DEP website.

This report provides summary information about the watersheds, streams, and reservoirs that are the sources of the City's drinking water. It is an annual report that provides the public, regulators, and other stakeholders with a general overview of the City's water resources, their condition during 2008, and compliance with regulatory standards or guidelines during this period. It is complementary to another report titled "New York City 2008 Drinking Water Supply and Quality Report", a report that is distributed to consumers annually to provide information about the quality of the City's tap water. The purpose of this watershed report is to provide information on the water quality status of the City's drinking water sources upstream of the distribution system, and how watershed management protects those sources. The report also describes the efforts of the New York City Department of Environmental Protection (DEP) to evaluate the effectiveness of watershed protection and remediation programs, and to develop and use predictive models for management of the water supply. More detailed reports on some of the topics described herein can be found in other DEP publications accessible through the DEP website at http://www.nyc.gov/dep/ (Figure 1.1).

1.2 What constitutes the New York City water supply system?

Figure 1.2 New York City water supply watershed.

The New York City water supply system (Figure 1.2) supplies drinking water to almost half the population of the State of New York, which includes over eight million people in New York City and one million people in upstate counties, plus millions of commuters and tourists. New York City's Catskill-Delaware System is one of the largest unfiltered surface water supplies in the world. (The Croton System, which can supply on average 10% of the City's demand, is expected to be filtered by 2012.) The water is supplied from a network of 19 reservoirs and three controlled lakes that contain a total storage capacity of approximately 2 billion cubic meters (580 billion gallons). The total watershed area for the system is approximately 5,100 square kilometers (1,972 square miles), extending over 200 kilometers (125 miles) north and west of New York City.

1.3 What are the objectives of water quality monitoring and how are the sampling programs organized?

Primary Objectives and Design of the Monitoring Program

In order to ensure high quality drinking water, DEP conducts extensive water quality monitoring that encompasses all areas of the watershed, including sites at aqueducts (keypoints), streams, and reservoirs. The watershed monitoring program meets the sampling needs for regulatory compliance requirements and also forms the basis for the DEP's ongoing assessment of watershed conditions, changes in water quality, and ultimately for developing any modifications to the policies, strategies, and management of the watershed protection programs.

The overall goals of DEP are documented in the Watershed Water Quality Monitoring Plan (WWQMP) (DEP 2008a), which establishes an objective-based water quality monitoring network. This provides scientifically defensible information regarding the understanding, protection, and management of the New York City water supply. The objectives of this monitoring plan have been defined by the requirements of those who ultimately require the information, including DEP program administrators, regulators, and other external agencies. As such, monitoring requirements were derived from legally binding mandates, stakeholder agreements, operations, and watershed management information needs. The plan covers four major areas that require ongoing attention: Compliance, Filtration Avoidance Determination (FAD) Program Evaluation, Modeling Support, and Surveillance Monitoring, with many specific objectives within these major areas. These objectives are described below.

Monitoring design must consider several elements, including choice of sites, analytes, analytical methodology and detection limits, and sampling frequency. Statistical features of the water quality database were used to guide the sampling design. For example, analyses of past data revealed that some sites were not significantly different from others, indicating that they could be adequately represented by similar sites. Sampling frequencies were based approximately on the rates of processes governing variability in water quality data. This statistical screening of differences between sites and collection times was used to streamline the monitoring site plans and to determine appropriate collection frequencies.

Compliance Sampling

The objectives of this sampling are focused on meeting the regulatory compliance monitoring requirements for the New York City watershed. This includes the requirements of the Surface Water Treatment Rule (SWTR) and its subsequent extensions, as well as the New York City Watershed Rules and Regulations (WR&R) (DEP 2002a), the Croton Consent Decree (CCD), Administrative Orders, and State Pollution Discharge Elimination System (SPDES) permits. The sampling sites, analytes, and frequencies are defined in each objective according to each specific rule or regulation and are driven by the need of the water supply as a public utility to comply with all regulations. These include regulations issued by the United States Environmental Protection Agency (USEPA), New York State Department of Health (NYSDOH), and DEP.

Filtration Avoidance and Watershed Protection Program Evaluation

New York City's water supply is one of the few large water supplies in the country that qualifies for Filtration Avoidance, based on both objective water quality criteria and subjective watershed protection requirements. USEPA has specified many requirements in the 2007 FAD that must be met to protect public health. These objectives form the basis for the City's ongoing assessment of watershed conditions, changes in water quality, and ultimately any modifications to the strategies, management, and policies of the long-term watershed protection program (DEP 2006a). As watershed protection programs develop and analytical techniques for key parameters change, it is necessary to reassess the monitoring program to ensure that it continues to support DEP's watershed management program. The periodic reassessment of the City's monitoring program is achieved by critical review and revision of the monitoring plan approximately every five years. The City also conducts a periodic assessment of the effectiveness of the watershed protection program. DEP's water quality monitoring data are essential to evaluate watershed programs. Program effects on water quality are reported in the Watershed Protection Summary and Assessment reports, also produced approximately every five years.

The 2007 FAD also requires that DEP's watershed-wide monitoring program meets the needs of the Long-Term Watershed Protection Program (DEP 2006b). The goals of this program are to:

- Provide an up-to-date, objective-based monitoring plan for the routine watershed water quality monitoring programs, including aqueducts, streams, reservoirs, and pathogens.
- Provide routine water quality results for aqueduct, stream, reservoir, and pathogen programs to assess compliance, provide comparisons with established benchmarks, and describe ongoing research activities.
- Provide mid-term results from routine watershed (e.g., stream and WWTP) pathogen monitoring.
- Use water quality data to evaluate the source and fate of pollutants, and the effectiveness of watershed protection efforts at controlling pollutants.
- Provide a comprehensive evaluation of watershed water quality status and trends to support assessment of the effectiveness of watershed protection programs.

These goals are met by targeting specific watershed protection programs and examining overall status and trends of water quality. Water quality represents the cumulative effects of land use and DEP's watershed protection and remediation programs. The ultimate goal of the watershed protection programs is to maintain the status of the City's water supply, as one of the few large unfiltered systems in the nation, far into the future.

Water Quality Modeling Data Requirements

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. The modeling goals of FAD projects include: implementation of watershed and reservoir model improvements based on ongoing data analyses and research results; ongoing testing of DEP's watershed and reservoir models; updating of data necessary for models, including land use, watershed program implementation data, and time series of meteorological data, stream flow and water chemistry; development of data analysis tools supporting modeling projects; and applications of DEP models to support watershed management, reservoir operations, climate change analysis and long-term planning, as identified in DEP's Climate Change Task Force Action Plan (DEP 2008b).

There are three types of data needed to generate models: stream, reservoir and aqueduct, and meteorological. Stream monitoring includes flow monitoring and targeted water quality sampling to support watershed and reservoir model development, testing, and applications. Reservoir monitoring provides flow and reservoir operations data to support reservoir water balance calculations. The water balance and reservoir water quality data are necessary model inputs, and are required to continue to test, apply, and further develop DEP's one and two dimensional modeling tools. The meteorological data collection effort provides critical input necessary to meet both watershed and reservoir modeling goals.

Water Supply Surveillance

The surveillance monitoring plan contains several objectives that provide information to guide the operation of the water supply system, other objectives to help track the status and trends of constituents and biota in the system, and specific objectives that include aqueduct monitoring for management and operational decisions. The aqueduct network of sampling points consists of key locations along the aqueducts, developed to track the overall quality of water as it flows through the system. Data from these key aqueduct locations are supplemented by reservoir water quality data. Another surveillance objective relates to developing a baseline understanding of potential contaminants that include trace metals, volatile organic compounds, and pesticides, while another summarizes how DEP monitors for the presence of zebra mussels in the system, a surveillance activity meant to trigger actions to protect the infrastructure from becoming clogged by these mussels. The remaining objectives pertain to recent water quality status and long-term trends for reservoirs, streams, and benthic macroinvertebrates in the Croton System. It is important to track the water quality of the reservoirs to be aware of developing problems and to pursue appropriate actions. Together, these objectives allow DEP to maintain an awareness of water quality for the purpose of managing the supply to provide the highest quality drinking water possible.

1.4 What types of monitoring networks are used to provide coverage of such a large watershed?

DEP's watershed monitoring networks cover the entire watershed and include meteorological stations, snow surveys, stream sites, reservoir sites, aqueducts, and wastewater treatment plants. Each network provides data that are used to characterize "state variables" (quantities), as well as their transformation rates, which are important components of the water supply's hydrology and water quality. Hydrological flow is the essential underlying element of water quality phenomena and water quality models are based on the hydrodynamics of the system. The interplay of water flow rates and physical, chemical, and biological rates determine water quality outcomes. These outcomes can only be estimated through water quality modeling. Therefore, it is essential to know the basic hydrology of the watershed in order to anticipate water quality changes for proactive management of the water supply.

Meteorological stations are located throughout the watershed. There are 20 sites west of the Hudson River and five sites east of the Hudson. This network was designed to provide the best data characterization of the conditions throughout the watershed in order to allow extrapolation and estimation of total precipitation entering the system. Orographic effects (such as greater precipitation at higher elevation on the windward side of mountains) were considered during site selection, so different site elevations were selected to represent the full range of conditions, i.e., from the mountain peaks in the Catskills to the lower elevations of the Croton System. Sites were also located on the reservoirs in order to characterize the temperature, wind, and solar radiation (including photosynthetically active radiation) needed for model input.

During the winter, snow surveys are periodically conducted to estimate how much water is stored on the watershed as snow and ice. These estimates are important in anticipating spring runoff and the impacts of rain-on-snow events, which may result in unusually large influxes of water to the reservoirs. Snow survey results also are used to determine reservoir release rates in accordance with the Flexible Flow Management Plan for DEP's Delaware System reservoirs. Snow is an important part of the hydrological cycle and has an impact on stream and reservoir water temperatures throughout the spring.

Stream sampling sites are presented in Figures 1.3, 1.4, and 1.5. They were established as water quality monitoring sites in order to meet several objectives including: assessing the status and trends of stream water quality, monitoring and pinpointing various potential sources of pollution, evaluating the effectiveness of watershed programs, and providing calibration and verification data fro water quality models. They also allow quantification of pollutants entering the system so that appropriate measures can be taken to minimize impairment of the drinking water. A typical stream site being sampled for pathogens is shown in Figure 1.6. Water quality of the streams and tributaries provides essential input for reservoir models that guide the management of the NYC reservoirs. A companion network to DEP's water quality stream sites is the network of US Geological Survey (USGS) stream gages. Most of the gage sites are operated and maintained by the USGS on behalf of DEP and provide important flow data. These data are available on the internet and are used widely by a variety of stakeholders. They are used by DEP to track the current condition of the system's stream flows, guide operational decisions, including meeting mandated flow targets, and also during droughts and floods. Stream flow data are particularly important to modeling, as they can provide key inputs to reservoir models that are used to evaluate the consequences of different operating strategies. They also provide data to calibrate and verify watershed models, which can estimate loads of water and nutrients to the reservoirs.

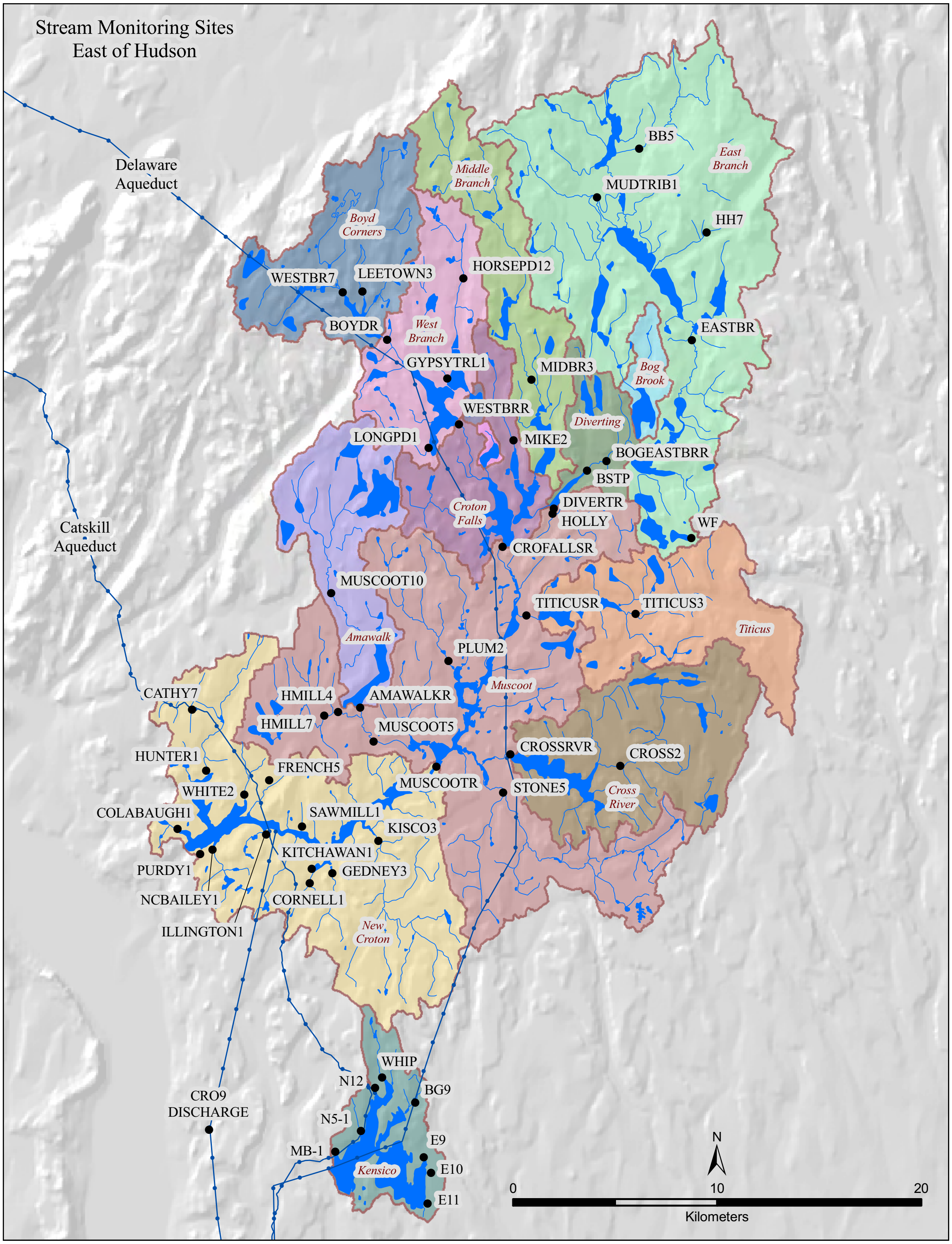

Figure 1.3 Stream sampling sites east of the Hudson River.

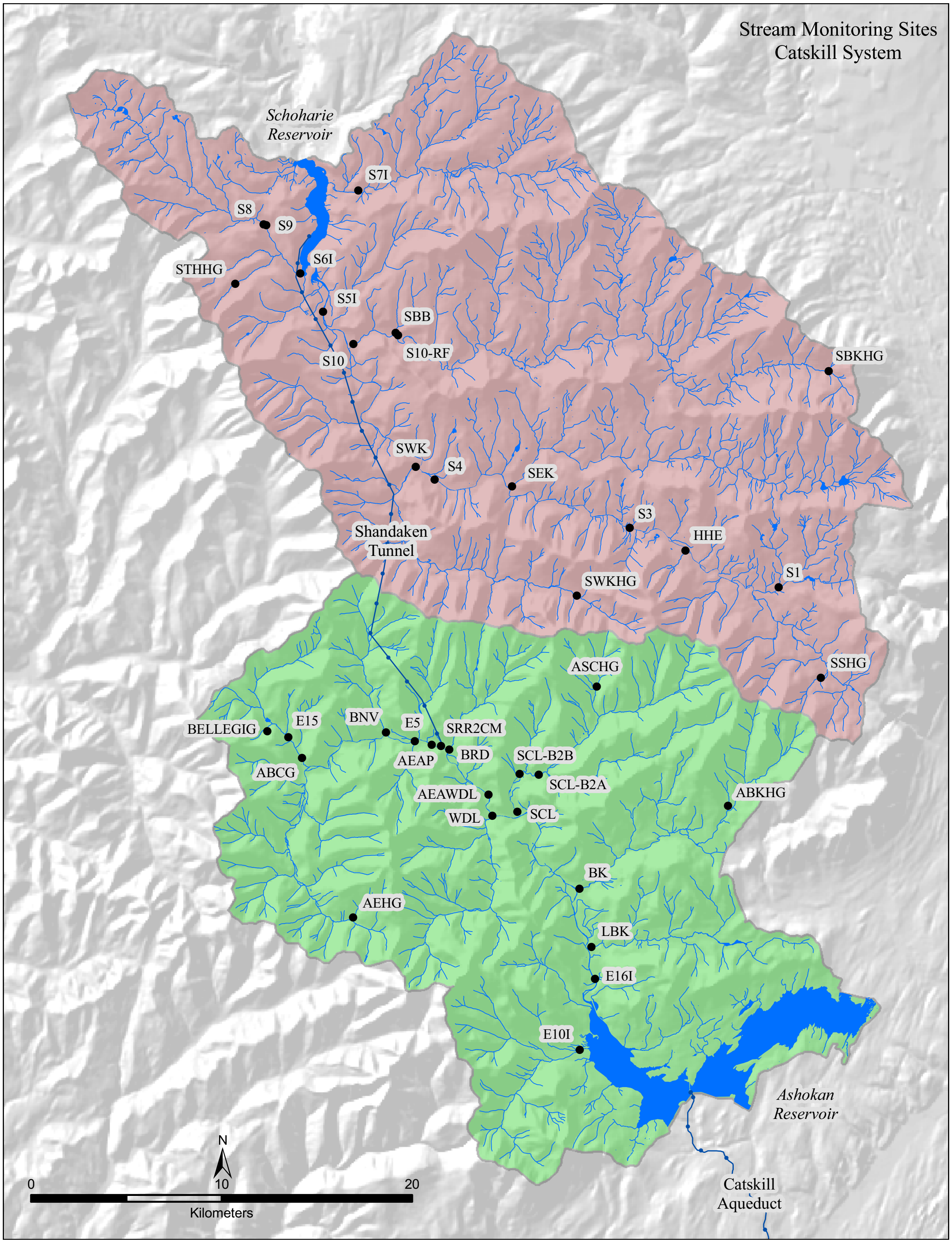

Figure 1.4 Stream sampling sites within the Catskill System drainage basins.

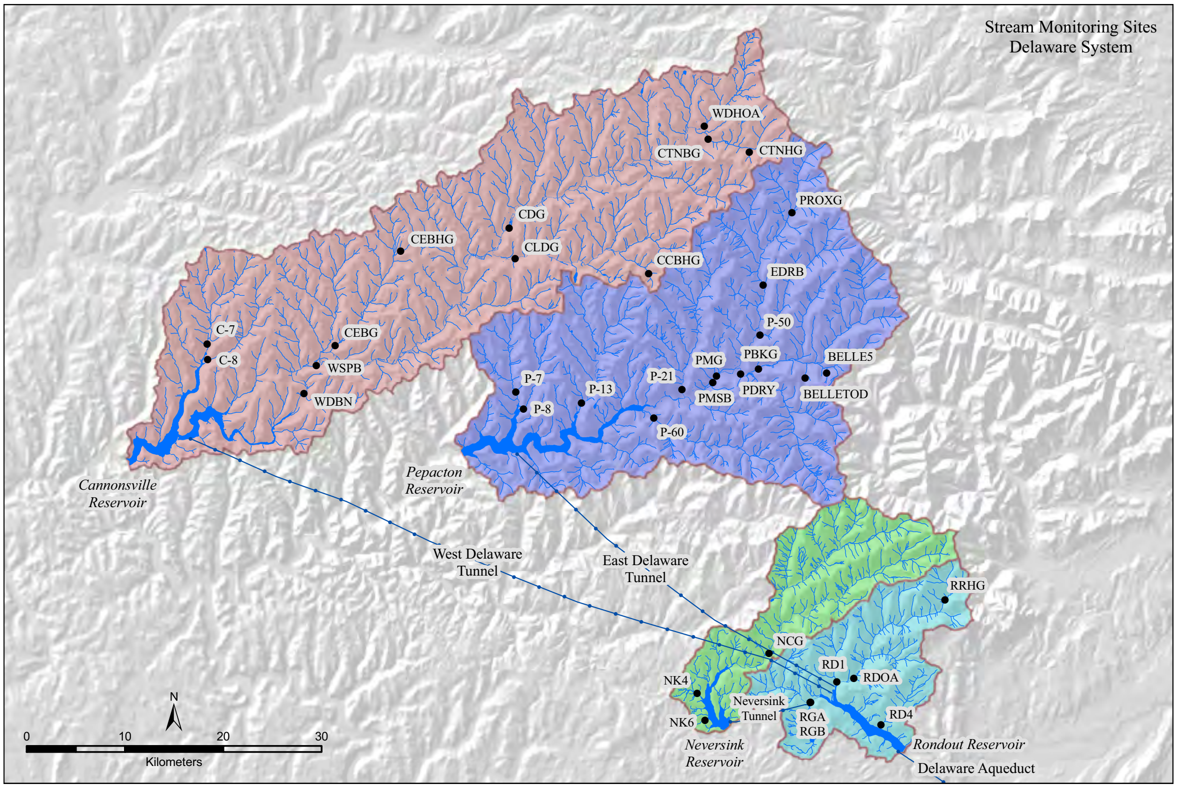

Figure 1.5 Stream sampling sites within the Delaware System drainage basins.

Figure 1.6 Pathogen sampling.

Reservoir sampling is shown in Figure 1.7 and reservoir sites for the west of the Hudson River and the east of the Hudson River reservoirs are shown in Figures 1.8 and 1.9, respectively. Sites were selected to provide coverage of water quality and physical conditions throughout each reservoir, and are typically sampled at multiple depths,. Limnological surveys are important in serving many objectives. They provide information on the current status of basic physical, chemical, and biological conditions that determine water quality in the system, allow tracking of trends, provide data for models, and guide current operational decisions.

Figure 1.7 Limnology survey in progress.

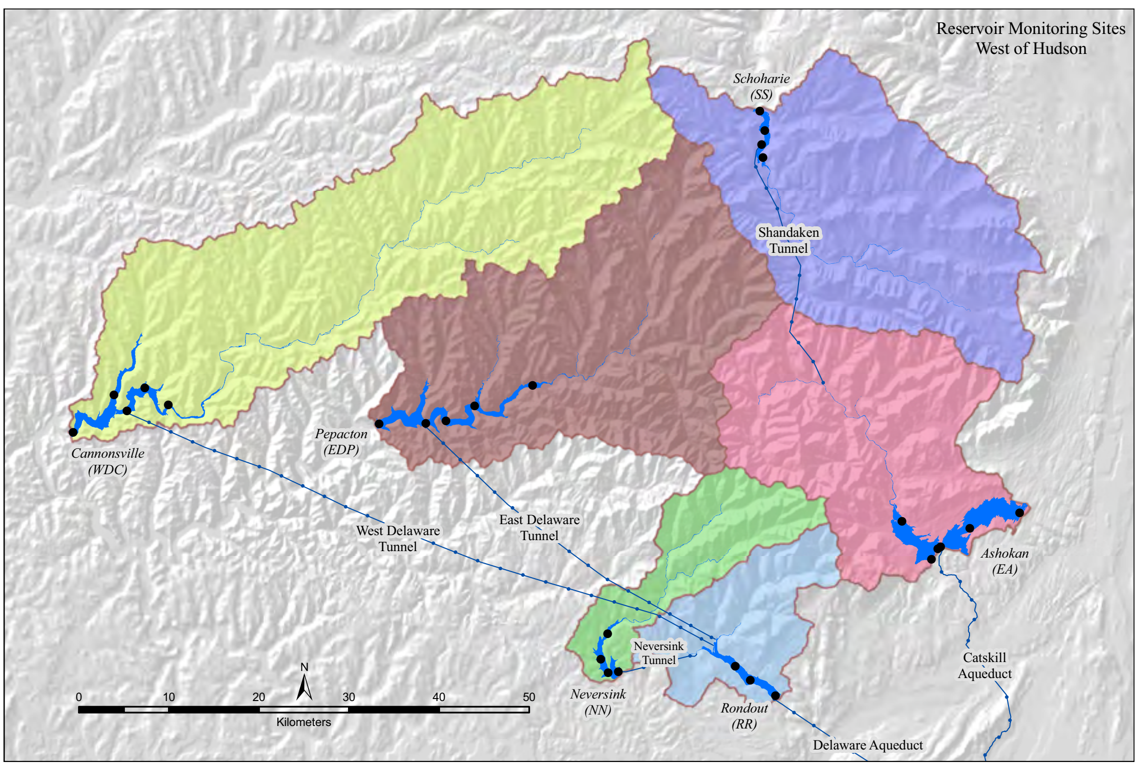

Figure 1.8 Limnological sampling sites for reservoirs west of the Hudson River.

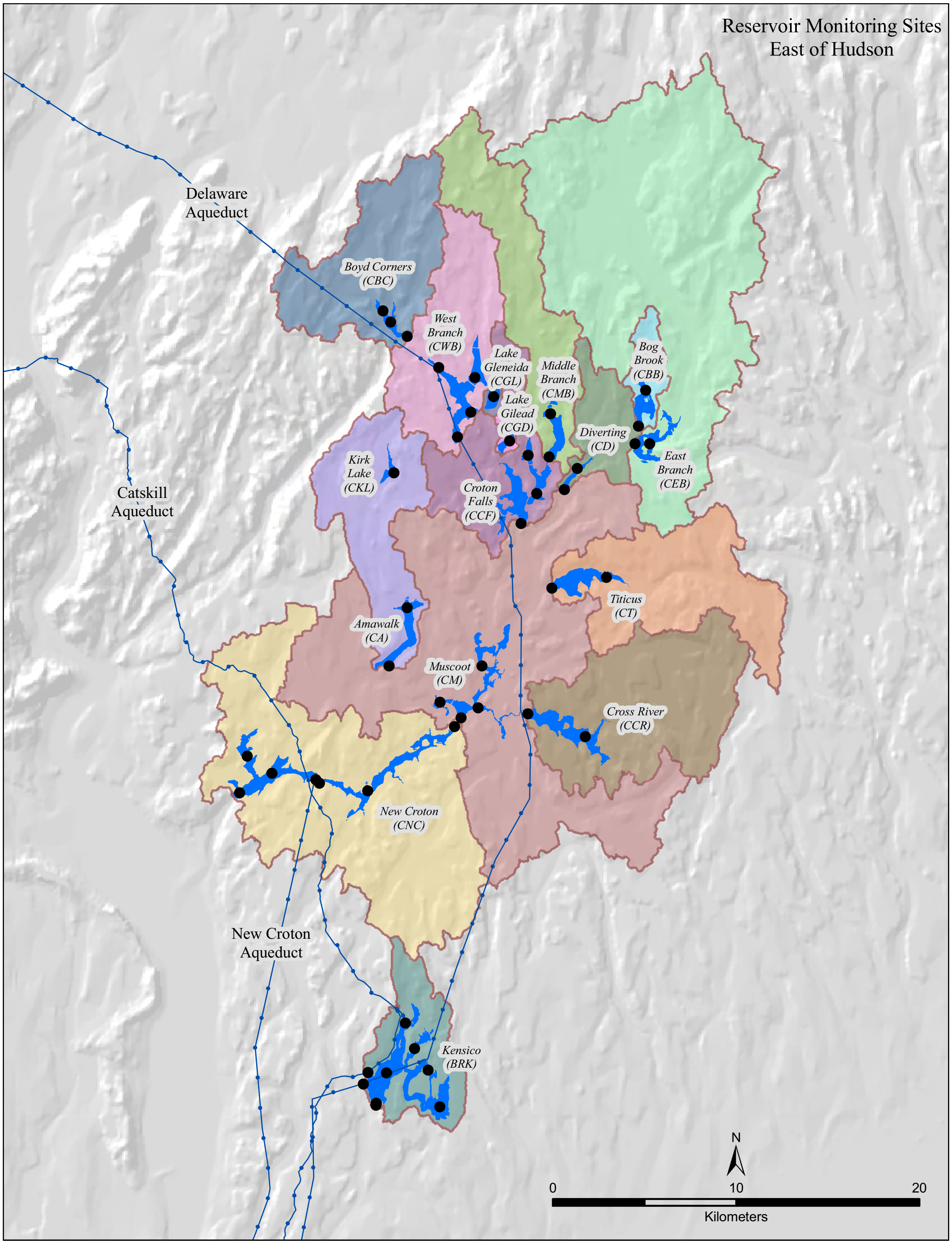

Figure 1.9 Limnological sampling sites for reservoirs east of the Hudson River.

Aqueduct "keypoint" monitoring is conducted as a means of keeping a "finger on the pulse" of the water supply with respect to the major water flowing through the system and into distribution. Monitoring at these sites is conducted through the use of continuous monitoring equipment, and taking daily or weekly grab samples. These sites have some of the highest frequencies of sampling, the purpose of which is to maintain a high degree of reliability in the quality of water entering the distribution system. In addition to sites used for operational decisions, aqueduct monitoring includes compliance sites for the Surface Water Treatment Rule (SWTR) and are of utmost importance for operation of the system to maintain the status of Filtration Avoidance.

Finally, DEP monitors wastewater treatment plants (WWTPs) located throughout the watershed. These treatment plants are potential sites of impairment. However, this risk has been enormously reduced in recent years because nearly all the discharge from treatment plants in the watershed is now microfiltered (or the equivalent) with tertiary treatment (nutrient removal). (For details on the WWTP upgrade program, see Chapter 5.) Plant upgrades have nearly eliminated the impacts that these plants formerly had in terms of nutrient and microbiological inputs. In the WWQMP, WWTP monitoring relies primarily on compliance monitoring to meet SPDES permits. Although DEP only owns six of the treatment plants and conducts monitoring according to their SPDES permits, additional monitoring of all plants is conducted to ensure that no problems arise.

1.5 How do the different monitoring efforts complement each other?

The WWQMP should be seen as superimposed networks that build on each other, and provide multidimensional information and multiple lines of evidence to support operational and policy decisions. Water quality management often requires a network design that can address water quality issues that demand distinct spatial and temporal monitoring efforts. These efforts may, for example, require a combination of long-term fixed-frequency surveys, supplemented by intensive short-term strategies. The design of water quality monitoring networks can be significantly enhanced by the coordination and integration of such monitoring strategies. The integration of water quality monitoring networks is essential for deriving the best value from the water quality data collected. The use of data gathered by the water quality monitoring network is routinely used to support water supply operations. In addition, the importance of the monitoring networks and full value of the data materializes when scientists provide analysis and interpretation for scientific reports and publications.

The monitoring plan has been designed to meet the broad range of DEP's many regulatory and informational requirements. These requirements include: compliance with all federal, state, and local regulations to ensure safety of the water supply for public health; watershed protection and improvement to meet the terms of the 2007 FAD; the need for current and future predictions of watershed conditions and reservoir water quality to ensure that operational decisions and policies are fully supported over the long term; and ongoing surveillance of the water supply to ensure continued delivery of the best water quality to consumers.

1.6 Why did DEP operate the Croton Falls Pump Station in 2008 and what effect did the operation of the pump station have on Kensico Reservoir water quality?

The NYC Water Supply System is an interconnected system of cascading reservoirs and connecting aqueducts. This system design provides DEP the flexibility to route and deliver water from many different sources. In October 2008, scheduled system maintenance required that the Delaware Aqueduct be temporally shut down. While the Delaware System was offline, DEP needed to rely more heavily on the Catskill and Croton Systems to meet the City's water demand. One system configuration option to deliver more water from the Croton System is the operation of the Croton Falls Pump Station (CFPS). Located at Croton Falls Reservoir, this station provides DEP with the ability to pump water from Croton Falls Reservoir into the Delaware Aqueduct (downstream of the shutdown), where it is delivered to Kensico Reservoir. Terms of operation of the CFPS are explicitly described in the 2007 FAD. The DEP must justify the need for operation and receive approval from NYSDOH prior to operation. In 2008, DEP received approval for and operated the CFPS to help supplement the supply while Delaware System repairs were being performed.

In response to this change in the delivery configuration of the water supply, DEP also modified its water quality monitoring program to closely track the quality of Croton Falls water and the effects, if any, of this alternate supply on Kensico Reservoir. Elements of this enhanced monitoring program included collecting daily samples of the water entering the CFPS and of the water exiting the Delaware Aqueduct into Kensico Reservoir. Also, the quality of Croton Falls Reservoir was closely monitored with weekly reservoir surveys. In addition to this water quality monitoring, DEP also increased surveillance of potential contaminant sources by conducting weekly reservoir waterfowl surveys and increasing inspections of watershed wastewater treatment plants. As a condition of the approval to operate, the DEP provided regulators with a weekly update on the status of the enhanced water quality monitoring program.

The operation of the CFPS was successful. The Station operated as designed to help augment the supply. The quality of water delivered from Croton Falls Reservoir was closely monitored and the quality of water within Kensico Reservoir remained high throughout the entire operation. Accordingly, the quality of water leaving Kensico Reservoir also remained high and appeared unaffected throughout this period.

1.7 What enhancements were made to DEP's monitoring capabilities in 2008?

A new, state-of-the-art laboratory was opened in Kingston, NY, in February 2008. The new laboratory replaced the Ben Nesin Laboratory that was located in Shokan, NY, and allowed for the consolidation of several laboratory processes with the transfer of some staff and analyses from DEP's Grahamsville Laboratory in Grahamsville, NY. The Kingston Laboratory performs water quality analyses for the WOH watersheds (Catskill and Delaware) as well as pathogen and metals analyses for both EOH and WOH watersheds. Altogether, the modern laboratory provides 19,000 square feet for performing water quality analyses and maintenance of equipment.

The laboratory consists of several individual laboratories with unique analytical functions. Three separate Field Laboratories are available so that field staff can perform the calibration of field instruments, the programming of automated sampling equipment, and the repair and maintenance of field equipment, including sample pumps and flow measuring devices. The Sample Receiving and Preparation Laboratory is where samples are officially received by the laboratory, and other tasks including instrumentation calibration, turbidity analysis, and sample distillation occur in this laboratory. The facility also includes a Microbiology Laboratory for the performance of phytoplankton and bacterial analysis and a Metals Laboratory for the analysis of metals, such as lead and mercury. The Wet Chemistry Laboratory performs the widest variety of analyses including solids, biochemical oxygen demand, alkalinity, chloride, sulfate, total organic carbon, nitrogen, phosphorus, ammonia and silica. These laboratories are certified by New York State's Environmental Laboratory Approval Program. The Pathogen Laboratory, certified by the USEPA, performs *Giardia* and *Cryptosporidium* analysis. The Wildlife Studies Laboratory is dedicated to performing dissections on wildlife specimens inhabiting the watershed environment for bacteria, pathogens, and nutrient analysis. Wildlife specimens are preserved and stored for a species reference collection and endangered species management work. The facility is also equipped with Organics and Research Chemistry Laboratories which currently allow for chlorophyll analysis, instrument repair, and instrument validation. These two laboratories will also allow DEP to expand analytical capabilities in the watershed in the future, as needed. Finally, the facility contains a small Quality Assurance/Quality Control Laboratory which is currently being utilized to house a Laboratory Information Management System (LIMS) pilot program. The implementation of the LIMS will result in more efficient data processing and record keeping for laboratory and field analyses.

The laboratory also features several analytical support rooms including walk-in coolers, clean rooms, a balance room, a wash room (complete with autoclaves and glassware washers) and sample receiving garage bays. New safety features include laboratory assessment and security systems, modern laboratory air flow and ventilation systems, and computerized environment monitoring.

The laboratory is located on the first floor of a two-story, 98,500-square-foot facility that currently houses 190 DEP employees. Also located on the first floor, which is dedicated entirely to the Water Quality Directorate, are field, administrative, compliance, and management staff (approximately 67 people) in 11,000 square feet of office space.

The second floor of the building provides office space for several Bureau of Water Supply programs as well as a GIS laboratory, numerous training rooms (including dedicated rooms for environmental health and safety training), a cafeteria, and conference rooms.

The Kingston headquarters provides an efficient, modern, and safe environment to conduct the work of DEP. It also has the space and capabilities to allow for growth, and should serve DEP well into the future.

1.8 How is the Bureau of Water Supply organized to provide stewardship for such a vast and important resource?

The objective for the Bureau was the delivery of high quality water, rigorous compliance with all regulations, and commitment to the long-term sustainability of the system, which are all considered core elements of operating the water supply.

The Bureau currently consists of five major Directorates, as follows: Compliance, Water Quality, Operations, Watershed Protection and Planning, and Management Services and Budget. The Directorate's senior managers each has a Compliance Advisor. This enables them to keep track of progress on all compliance matters. The primary functions of the five Directorates are described below.

Compliance

Compliance is responsible for ensuring that the Bureau operates within a safe work environment by meeting all regulations and standards. DEP and BWS have developed extensive, high quality, Environmental Health & Safety (EH&S) programs that include regular training of staff and on-going tracking systems to ensure maintenance of these programs. The Compliance Directorate consists of five divisions. They are overseen by a Director of Compliance who is assisted by an Administrator and Special Technical Assistant. The divisions are Health and Safety Compliance, Environmental Engineering, Environmental Compliance, Compliance Training, and Compliance Audit.

Water Quality

The Water Quality Directorate consists of four divisions; two are devoted to the upstate watershed and two are devoted to the downstate distribution system. The functions of the two operational divisions, (i.e., Watershed Water Quality Operations and Distribution Water Quality Operations) include responsibility for sampling, analysis, quality assurance, compliance data management and reporting, and environmental health and safety. The functions of the two science and research divisions, (i.e., Watershed Water Quality Science and Research, and Distribution

Water Quality Science and Research) include responsibility for planning, assessment and scientific research. Watershed Water Quality Science and Research is also responsible for FAD reporting, while Distribution Science and Research is responsible for drinking water compliance reporting. Project Management and Budget provides assistance to the Director and Divisions with budget, personnel, and other administrative matters. See Section 1.9 for more detail on the two upstate watershed water quality divisions.

Operations

The Operations Directorate is designed to provide oversight to all engineering operations. It is divided into two geographical areas: Eastern and Western Operations. Eastern Operations consists of northern and southern regions (the Highlands Region and the Kensico Region, respectively). Western Operations consists of three geographic regions, i.e., the Downsville Region, the Grahamsville Region, and the Shokan Region. Each of the five regions is led by a Regional Manager who has broad, overall responsibility for all operations in the region's geographic area, including operations and maintenance, land management, hazardous material (HazMat) response, and overall compliance sustainability. Regional Managers provide the management and leadership required to ensure that BWS can handle its wide range of responsibilities in an integrated manner within each region. Additionally, Eastern and Western Operations have an Engineering and Technical group to support their division's operation. Those hazardous material and land management functions that are not suitable for geographic dispersion continue to reside at the "central BWS" level. Land stewards and HazMat personnel work within the integrated regional structures, and provide policy and programmatic support and guidance to the Regional Managers.

Additionally, the Water Systems Operations group, Strategic Services, Community Supplies, and all reservoir operations operate under the direction of' one manager. This group is responsible for the long-term and day-to-day decision making regarding operations of the water supply system.

The Wastewater Operations Division is responsible for operation of the Bureau's seven wastewater treatment plants. This division includes a dedicated Compliance and Procurement group, as well as an Engineering and Technical group for support of the division. Finally, a Technical Advisor to the Director coordinates all HazMat training and certifications, ensures quality control of HazMat responses, ensures that required supplies are available, and handles communications with outside agencies relating to HazMat responses.

Watershed Protection and Planning

Under the direction of an Assistant Commissioner, this group consolidates the majority of the Bureau's water quality protection and planning initiatives into one unit. There are three major divisions within Watershed Protection and Planning (WPP). Watershed Lands and Community Planning (WLCP) is responsible for implementing key watershed protection programs, many of which are specified in the FADs issued periodically by USEPA. These include land acquisition, stream management, farm and forestry programs, and partnership programs. In addition, WLCP directs land management policy and planning for all City-owned land in the watershed, in close coordination with the regional managers within Operations. Further, the Natural Resources unit has been integrated into WLCP and continues to perform its current functions. Regulatory Review and Engineering is a second division within WPP. It includes virtually all of DEP's watershed regulatory oversight functions, Infrastructure Design and Construction, and the Wastewater Treatment Plant Upgrade Program. The third division, Planning, is responsible for all planning functions within the Bureau, including capital planning, long-term planning, emergency response planning, and coordination with the Bureau of Engineering Design and Construction. This Directorate is also supported by a Compliance Advisor, a Special Assistant to the Director, and a Watershed Outreach specialist.

Management Services and Budget

Management Services and Budget (MS&B) serves the Bureau by providing administrative assistance for all aspects of procurement and personnel that are required to keep the Bureau functioning. The Director is assisted by an Administrative Assistant and oversees four units—Analysis and Support, Personnel, Expense, and Capital Budget.

Office of Information and Technology

The Office of Information and Technology (OIT) is part of the larger Department's organization. This group is directed by an Assistant Commissioner for Information and Technology. The staff support BWS, while unifying and developing consistent computing systems, and strengthening technological support and sophistication.

The BWS Directorates described above work together to operate and protect the water supply for the City of New York.

1.9 What are the roles of the upstate watershed water quality divisions within the Water Quality Directorate?

The condition of the water supply is monitored by the Directorate of Water Quality. This Directorate has a staff of over 200, who are responsible for monitoring and maintaining high water quality for the entire (upstate and downstate) water supply. As mentioned above, it is the work of the two watershed (upstate) divisions that is described in this report.

The role of the watershed divisions is to (1) design scientific studies, (2) collect environmental samples for routine and special investigations, (3) analyze the samples in DEP's laboratories and enter the results into a permanent database, (4) provide regulatory reports, (5) statistically analyze and interpret the results, (6) document findings, and (7) provide recommendations for operating the water system. Extensive monitoring of a large geographic network of sites to support reservoir operations and watershed management decisions are the top priority of the Directorate. The high quality of water and reliability of the supply demonstrate the success of the BWS watershed programs and operations. This report provides insight into how the Water Quality Directorate of

BWS monitors the water supply, and documents the final result of the combined programs and operations to demonstrate program effectiveness and compliance with all drinking water regulations.

The Watershed Water Quality Operations (WWQO) Division includes sections for WOH Water Quality Operations, EOH Water Quality Operations, Watershed Water Quality Compliance, and Wildlife Studies. These sections conduct all sampling and laboratory analysis work at four laboratory locations (Kingston, Grahamsville, Brewster, and Kensico) located throughout the watershed. The sections are comprised of field managers, laboratory managers, chemists, microbiologists, laboratory support and sample collection personnel, technical specialists, and administrative staff. The four water quality laboratories are certified by the NYSDOH Environmental Laboratory Approval Program (ELAP) for approximately 60 analytes in the non-potable water and potable water categories. These analytes include physical, chemical, microbiological, trace metals, and organic compounds. The NYC DEP Pathogen Laboratory has been granted "Approved" status by the US EPA for the analysis of *Cryptosporidium* under the SDWA using Method 1623. Watershed Water Quality Operations conducts monitoring of wastewater treatment, streams, reservoirs potable water sites and key aqueduct sites. Working with Bureau Operations to provide water quality information and input for Water Supply Operations is one of WWQO's top priorities.

The Watershed Water Quality Science and Research (WWQSR) Division is responsible for planning scientific studies, reviewing and revising monitoring plans, analyzing data, writing reports, and providing recommendations for watershed protection programs. The division consists of four sections—Program Evaluation and Planning, Pathogen Planning and Assessment, Water Quality Modeling, and Reporting and Publications. WWQSR interacts with WWQO by providing monitoring plans and sampling recommendations, which are carried out by the field and laboratory personnel of WWQO and entered into the DEP water quality database. These results are then analyzed and presented in reports, like this one, to make water quality information accessible to managers, regulators, and the public.

2. Water Quantity

2.1 What is NYC's source of drinking water?

New York City's water supply is provided by a system consisting of 19 reservoirs and three controlled lakes with a total storage capacity of approximately 2 billion cubic meters (580 billion gallons). The total watershed area for the system drains approximately 5,100 square kilometers (1,972 square miles) (Figure 2.1).

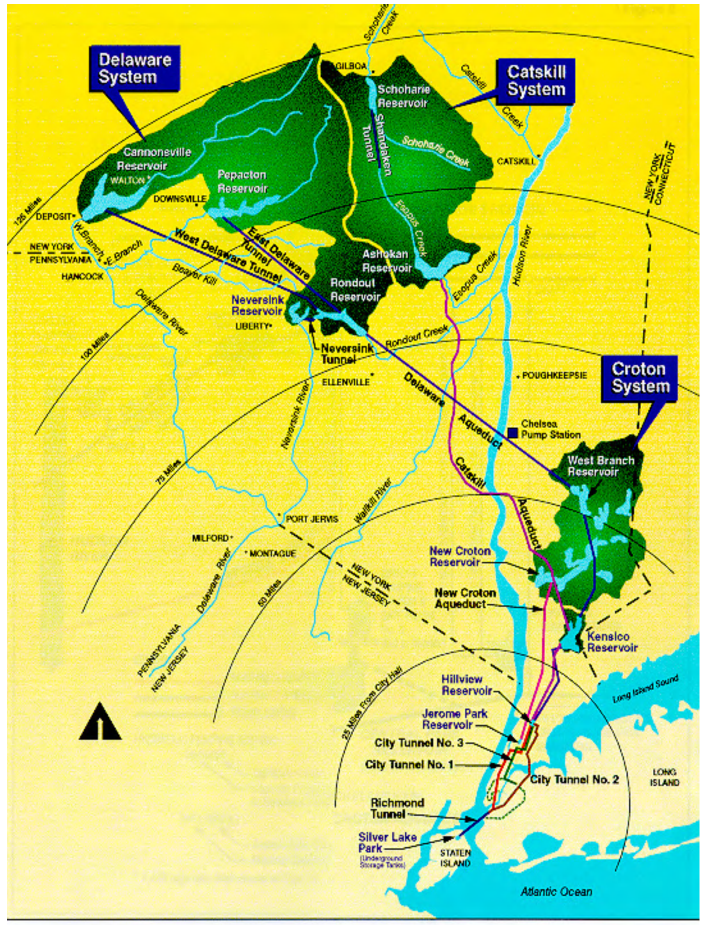

Figure 2.1 New York City water supply watershed.

The system is dependent on precipitation (rainfall and snowmelt) and subsequent runoff to supply the reservoirs in each of three watershed systems, Catskill, Delaware, and Croton. The first two are located West of Hudson (WOH), while the Croton System is located East of Hudson (EOH). As the water drains from the watershed, it is carried via streams and rivers to the reservoirs. The water is then moved via a series of aqueducts to terminal reservoirs before the water is piped to the distribution system. In addition to supplying the reservoirs with water, precipitation and surface water runoff also directly affect the nature of the reservoirs. The hydrologic inputs to and outputs from the reservoirs control the nutrient and turbidity loads and hydraulic residence time, which in turn directly influence the reservoirs' water quality and productivity.

2.2 How much precipitation fell in the watershed in 2008?

The average precipitation for each watershed was determined from a network of precipitation gages located in or near the watershed that collect readings daily. The total monthly precipitation is the sum of the daily average precipitation values calculated for each reservoir watershed. The 2008 monthly precipitation total for each watershed is plotted along with the historical monthly average in Figure 2.2.

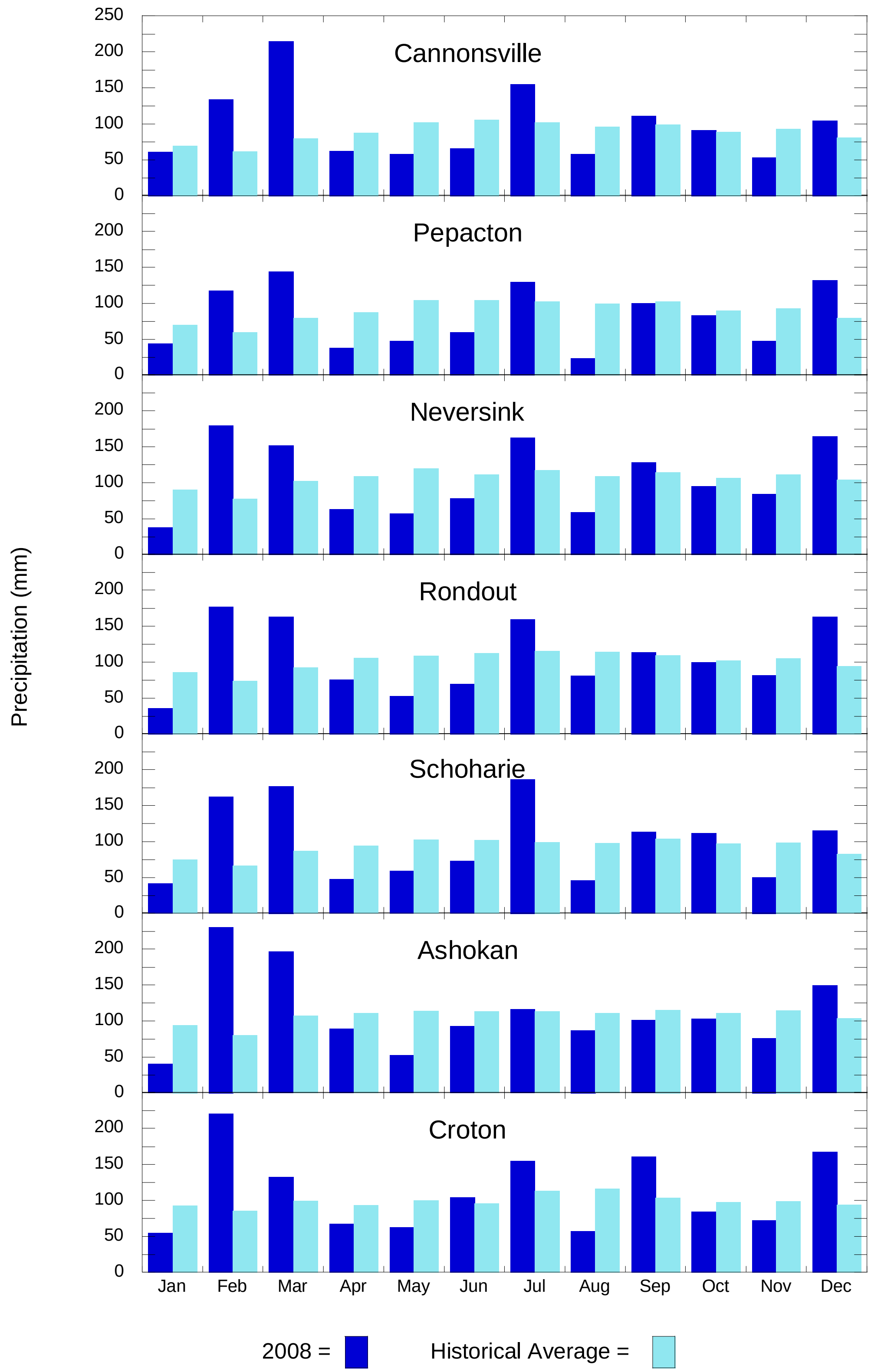

Figure 2.2 Monthly rainfall totals for NYC watersheds, 2008 and historical values.

The total monthly precipitation figures show that in general precipitation was below normal for January, but well above normal for February and March due to a series of winter storms. (As a result of these storms DEP used model simulations to support turbidity management and avoid alum treatment (see Section 6.4).) In fact, the National Climatic Data Center's (NCDC) 2008 Annual Climate Review U.S. Summary (http://www.ncdc.noaa.gov/oa/climate/research/2008/ann/us-summary.html) reports that New York State had its wettest winter (December-February) on record (1895-2008). From April through June precipitation was below normal, except for the Croton watershed in June which was slightly above average. Precipitation was above normal in July for all watersheds (see Section 2.5 to see how July precipitation impacted reservoir storage), and below normal in August. September and October precipitation was fairly typical, although the Croton watershed in September was slightly above average. Precipitation in all watersheds was below normal in November for all watersheds and above normal in December. The total precipitation in the watershed for 2008 was 1,198 mm (47.2 inches), which is 53 mm (2.1 inches) above normal. Overall, 2008 was New York State's seventh wettest year on record (1895-2008) according to the NCDC 2008 Annual Climate Review U.S. Summary.

2.3 What improvements were made to DEP's meteorological data network in 2008, and how were the data used?

Weather is one of the major factors affecting both water quality and quantity. As such, weather data is one of the critical components of an integrated data collection system. Timely and accurate weather forecasts are essential, especially with regard to rainfall. The worst episodes of stream bank erosion and associated nutrient, sediment, and pollutant transport occur during high streamflow events caused by heavy rain. Monitoring these events is critical to responding, making operational decisions, understanding, and ultimately reducing, the amounts of sediment, turbidity, nutrients, and other pollutants entering the reservoirs.

Recognizing that, in addition to the precipitation data that have been historically collected, meteorological data are valuable in meeting DEP's mission of providing high-quality drinking water through environmental monitoring and research, DEP maintained and upgraded the network of 25 Remote Automated Weather Stations (RAWS) covering both the EOH and WOH watersheds. Each station measures air temperature, relative humidity, rainfall, snow depth, solar radiation, wind speed, and wind direction. A reading is taken every minute, and values are summarized hourly (summed or averaged). All but one of the stations now utilize radio telemetry to transmit data in near real-time. In addition to being used by DEP, these data are shared with the National Weather Service to help it make more accurate and timely severe weather warnings for watershed communities. The data are also important as input for DEP's water quality models (Chapter 6).

In 2008, DEP continued to upgrade its rain gages and telemetry system. The RAWS network originally used tipping bucket rain gages, which only measure liquid precipitation. These are being replaced with a weighing bucket gage (the Ott Pluvio) which can also measure frozen precipitation such as snow and freezing rain. The Pluvios are also more accurate than tipping buckets, and they are equipped with wind shields to help reduce catch error. Installation of these began in 2007 and will be completed between 2010 and 2012. The telemetry upgrade was completed in 2008 (with the exception of one remote base station site, which was still awaiting installation of high-speed networking capability, expected to occur in early 2009). This upgrade utilizes multiple base stations located at DEP facilities (wastewater treatment plants, valve chambers, etc.) spread throughout both the East and West of Hudson watersheds. Each RAWS transmits data to the nearest base station, where it is put onto the DEP computer network and routed to the master dataset at Grahamsville, as well as to a separate backup location. This upgrade has improved the reliability of data reception, increased data security, and brought EOH stations into the near-real-time data program.

DEP continued to develop the automated snow water monitoring system it started building in 2007. Based on experience with the original sensors from the Army Corps of Engineers, DEP developed a modified design which is smaller, lighter, less expensive, and easier to install than the original. A prototype was built by a contractor and installed by DEP staff in January 2008. Preliminary data were very encouraging. DEP will purchase several more “SnoScale” devices for expanded testing in the future with the ultimate goal of eventually developing a watershed-wide, continuous automated snow water monitoring program that would greatly reduce the use of manual snow surveys while providing much more timely and useful data.

2.4 How much runoff occurred in 2008?

Runoff is defined as the part of the precipitation and snowmelt that appears in uncontrolled surface streams and rivers, i.e., “natural” flow. The runoff from the watershed can be affected by meteorological factors such as type of precipitation (rain, snow, sleet, etc.), rainfall intensity, rainfall amount, rainfall duration, distribution of rainfall over the drainage basin, direction of storm movement, and antecedent precipitation and resulting soil moisture. The physical characteristics of the watersheds also affect runoff. These include land use; vegetation; soil type; drainage area; basin shape; elevation; slope; topography; direction of orientation; drainage network patterns; and ponds, lakes, reservoirs, sinks, etc., in the basin which prevent or alter runoff from continuing downstream. The annual runoff coefficient is a useful statistic to compare the runoff between watersheds. It is calculated by dividing the annual flow volume by the drainage basin area. The total annual runoff is the depth to which the drainage area would be covered if all the runoff for the year were uniformly distributed over the basin. This statistic allows comparisons to be made of the hydrologic conditions in watersheds of varying sizes.

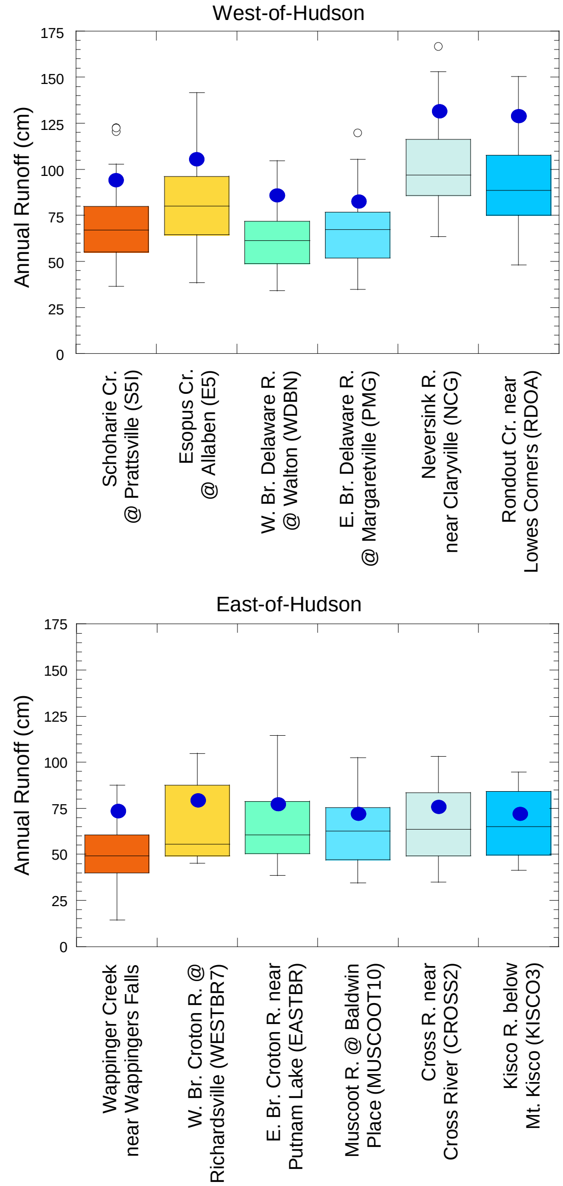

Figure 2.3 Historical annual runoff (cm) as box-plots for the WOH and EOH watersheds, with the values for 2008 displayed as a dot.

Selected USGS stations (Figure 2.8) were used to characterize annual runoff in the different NYC watersheds (Figure 2.3). The annual runoff in 2008 from the WOH watersheds was generally above the 75th percentile of the annual runoff from each watershed's historical record (i.e., more than 75 percent of the annual runoff values were below the values observed in 2008). In the EOH watersheds, the 2008 annual runoff was generally above the watersheds' historical medians (50th percentile). The differences between EOH and WOH may be partly explained by differences in precipitation patterns, but are also due to differences in the periods of record. The EOH stations have a 13-year period of record, except for the Wappinger Creek site (80-year period of record), which, like the WOH watersheds, showed a 2008 annual runoff above the 75th percentile. On the other hand, the period of record for the WOH stations ranges from 45 years at the Esopus Creek at Allaben station to 102 years at the Schoharie Creek at Prattsville gage.

2.5 What was the storage history of the reservoir system in 2008?

DEP has established typical or "normal" system-wide usable storage levels for each calendar day. These levels are based on historical storage values, which are a function of system demand, conservation releases, and reservoir inflows. Ongoing daily monitoring of these factors allows DEP to compare the present system-wide storage against what is considered typical for any given day of the year. In 2008 the actual system-wide storage values remained close to the typical or "normal" storage values (Figure 2.4). In order to meet system demand and required releases during the summer drawdown period, DEP aims to have the system-wide usable storage at 100% (547.53 billion gallons (bg)) on June 1 of each year. In 2008 the June 1 system-wide usable storage was at 95.34 % of capacity, or 522.02 bg. A late July storm brought the storage values back to normal levels.

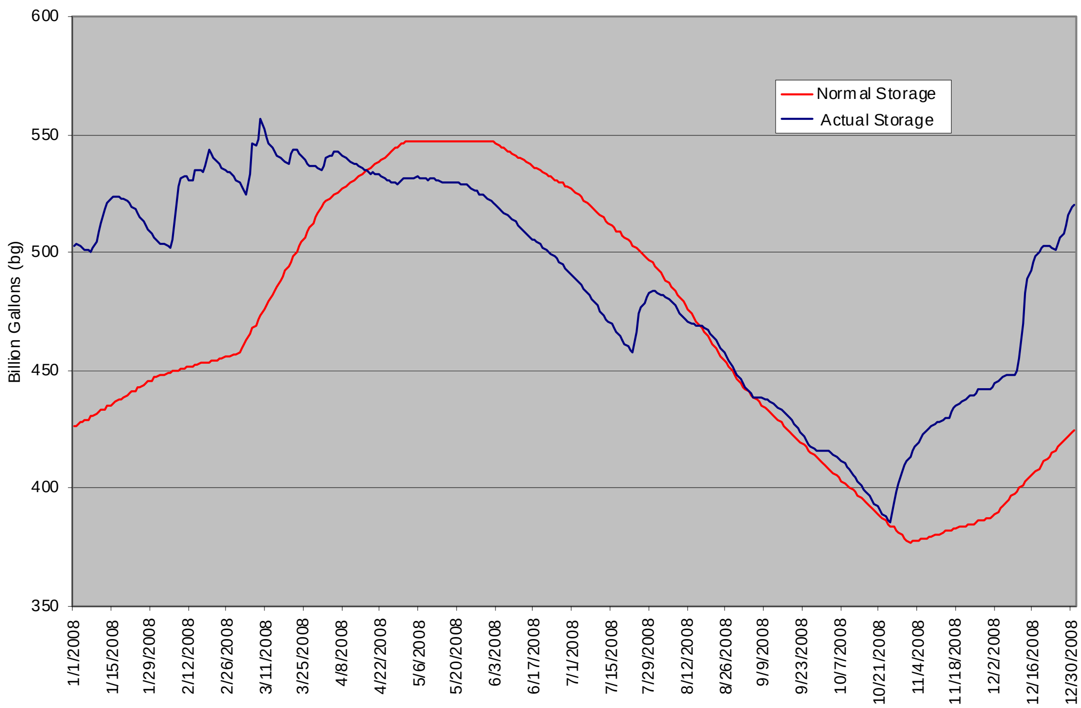

Figure 2.4 Actual system-wide usable storage compared to normal system-wide usable storage.

3. Water Quality

3.1 How did DEP ensure the delivery of the highest quality water from upstate reservoirs in 2008?

DEP continued to perform extensive water quality monitoring at multiple sampling sites from aqueducts, reservoir intakes, and tunnel outlets within the Catskill, Delaware, and Croton Systems. In 2008, over 69,292 physical, chemical, and microbiological analyses were performed on 6,659 samples that were collected from 53 different key aqueduct locations. DEP's Early Warning Remote Monitoring Group also continued to operate and maintain continuous monitoring instrumentation at critical locations to provide real-time water quality data to support operational decision making.

Scientists in the Watershed Water Quality Operations Division work cooperatively with the Bureau's Operations Directorate to determine the best operational strategy for delivering the highest quality water to NYC consumers. DEP continued to implement numerous operational and treatment techniques to effectively manage the Catskill, Delaware, and Croton Systems. Operational and treatment strategies employed in 2008 included:

- Selective Diversion

DEP optimized the quality of water being sent into distribution by maximizing the flow from reservoirs with the best water quality and minimizing the flow from reservoirs with inferior water quality. In the fall of 2008, DEP diverted acceptable quality water from the West Basin of Ashokan Reservoir to keep Kensico Reservoir full and to create a void in the West Basin (Figure 3.1).

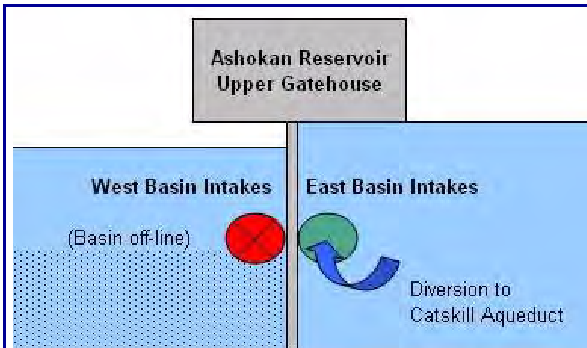

Figure 3.1 Water being diverted into the Catskill Aqueduct from the West Basin of Ashokan Reservoir.

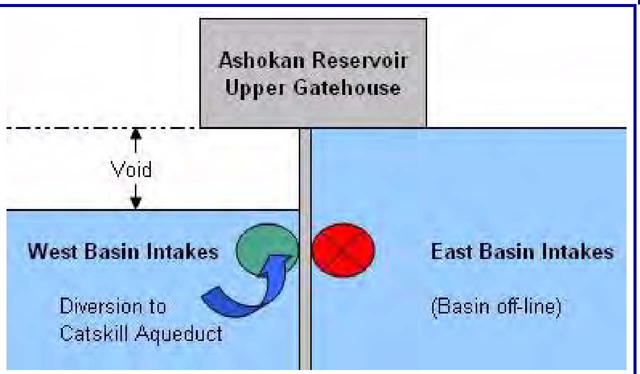

Figure 3.2 Water being diverted into the Catskill Aqueduct from the East Basin of Ashokan Reservoir with increasing turbidity levels in the West Basin.

When turbidity levels in the Ashokan West Basin began to increase in October due to rain events, DEP responded by isolating the West Basin and diverting water from the East Basin where turbidity levels were lower. These basin operations allowed DEP to continue to deliver a sufficient quantity of good quality water to Kensico Reservoir and to absorb the impacts of storms in the isolated West Basin (Figure 3.2).

• Selective Withdrawal

DEP continued to monitor water quality at different intake elevations within the reservoirs and used the data obtained to determine the optimal level of withdrawal. While operating the Croton System during the fall, DEP monitoring results indicated that turbidity and manganese levels were increasing at lower elevations in New Croton Reservoir in late October. By changing the level of withdrawal from the bottom to the surface, DEP was able to optimize water quality and continue to operate the Croton System into the month of December.

• Other Strategies

DEP continued to look for strategies to protect water quality near the intakes at Kensico Reservoir. In August, Eastern Operations staff installed a 15-inch wave stabilization boom (Figure 3.3) that starts at the southeast corner of the Catskill Upper Effluent Chamber (Figure 3.4) and extends 600 feet south along the western shoreline of Kensico Reservoir (Figure 3.5). The bottom half of the boom consists of a weighted curtain while the top half floats above the water surface. The boom has served to decrease surface water activity as well as the resuspension of shoreline sediments. This has assisted DEP in minimizing the effects of wind-induced turbidity in the Catskill Influent cove and the diversion to Hillview Reservoir.

Figure 3.3 Wave stabilization boom installation.

Figure 3.4 Wave stabilization boom connection to the Catskill Upper Effluent Chamber.

Figure 3.5 Wave stabilization boom extending along the western shoreline of Kensico Reservoir.

3.2 How did the 2008 water quality of NYC's source waters compare with SWTR standards for fecal coliforms and turbidity?

The Surface Water Treatment Rule (SWTR) (40 CFR141.71(a)(1)) requires that water at a point just prior to disinfection not exceed the thresholds for fecal coliform bacteria and turbidity. To ensure compliance with this requirement, DEP monitors water quality for each of the water supply systems at "keypoints" (entry points from the reservoirs to the aqueducts) just prior to disinfection (the Croton System at CROGH, the Catskill System at CATLEFF, and the Delaware System at DEL18). Figures 3.6 and 3.7 depict fecal coliform and turbidity data, respectively, for 1992-2008. Each graph includes a horizontal line marking the SWTR limit.

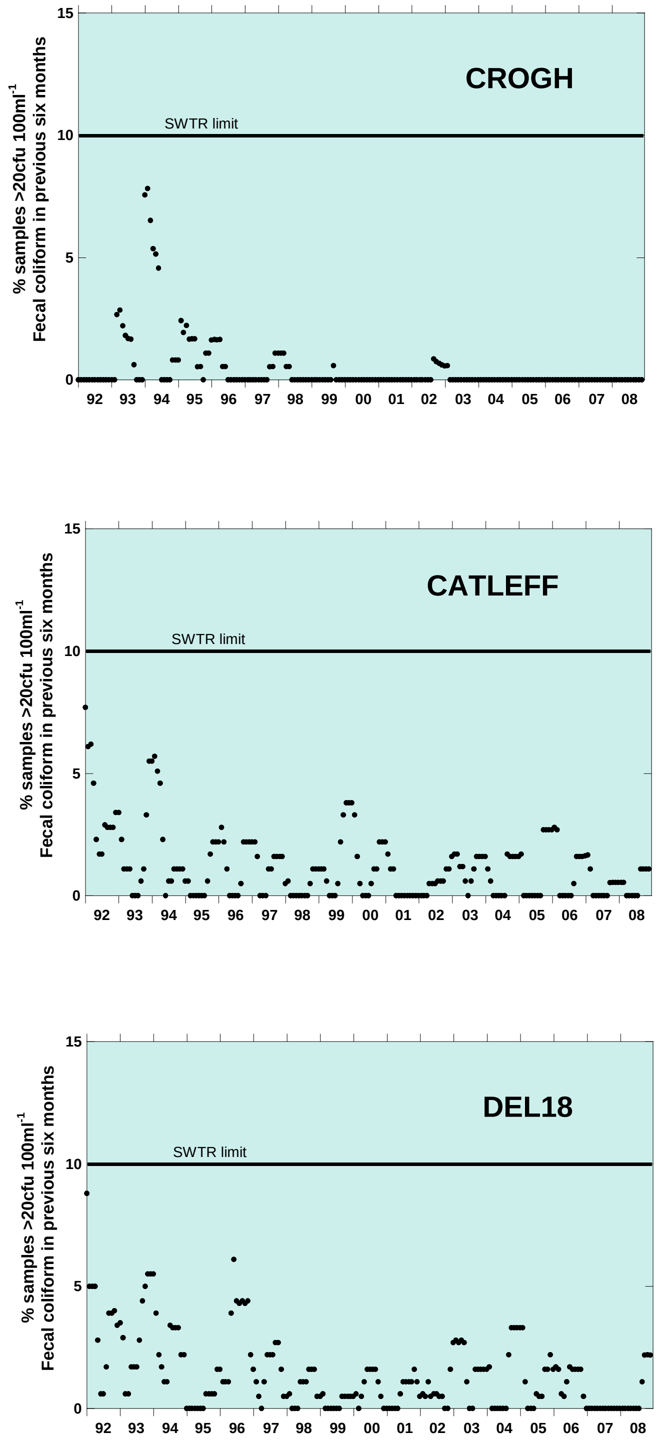

Figure 3.6 Fecal coliform (percent of daily samples > 20 CFU $100ml^{-1}$ in the previous six months) at keypoints compared to Surface Water Treatment Rule limit, 1992–2008.

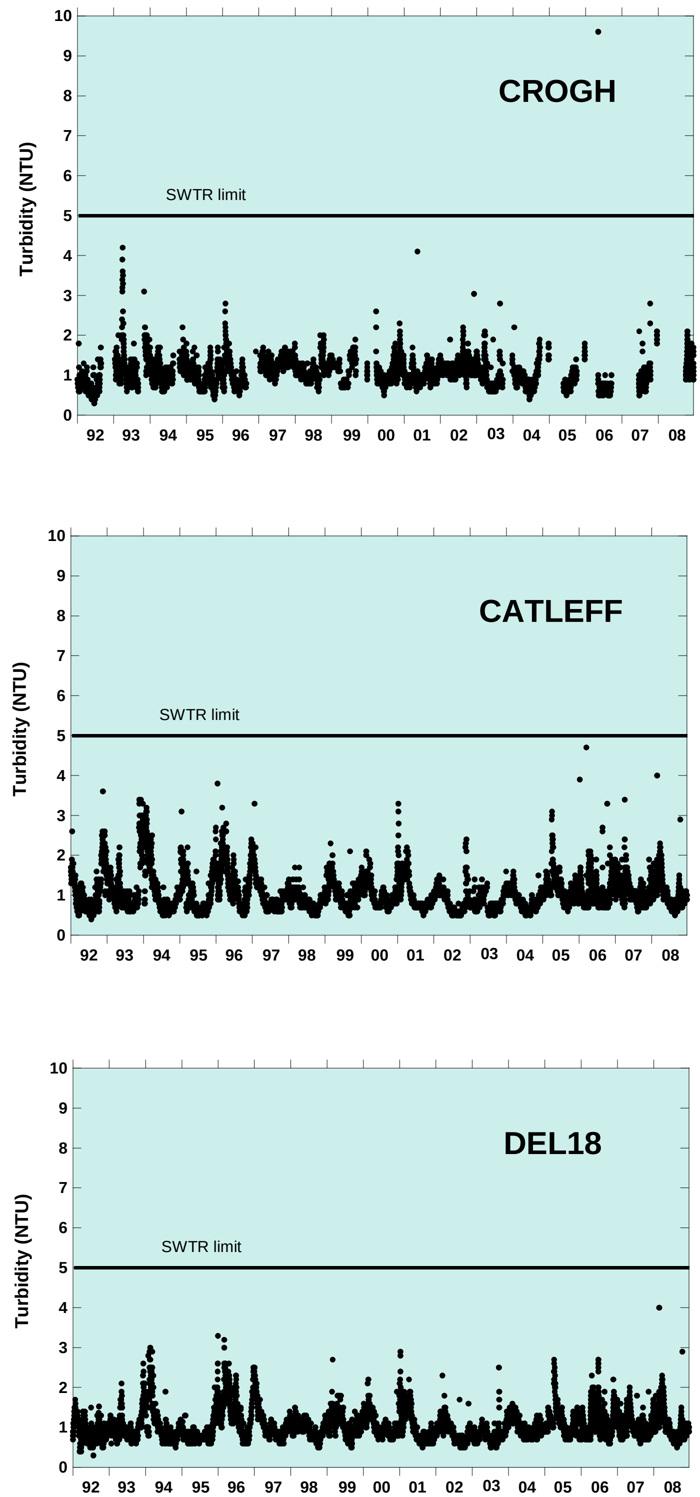

Figure 3.7 Turbidity at keypoints compared to Surface Water Treatment Rule limit, 1992–2008.

As indicated in Figure 3.6, the fecal coliform counts at all three keypoints consistently met the SWTR standard that no more than 10% of daily samples may contain > 20 CFU $100mL^{-1}$. The 2008 calculated percentages for effluent waters at CROGH, CATLEFF, and DEL18 were far below this limit. Median fecal coliform counts (CFU $100mL^{-1}$) in raw water samples taken at these sites were the same, at 1 CFU $100mL^{-1}$, while maxima were 7, 45, and 74, respectively.

The SWTR limit for turbidity is 5 NTU. As indicated in Figure 3.7, all three effluent waters, measured at 4-hour intervals, were consistently well below this limit in 2008. For CROGH, CATLEFF, and DEL18, median turbidity values (NTU) were 1.2, 1.0, and 1.0, respectively, while maximum values were 2.1, 4.0, and 2.2, respectively. (Note: The plot shows one high value at CROGH in 2006 that was caused by an operational adjustment, as discussed in the Watershed Water Quality Annual Report for 2006 (DEP 2007a).)

3.3 What was the water quality in the major inflow streams of NYC's reservoirs in 2008?

The stream sites discussed in this section are listed in Table 3.1 and shown pictorially in Figure 3.8. The stream sites were chosen because they are the farthest sites downstream on each of the six main channels leading into the six Catskill/Delaware reservoirs and into five of the Croton reservoirs. This means they are the main stream sites immediately upstream from the reservoirs and therefore represent the bulk of the water entering the reservoirs from their respective watersheds (except for New Croton, where the major inflow is from the Muscoot Reservoir release). The Kisco River and Hunter Brook are tributaries to New Croton Reservoir and represent water quality conditions in the New Croton watershed.

Table 3.1: Site codes and site descriptions of the stream sample locations discussed in Section 3.3.

Site Code	Site Description
S5I	Schoharie Creek at Prattsville, above Schoharie Reservoir
E16I	Esopus Creek at Boiceville bridge, above Ashokan Reservoir
WDBN	West Br. Delaware River at Beerston, above Cannonsville Reservoir
PMSB	East Br. Delaware River below Margaretville WWTP, above Pepacton Reservoir
NCG	Neversink River near Claryville, above Neversink Reservoir
RDOA	Rondout Creek at Lowes Corners, above Rondout Reservoir
WESTBR7	West Branch Croton River, above Boyd Corners Reservoir
EASTBR	East Branch Croton River, above East Branch Reservoir
MUSCOOT10	Muscoot River, above Amawalk Reservoir
CROSS2	Cross River, above Cross River Reservoir
KISCO3	Kisco River, input to New Croton Reservoir
HUNTER1	Hunter Brook, input to New Croton Reservoir

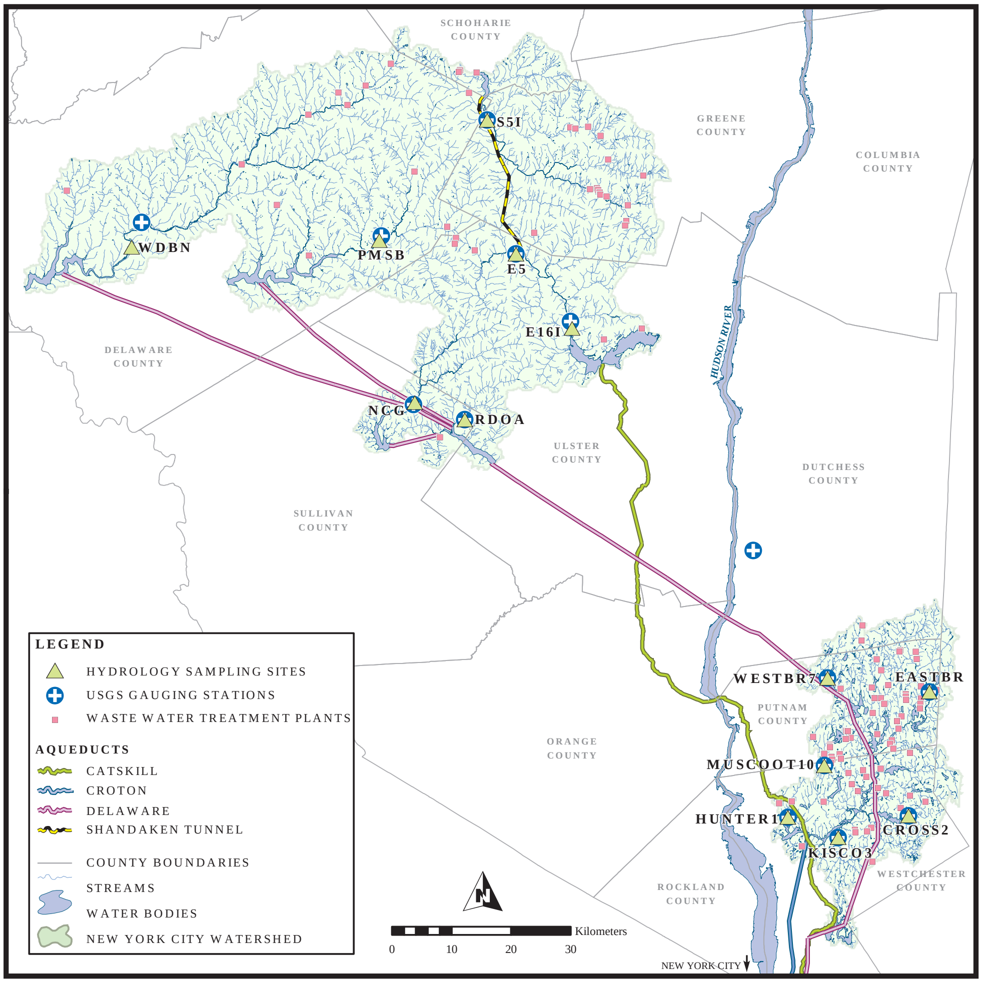

Figure 3.8 Locations of sampling sites discussed in Section 3.3 and USGS stations used to calculate the runoff values presented in Section 2.4.

Water quality in these streams was assessed by examining those analytes considered to be the most important for the City water supply. For streams, these are turbidity (values may not exceed the SWTR limit), total phosphorus (nutrient/eutrophication issues), and fecal coliform bacteria (values may not exceed SWTR limits).

The results presented in Figure 3.9 are based on grab samples generally collected twice a month (but generally once a month for turbidity and total phosphorus for the East of Hudson (EOH) sites). The figures compare the 2008 median values against historical median annual values for the previous 10 years (1998–2007). However, one of the EOH sites, KISCO3, has a shorter sampling history (1999–present).

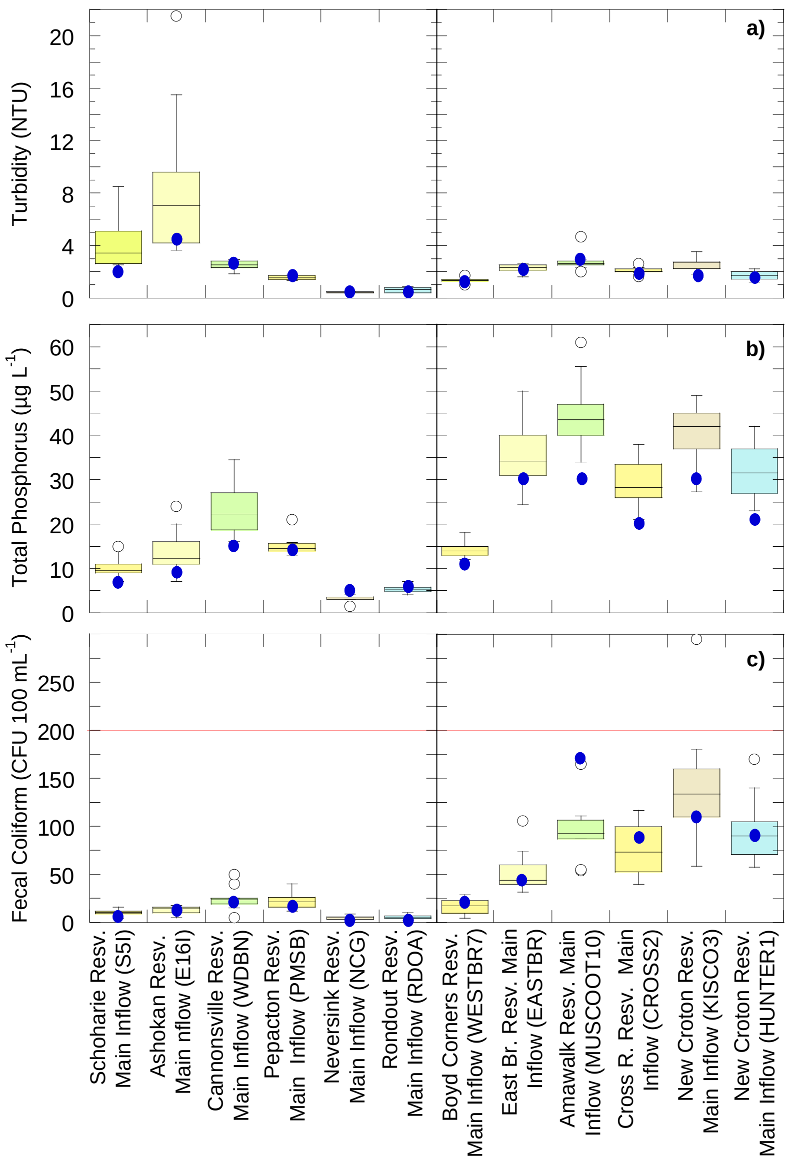

Figure 3.9 Boxplot of annual medians (1998–2007) for a) turbidity, b) total phosphorus, and c) fecal coliforms for selected stream (reservoir inflow) sites, with the value for 2008 displayed as a dot.

Turbidity

The turbidity levels for 2008 were generally near "normal" values (Figure 3.9a) with the 2008 median turbidity values in the inflows to Ashokan and Schoharie Reservoirs being somewhat less than the historical median for the previous 10 years. East of Hudson, the 2008 median turbidity values in the Kisco River was also less than the historical median for the previous 10 years.

Total Phosphorus

In the Catskill and Delaware Systems, the 2008 median total phosphorus (TP) levels (Figure 3.9b) were for the most part near typical historical values. As with turbidity, the annual total phosphorus median for 2008 for the inflows to Ashokan and Schoharie were somewhat less than the historical median for the previous 10 years. Also, the TP value in Cannonsville in 2008 remained below the historical median, perhaps reflecting the influence of improvements in agricultural practices and wastewater treatment plant (WWTP) upgrades. The 2008 TP medians in the Croton System were all less than historical values.

Fecal Coliform Bacteria

The 2008 median fecal coliform bacteria levels (Figure 3.9c) in the Catskill, Delaware, and Croton Systems were generally near the typical historical levels. Only MUSCOOT10, the inflow to Amawalk Reservoir, showed an elevated median value of fecal coliform in 2008. A fecal coliform benchmark of 200 CFU $100mL^{-1}$ is shown as a solid line in Figure 3.9c. This benchmark relates to the New York State Department of Environmental Conservation (DEC) water standard (expressed as a monthly geometric mean of five samples, the standard being <200 CFU $100mL^{-1}$) for fecal coliform (6 NYCRR §703.4b). The 2008 median values for all streams shown here lie below this value.

3.4 How does drawdown affect water quality?

Numerous studies of NYC watersheds and other watersheds throughout the nation have been conducted on the impact of water level fluctuations on reservoirs. These fluctuations may be due to natural events, such as drought, or human-induced by variations in the withdrawal. Water level drawdown has been used as a reservoir management technique to control certain aquatic plants, manage fish populations, and carry out repairs or improvements to reservoir structures (Cooke et al. 1986). The fluctuations in water level may impact biological, chemical, and physical processes within the reservoir due to effects of drawdown on the reservoir's thermal structure, light environment, and sediment exposure (Furey et al. 2004). The magnitude of impacts from a seasonal drawdown is dependent on factors including reservoir-specific hydrology and morphometry, as well as interannual climatic conditions (Nowlin et al. 2004).

Studies within the NYC watershed have demonstrated the impacts that drawdown can have on a reservoir. In 1995 a major drawdown occurred at Cannonsville Reservoir. Data from that year and long-term data were examined by Effler and Bader (1998). During the drawdown, sediment resuspension was at least in part responsible for introducing particles into the water column. These (non-phytoplankton) particles are referred to as tripton. As a result of the resuspension, the TP levels increased and the Secchi depth decreased. There was also a decrease in the duration of stratification. The resuspension of sediments led to the development of a benthic nepheloid layer (a bottom layer of turbid water) that eventually extended 10 meters above the bottom of the reservoir at one point. The increased tripton in the upper waters led to an increase in turbidity (Effler et al. 1998). Effler and Matthews (2004) showed that higher levels of inorganic tripton were generally observed in the years of greater drawdown. Tripton has an impact on the optical properties of a reservoir, and contributes to turbidity levels. Sediment resuspension can also enhance phytoplankton growth by release of phosphorus from decaying plankton to the productive (euphotic) layers of the reservoir and by desorption from suspended sediment. Resuspension of sediments can also have a negative effect on phytoplankton growth if shading interferes with light penetration. In Cannonsville Reservoir, resuspension is likely promoted by the drawdown of the water surface (Effler et al. 1998).

To further study the impact of drawdown on water quality, case studies of specific periods of drawdown, such as those in 2008 for Ashokan and West Branch, were examined (DEP 2009). Model simulations show that measured turbidity levels in the West Basin of Ashokan were affected by sediment resuspension during drawdown. Similar effects would be expected to occur in the East Basin and this could impact use of Ashokan water. Close monitoring of West Branch turbidity during a 2008 Delaware Aqueduct shutdown also indicated increased turbidity during drawdown. In this case, increases in turbidity were relatively small, but these could impact Kensico Reservoir, which is subject to the most stringent regulatory criteria.

A basic tenet of limnology is that water quality is influenced by reservoir or lake morphometry and watershed hydrology. The combination of these factors determines both nutrient loading and water residence times. Together, nutrient loading and water residence times determine biological productivity. Operation of the reservoir system imparts different elevation histories and water residence times to headwater versus terminal reservoirs and this was used to characterize reservoirs. An analysis of 20 years of data on reservoirs was conducted to demonstrate how water quality has responded to drawdown in the past (DEP 2009). Time series plots, scatter plots, and correlations were used to identify the strongest relationships between water quality and reservoir elevation. An interesting feature of these data was that in many cases, the relationship between drawdown and water quality parameters became stronger once water levels fell below a critical elevation.

3.5 What factors contributed to the turbidity patterns observed in the reservoirs in 2008?

Turbidity in reservoirs is caused by organic (e.g., plankton) and inorganic (e.g., clay, silt) particulates suspended in the water column. Turbidity may be generated within the reservoir itself (e.g., plankton, sediment resuspension) or it may be derived from the watershed by erosional processes (storm runoff in particular).

In 2008, turbidity in the Catskill System was lower than normal (Figure 3.10). Precipitation was high in February and March, which required the Shandaken Tunnel to be shut down; much of the turbid water from Schoharie was spilled to the Mohawk River. Turbid water entering Ashokan Reservoir via Esopus Creek was released to the waste channel from the West Basin, minimizing its impacts to Ashokan, especially the East Basin. Although July was wetter than normal, elevated turbidity was only observed at Schoharie Reservoir during this month. The operational changes and the relative absence of any additional runoff events during the year are the likely factors explaining such low turbidities in the Catskill System.

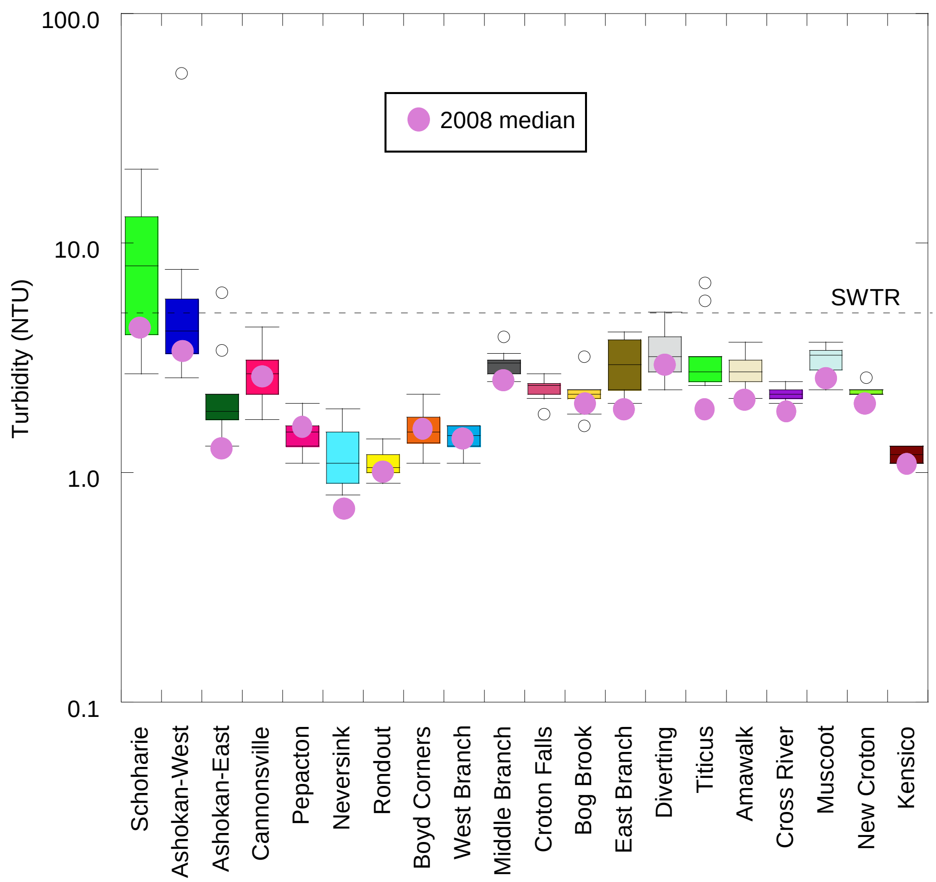

Figure 3.10 Annual median turbidity in NYC water supply reservoirs (2008 vs. 1998–2007). The dashed line at 5 NTU represents the SWTR criterion that considers 2 consecutive days > 5 NTU a violation in source water reservoirs.

Note: In general, data were obtained from multiple sites, multiple depths, at routine sampling frequencies (1 or 2x per month) from April through December. Medians were not calculated in 2008 for Croton Falls Reservoir due to insufficient data.

Unlike the Catskill reservoirs, most Delaware reservoirs were very close to their long-term median turbidity levels in 2008. Runoff events in February and March caused above average turbidities that lasted from April to June in Cannonsville. In Pepacton Reservoir the turbidity levels fell after the month of April. Pepacton also experienced elevated turbidity from late July to early August caused by locally heavy rain. Turbidity in Neversink, unlike the other Delaware reservoirs, was at its lowest level in the last 11 years. Despite 13.1 inches of rain that fell in February and March, Neversink showed little effect from the runoff since turbidity levels were near the median in April and below the median from May to November. Rondout, which receives most of its water from Cannonsville, Pepacton, and Neversink, was just below the long-term median turbidity for the year.

West Branch Reservoir, a blend between Rondout and Boyd Corners water, had slightly lower turbidity than its long-term median. Kensico Reservoir had lower than normal turbidity in 2008, reflecting the low turbidities of its primary inputs—Rondout, West Branch, and Ashokan Reservoirs.

Most of the Croton System reservoirs were close to or less than their long-term median turbidity levels. A relative absence of large rain events in 2008 is the likely cause. Although precipitation was high in February and March, the effect of this early runoff produced only low to median spring turbidity levels in all reservoirs except Boyd Corners. Low amounts of precipitation in April, May, and August also contributed to the low annual medians in all the other Croton reservoirs. Turbidity samples were only collected in August and late October for Lakes Gilead, Gleneida, and Kirk (results not shown in Figure 3.10). Turbidity levels were near the median for Gilead and Gleneida (1.4 and 1.6 NTU, respectively) and about 30% lower than normal for Kirk (3.3 NTU).

3.6 How were the total phosphorus concentrations in the reservoirs affected by precipitation and runoff in 2008?

Precipitation and runoff are important mechanisms by which phosphorus is transported from local watersheds into streams and reservoirs. Primary sources of phosphorus include human and animal waste, fertilizer runoff, and internal recycling from reservoir sediments.

In 2008, median TP levels in all Catskill and Delaware System reservoirs were at or near their lowest concentrations since 1997 (Figure 3.11). Monthly TP concentrations were especially low in April, May, and June. An early snowmelt from February to early March, along with operational increases in reservoir releases and spills in headwater reservoirs, were largely responsible for the low spring TP concentrations. Infrequent large storms (i.e., total rainfall greater than 1 inch) during the remaining months helped ensure a low TP year. Additional factors were apparent at Cannonsville Reservoir where monthly TP concentrations were lower in all months except June. Efforts to reduce TP loads (e.g., continued construction of agricultural BMPs and WWTP upgrades) and a continuing decline in dairy farming are likely factors contributing to these low TP values.

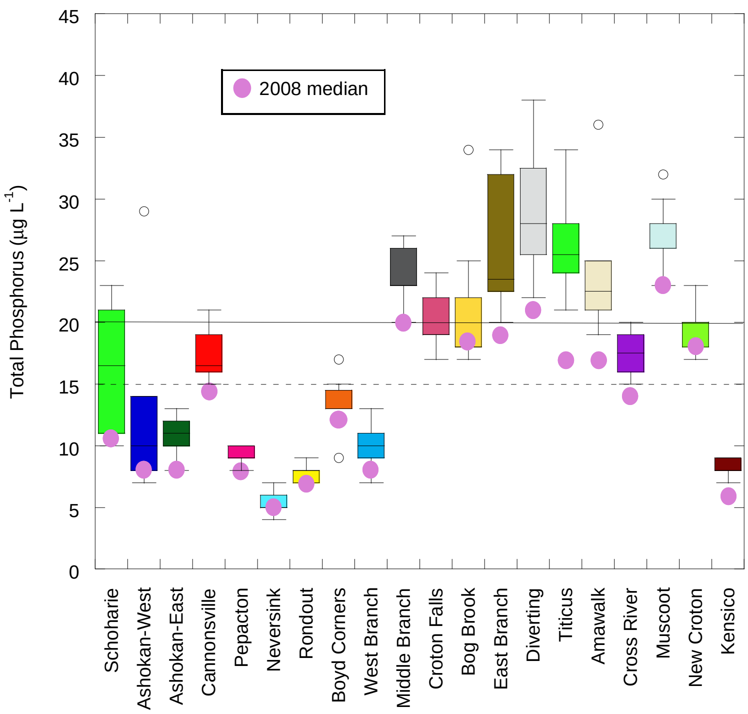

Figure 3.11 Annual median total phosphorus in NYC water supply reservoirs (2008 vs. 1998–2007). The horizontal dashed line at 15 µg L^{-1} represents the NYC TMDL guidance value for source waters (in the NYC water supply system, New Croton and Kensico Reservoirs, but see note below). The horizontal solid line at 20µg L^{-1} represents the DEC ambient water quality guidance value appropriate for reservoirs other than source waters.

Note: In general, data were obtained from multiple sites, multiple depths, at routine sampling frequencies (1 or 2x per month) from April through December. Medians were not calculated in 2008 for Croton Falls Reservoir due to insufficient data.

The terminal reservoirs are Kensico, New Croton, Rondout, Ashokan East, Ashokan West, and West Branch.

West Branch Reservoir is a blend of Rondout water from the Delaware System and of Boyd Corners water from the Croton System. TP concentrations in these inputs were both below the median and resulted in below median TP in West Branch in 2008.

Kensico Reservoir, which receives water from Rondout, West Branch, and Ashokan, had a low TP median in 2008, largely due to the low TP concentrations of its inputs.

As shown in Figure 3.11, TP concentrations in the Croton System reservoirs are normally much higher than in the Catskill and Delaware Systems. The Croton watershed is more urbanized; there are 60 WWTPs, numerous septic systems, and abundant paved surfaces scattered throughout the watershed. The 2008 TP concentrations are low relative to past concentrations for all Croton reservoirs and Kirk Lake (Figure 3.11 and Table 3.2). Lake Gleneida was slightly elevated compared to the 10-year historical median but the lake was only sampled in August and September in 2008.

Table 3.2: Total phosphorus summary statistics for NYC controlled lakes (µg L^{-1}).

Lake	Median Total Phosphorus (10-year)	Median Total Phosphorus (2008)
Gilead	20	20
Gleneida	18	21
Kirk	29	26

Data for Croton Falls were very limited in 2008 due to continuing dam rehabilitation work that necessitated the drawdown of this impoundment. Although accurate representative medians could not be calculated for 2008, the distribution of past annual medians is provided in Figure 3.11.

Several factors may be responsible for the nearly system-wide low TP concentrations. Reduced concentrations in April and May were probably a result of the early “flushing” of TP from the watersheds by unusually heavy rainfall in February and March. Reduced summer drawdown due to above average rainfall in July and September was another factor. At more typical drawdown levels, resuspension of exposed sediments can be an important source of TP to the reservoirs.

3.7 Which basins were phosphorus-restricted in 2008?

Phosphorus-restricted basin status is presented in Table 3.3 and was derived from two consecutive assessments (2003–2007 and 2004–2008) using the methodology stated in Appendix C. Table C.1 in Appendix C lists the annual growing season geometric mean phosphorus concentration for NYC reservoirs. Reservoir basins that exceed the guidance value for both assessments are classified as restricted. Figure 3.12 graphically depicts the phosphorus restriction status of the NYC reservoirs and the 2008 geometric mean phosphorus concentration.

Table 3.3:   Phosphorus-restricted reservoir basins for 2008.

Reservoir Basin	03–07 Assessment (mean + S.E.) (µg L^{-1})	04–08 Assessment (mean + S.E.) (µg L^{-1})	Phosphorus Restricted Status
Delaware System			
Cannonsville	18.2	18.0	Non-Restricted
Pepacton	9.9	9.8	Non-Restricted
Neversink	6.5	6.4	Non-Restricted
Rondout	8.2	8.1	Non-Restricted
Catskill System			
Schoharie	16.1	16.3	Non-Restricted
Ashokan-West	15.7	15.8	Non-Restricted
Ashokan-East	9.8	9.9	Non-Restricted
Croton System			
Amawalk	24.3	24.2	Restricted

Table 3.3: (Continued) Phosphorus-restricted reservoir basins for 2008.

Reservoir Basin	03–07 Assessment (mean + S.E.) (µg L^{-1})	04–08 Assessment (mean + S.E.) (µg L^{-1})	Phosphorus Restricted Status
Bog Brook	22.9	23.5	Restricted
Boyd Corners	15.9	15.8	Non-Restricted
Cross River	19.1	18.9	Non-Restricted
Croton Falls	19.9	18.7	Restricted*
Diverting	Insufficient data	Insufficient data	Restricted
East Branch	33.7	33.1	Restricted
Middle Branch	27.9	28.8	Restricted
Muscoot	27.9	27.2	Restricted
Titicus	27.0	25.8	Restricted
West Branch	12.2	12.1	Non-Restricted
Lake Gleneida	Insufficient data	Insufficient data	Restricted
Lake Gilead	31.1	32.2	Restricted
Kensico	8.6	8.5	Non-Restricted
New Croton	20.0	19.5	Restricted

* Croton Falls Reservoir was only sampled in the main basin in 2008. Since this basin receives water primarily from West Branch Reservoir, the 2008 geometric mean and the subsequent five-year analysis were biased low. For this reason, Croton Falls Reservoir remains restricted.

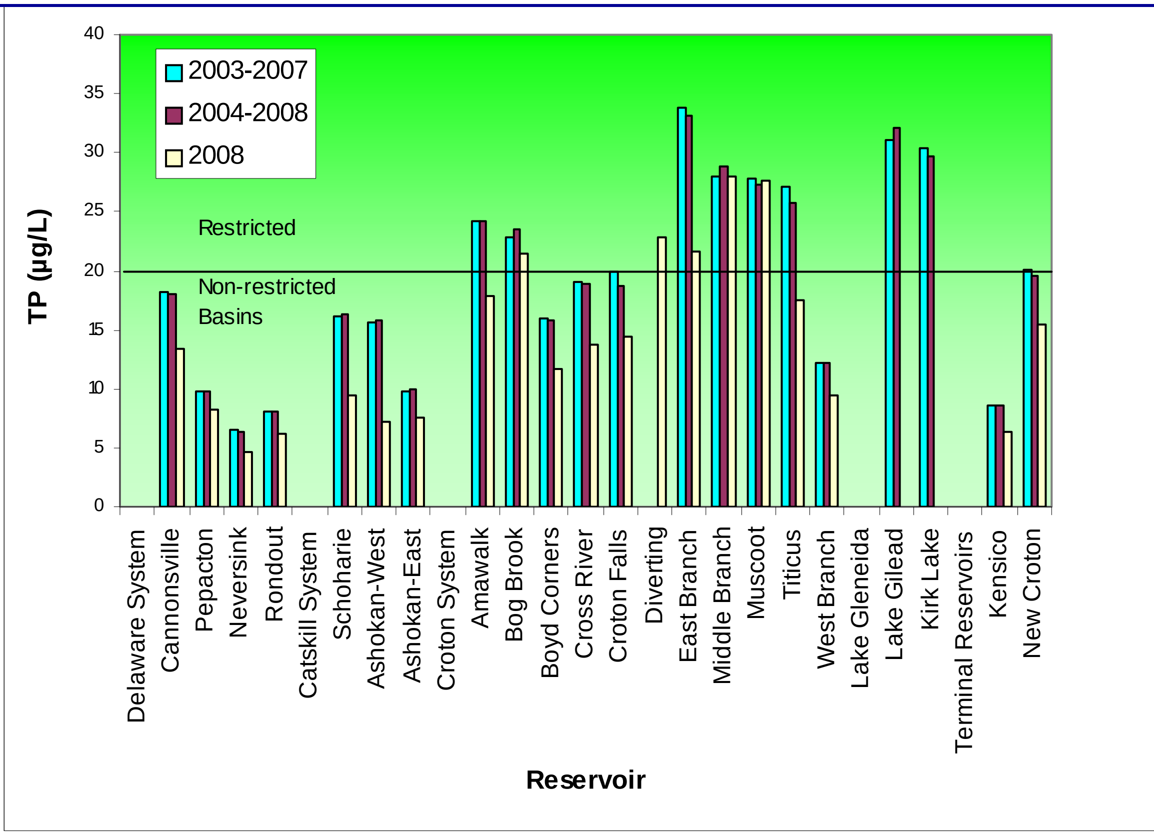

Figure 3.12 Phosphorus-restricted basin assessments, with the current year (2008) geometric mean phosphorus concentration displayed for comparison. The horizontal solid line at 20µg L^{-1} represents the DEC ambient water quality guidance value appropriate for reservoirs other than source waters.

Some notes and highlights regarding phosphorus-restricted basin status in 2008 are listed below:

- The Delaware System reservoirs remained non-restricted with respect to TP. Figure 3.12 shows that the 2008 geometric mean was lower than the mean for the two five-year assessments for all four reservoirs.
- The Catskill System reservoirs were also non-restricted since the two five-year assessment periods were well below 20 µg L^{-1}. The 2008 geometric mean was lower in all reservoirs compared to the two assessments.
- The Croton System reservoirs had some differences from previous assessments. In general, the geometric means of the TP concentrations for 2008 were lower than in previous years (Appendix C). The three controlled lakes were only sampled twice for TP during 2008 so their geometric mean couldn't be included in Figure 3.12. Lakes Gilead and Kirk had sufficient data in previous years to calculate the five-year assessments and their status remained restricted. Since insufficient data were available to change the status of Lake Gleneida, it also

remained restricted. Boyd Corners, Cross River, and West Branch Reservoirs remained non-restricted. Croton Falls Reservoir dropped below 20 µg L^{-1} for the 2004–2008 assessment. Upon closer examination, it was found that the 2008 mean concentration was unusually low because only the main basin, which has the best water quality, was sampled. Since the other sites were not sampled, an assessment could not be made, because any assessment that failed to include all the sites would not have been truly representative of the reservoir. The basin remains restricted until additional data confirm a decrease in 2009.

- Kensico Reservoir TP levels continue to be well below 20 µg L^{-1} for each of the last two assessments, and the basin remains unrestricted. New Croton Reservoir continues to show a decreasing geometric mean TP since 2004 (Table C.1 in Appendix C). As a result, the last five-year assessment dropped below 20 µg L^{-1}. If this trend continues, New Croton could be removed from TP-restricted status next year.

3.8 Are eutrophication patterns in NYC reservoirs comparable to those of other northern temperate water bodies?

Eutrophication is defined as a process where water bodies receive excess nutrients that stimulate excessive algal growth. The Organization for Economic Co-operation and Development (OECD) funded an international program on eutrophication of lakes in the late 1970s and early 1980s. Research on inland temperate lakes during the OECD program showed that chlorophyll *a* (chl *a*) (an indicator of algal biomass) is positively correlated with TP (Janus and Vollenweider 1981).

DEP conducted a comparison of NYC reservoirs and the OECD lakes using growing season (May through October) photic zone samples to determine whether the same relationship applied in the City's reservoirs. The long-term (1998–2007) mean and the annual mean for 2008 were compared to the regression line developed by the OECD program (Figure 3.13). Upper and lower 95% confidence intervals are also shown in the figure. The shift in the NYC regression line compared to the OECD line is likely due to methodology differences. The high performance liquid chromatography (HPLC) used by DEP is a more exact method for determination of chl *a* as compared with the methods used to develop the OECD relationships in 1981 (fluorometric or spectrophotometric analysis).

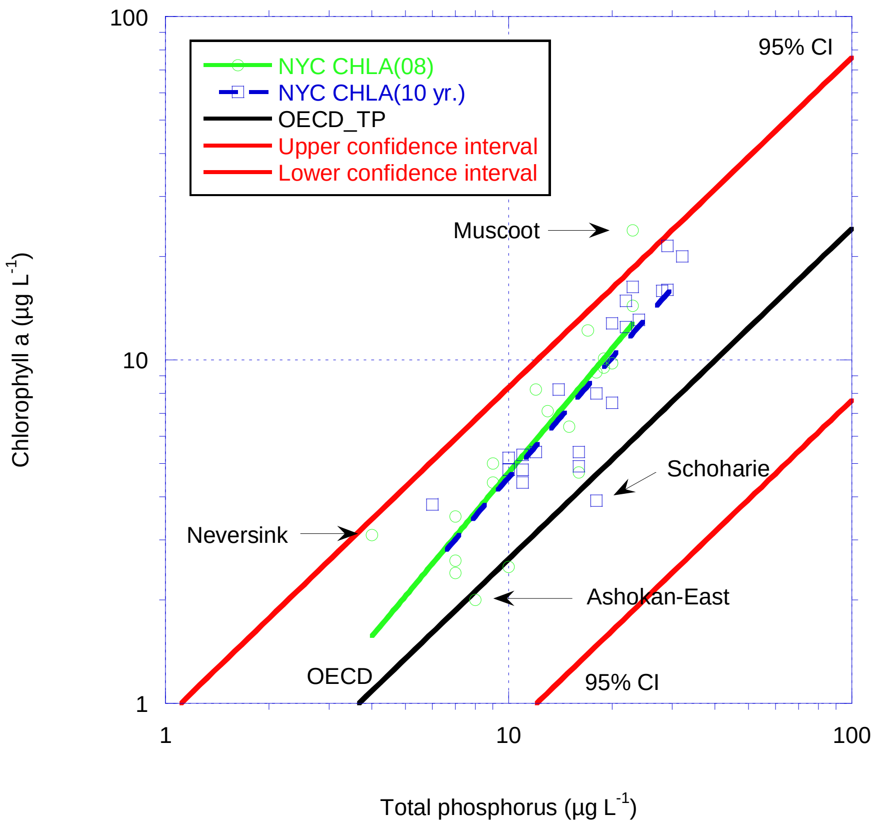

Figure 3.13 Mean chlorophyll *a* vs. total phosphorus concentration in NYC reservoirs compared to OECD Eutrophication Program lakes. For NYC reservoirs, samples were collected in the photic zone during the growing season (May–October) over a 10-year period (1998-2007) and in 2008.

Note: Chl *a* results were obtained through the use of a spectrophotometer or fluorometer from 1997-2000, and by HPLC thereafter. TP results were obtained by the Valderamma method (1980) from 1997–1999, and by APHA (1992, 1998) thereafter.

In general, NYC reservoirs achieved a greater algal response (as indicated by chl *a*) for each unit of nutrient concentration increase (as measured by TP) than the OECD water bodies. Reservoirs of the Catskill and Delaware systems mostly had lower nutrient levels as exemplified by Neversink Reservoir and Ashokan's East Basin in the plot. Reservoirs of the Croton System tended to have higher nutrient concentrations and higher chl *a*. Muscoot Reservoir is a notable example of this—its annual growing season mean TP and chl *a* were above the 95% confidence interval compared to the OECD water bodies. The long-term data for Schoharie Reservoir are shown below the OECD line, indicating the relationship between chl *a* and TP in this reservoir is different from the other NYC reservoirs. Apparently the low clarity of Schoharie inhibits algal response despite its moderate phosphorus concentration. This effect was not as apparent in the 2008 data for Schoharie, and indeed several reservoirs had lower TP and chl *a* in 2008 as compared to the long-term data.

NYC reservoirs generally conform to the expectations set by the OECD that Secchi transparency (Z_{SD}) is inversely related to chl *a* concentration (Janus and Vollenweider 1981) (Figure 3.14). The long-term regression line for NYC reservoirs is clustered about the OECD line, while the 2008 data show a lower slope than either the long-term or OECD regression lines. Most reservoirs had lower TP values in 2008, which could explain the lower chl *a* values in this plot.

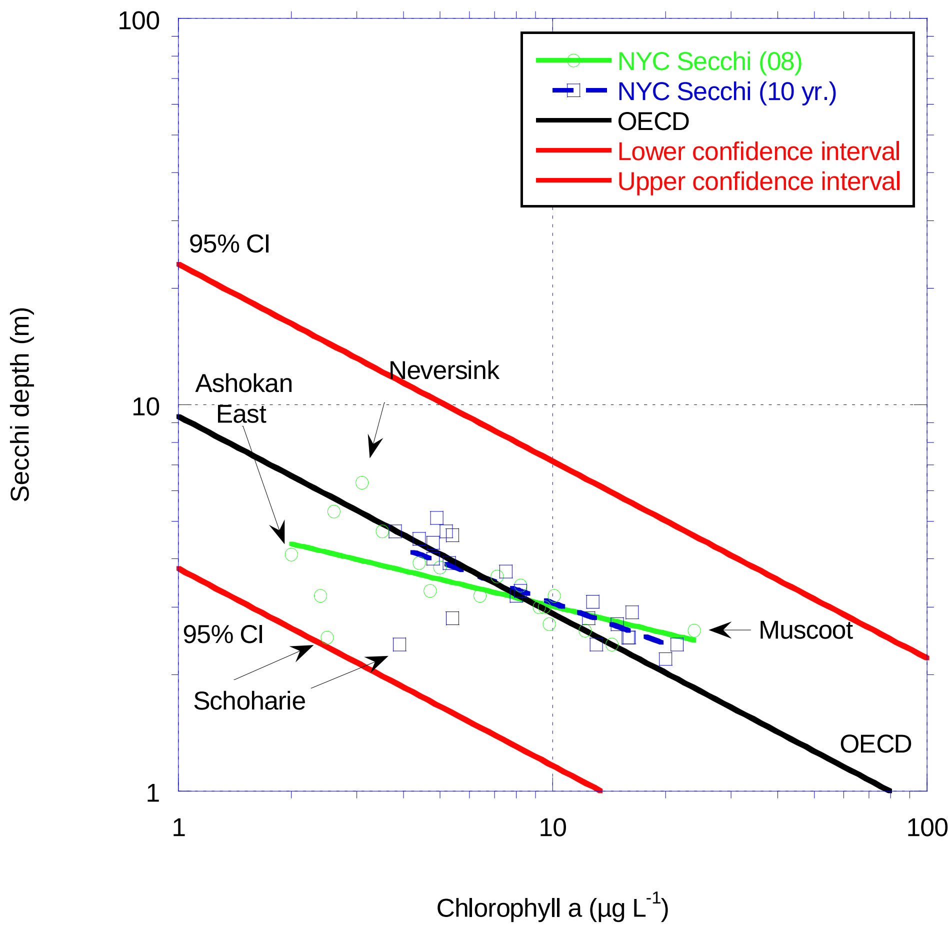

Figure 3.14 Mean chlorophyll *a* vs. Secchi transparency (Z_{SD}) in samples collected in the photic zone during the growing season (May–October) in NYC reservoirs over a 10-year period (1998–2007) and for 2008.

Note: Chl *a* results were obtained through the use of a spectrophotometer or fluorometer from 1998–2000, and by HPLC thereafter. Z_{SD} results were obtained on the shady side of the boat using the naked eye in 1998, and by use of a viewer box on the sunny side of the boat 1999–2007, producing slightly higher results (Smith and Hoover 1999, Smith 2001).

The West of Hudson reservoirs have lower chl *a* levels and deeper Secchi transparency as compared to East of Hudson impoundments. Neversink, Muscoot, and Ashokan's East Basin are noted on the plot as examples. Schoharie Reservoir stands out because of its relatively low transparency and low chl *a* concentrations compared to other NYC reservoirs and OECD water bodies. The departure of Schoharie from the "standard" Secchi-chl *a* relationship was due to the elevated concentration of suspended material that periodically occurs in those reservoirs. The higher turbidity blocks the transmission of light, resulting in lower transparency and lower primary production. Interestingly, the 2008 chl *a* mean was lower than the long-term value, but the Secchi values remained similar for the two periods.

The combination of three plots (chl *a* vs. TP, chl *a* vs. Z_{SD}, and Trophic State Index (TSI) (Section 3.9) can be used to provide valuable information about the reservoirs. For example, algal growth is driven by TP for most reservoirs and, in general, algae are the principal cause of light attenuation. The high TSI values indicate that reservoirs like Middle Branch and Muscoot are clearly eutrophic. Typically, blue-green algae are likely to dominate in these impoundments. The plots also show that the primary cause of light attenuation in Schoharie and Ashokan's West Basin is the presence of non-algal particulates, and the terminal receiving water reservoirs (closer to the distribution system) tend to be at a lower trophic state than outlying reservoirs. With the exceptions of Cannonsville and Schoharie, Catskill and Delaware reservoirs have deeper Secchi transparency, lower phosphorus concentrations, and lower chl *a* than the Croton System reservoirs.

3.9 What was the trophic status of each of the City's 19 reservoirs and why is this important?

The trophic state index (TSI) is commonly used to describe the productivity of lakes and reservoirs. Three trophic state categories—oligotrophic, mesotrophic, and eutrophic— are used to separate and describe water quality conditions. Oligotrophic waters are low in nutrients, low in algal growth, and tend to have high water clarity. Eutrophic waters, on the other hand, are high in nutrients, high in algal growth, and low in water clarity. Mesotrophic waters are intermediate. The indices developed by Carlson (1977, 1979) use commonly measured variables (i.e., chl *a*, TP, and Secchi transparency) to delineate the trophic state of a body of water. TSI based on chl *a* concentration is calculated as:

$$TSI = 9.81 \times (\ln (CHLA)) + 30.6$$

where CHLA is the concentration of chlorophyll *a* in $\mu g\ L^{-1}$.

The Carlson Trophic State Index ranges from approximately 0 to 100 (there are no upper or lower bounds), and is scaled so that values under 40 indicate oligotrophy, values between 40 and 50 indicate mesotrophy, and values greater than 50 indicate eutrophy. Trophic indices are generally calculated from data collected in the photic zone of the reservoir during the growing season (the DEP definition of "growing season" is May through October) when the relationship between the variables is most highly correlated. DEP water supply managers prefer reservoirs of a lower trophic state, because such reservoirs reduce the need for chemical treatments and produce better water quality at the tap; eutrophic waters, by contrast, may be aesthetically unpleasant from a taste and odor perspective.

Historical (1998–2007) annual median TSI based on chl *a* concentration is presented in boxplots for all reservoirs in Figure 3.15. The 2008 annual median TSI appears in the figure as a circle containing an "x". This analysis usually shows a split between West of Hudson reservoirs, which usually fall into the mesotrophic category, and East of Hudson reservoirs, which are typically classified as eutrophic. The exceptions to these generalities are Cannonsville, which is usually considered eutrophic; West Branch, which is considered mesotrophic due to incoming water from Rondout Reservoir; and Kensico, which is considered mesotrophic due to inputs from Rondout (usually via West Branch) and from the East Basin of Ashokan.

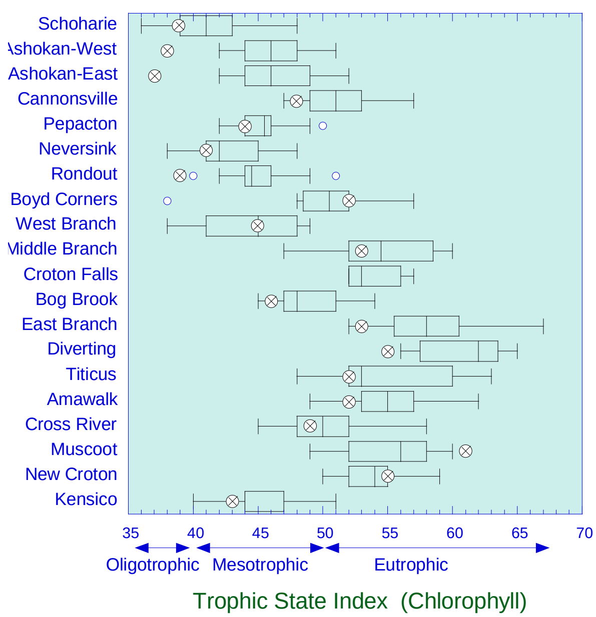

Figure 3.15 Annual median Trophic State Index (TSI) in NYC water supply reservoirs (2008 vs. 1998–2007).

Note: In general, data were obtained from epilimnetic depths at multiple sites and at routine sampling frequencies (1 or 2x per month) from May through October. TSI is based on chl *a* concentration.

In 2008, TSI was low in both the Catskill and Delaware Systems. In fact, TSI calculations for the three Catskill reservoirs placed them all in the oligotrophic range for the first time in the same year (Figure 3.15). It is likely that phytoplankton populations were limited by a scarcity of nutrients from April to June, presumably due to the early flushing of phosphorus through the systems in February to March, followed by an absence of runoff events in April and May. High turbidity levels in June and July at Schoharie and in August at Ashokan-West reduced light availability to algae and is an additional factor explaining low plankton counts in these reservoirs.

For headwater Delaware reservoirs, lesser quantities of nutrients were available in the summer of 2008. These reservoirs experienced less drawdown than usual so nutrient inputs from resuspension were probably reduced in 2008. Rondout, the terminal reservoir of the Delaware System, had its lowest TSI in the last 11 years.

TSI in West Branch, a blend of Rondout and Boyd Corners reservoirs, was equivalent to its historical median level, approximately halfway between the TSI levels of its inputs. In 2008, Kensico received most of its water from Rondout and Ashokan-East and, to a lesser extent, West Branch. Although Kensico's TSI was slightly lower than its historical median it was about 5 TSI units higher than its primary inputs, perhaps an indication of local primary production.

TSI patterns were not consistent for the Croton System reservoirs but most were close to their historical medians or significantly lower (Figure 3.15). Sampling was insufficient to calculate representative medians at Croton Falls and the controlled lakes Kirk, Gilead, and Gleneida. The reservoirs that showed lower TSI in 2008 were associated with reduced phosphorus concentrations attributable to the very mild drawdown of these reservoirs in 2008.

TSI was higher than usual at three Croton System reservoirs: Boyd Corners, New Croton, and Muscoot. Productivity in Boyd Corners was up because of blooms in July and August, apparently brought on by rain events. New Croton had higher TSI in 2008 because its main input, Muscoot, had a high TSI. Reasons for Muscoot's productivity increase are not clear. Four of the five major inputs to Muscoot (Amawalk, Diverting, Titicus, and Cross River) were all lower in TSI than their respective long-term medians, with the highest TSI of 55 recorded at Diverting. Normally the receiving water in a cascading system will show less productivity than its inputs due to die off of algae and settling of algae and TP. This was not the case for Muscoot where, in 2008, a TSI of 61 was observed, much higher than any of these four inputs and the highest at Muscoot in the last 11 years. Potentially, elevated flow inputs from Croton Falls may be a factor. In recent years releases from Croton Falls to Muscoot have greatly increased to facilitate dam and pump repairs. These increased releases tend to keep water levels lower in Croton Falls, which, in general, tends to increase productivity. Unfortunately, the low water levels have also prevented samples from being collected at Croton Falls, so this possible source of productivity can not be verified. The morphometry of Muscoot may also be partly responsible. Most of the reservoir is shallow so the water is warm and the likelihood of nutrient resuspension due to storm events is increased. Finally, the dendritic morphometry of Muscoot's shoreline creates many backwater areas with abundant macrophyte growth, which greatly restrict flow. All of these factors tend to promote algal growth.

3.10 What were the total and fecal coliform levels in NYC's reservoirs?

Total coliform and fecal coliform bacteria are regulated at raw water intakes by the SWTR at levels of 100 CFU 100 mL^{-1} and 20 CFU 100 mL^{-1}, respectively. Both are important as indicators of potential pathogen contamination. Fecal coliform bacteria are more specific in that their source is the gut of warm-blooded animals; total coliforms include both fecal coliforms and other coliforms that typically originate in water, soil, and sediments.

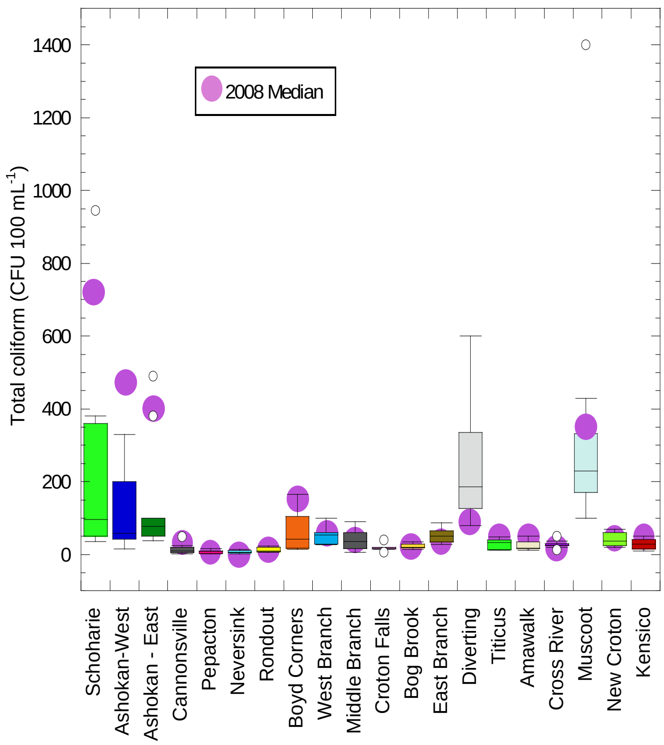

Figure 3.16 Annual median total coliform in NYC water supply reservoirs (2008 vs. 1998–2007).

Note: In general, data were obtained from multiple sites and depths, and at routine sampling frequencies (1 or 2x per month), from April through December. Medians were not calculated in 2008 for Croton Falls Reservoir due to insufficient data.

Figure 3.16 shows that the long-term (1998–2007) annual median levels of total coliform usually exceed 100 CFU $100mL^{-1}$ in Diverting and Muscoot Reservoirs. This situation does not occur in any of the other Croton System reservoirs. Muscoot is much shallower than the other Croton System reservoirs and is susceptible to wind driven resuspension events, which may distribute bacteria and detritus into the water column. The shallow depths are also conducive to warm temperatures, which allow many types of coliforms to survive. Diverting is deeper, but has a small volume, and rapid flow through this reservoir may influence total coliform levels. Although the broad Y-axis scale of Figure 3.16 makes it difficult to discern changes, the 2008 data showed that some Croton reservoirs had large increases compared to their long-term medians. These include: Amawalk at 182%, Boyd Corners at 231%, Muscoot at 34%, and Titicus at 47%. For all Croton reservoirs, the highest coliform counts occurred during summer months and were very often associated with rainfall. Decreases were also apparent, most notably at Diverting and Cross River. Their median total coliform counts were down 39% and 20%, respectively. Reasons for the decrease are not clear, but may be related to the 2008 dam construction, which resulted in very low water levels and consequently fewer samples being collected. The remaining Croton reservoirs were very close to their long-term annual medians. In 2008, insufficient data exist from Croton Falls to accurately estimate the median.

Results for the controlled lakes—Gilead, Gleneida and Kirk—are provided in Table 3.4 below. The higher total coliforms observed at Kirk as compared to the other two lakes were probably due to sediment resuspension events common in shallow water bodies like Kirk, where mean depth is 2 meters.

Table 3.4: Coliform summary statistics for NYC controlled lakes (CFU $100mL^{-1}$).

Lake	Median Total Coliform (1998–2007)	Median Total Coliform (2008)	Median Fecal Coliform (1998–2007)	Median Fecal Coliform (2008)
Gilead	25	25	<1	<1
Gleneida	10	10	<1	<1
Kirk	86	40	<1	<1

In 2008, the Catskill reservoirs continued to have annual median total coliform levels that were above their long-term medians. Extensive periods of elevated coliform counts occurred in all Catskill basins during the 2005–2007 period and elevated coliform levels were usually observed during summer and fall. Research has shown that total coliforms commonly adhere to soil particles. Some of the bacteria have previously been determined to be of terrestrial origin. The Catskill System is underlain with glacial lacustrine clays that are easily mobilized during large storm events. Coliforms were probably transported to the reservoirs during runoff events by adsorption to the easily erodible clay particles common in the Catskill watersheds.

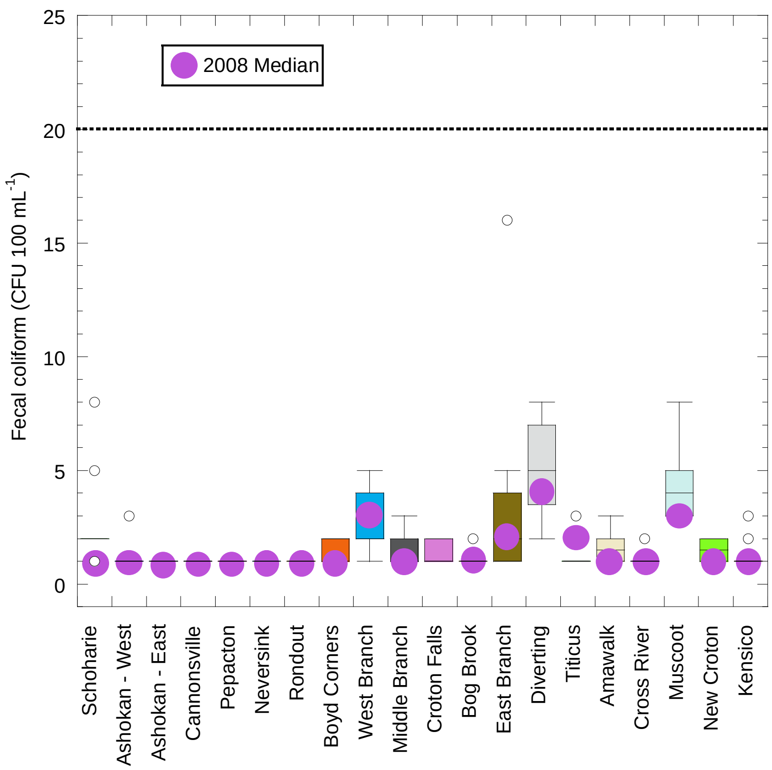

Figure 3.17 Annual median fecal coliform in NYC water supply reservoirs (2008 vs. 1998–2007). The dashed line represents the SDWA standard for source waters.

Note: In general, data were obtained from multiple sites and depths, and at routine sampling frequencies (1 or 2x per month), from April through December. Medians were not calculated in 2008 for Croton Falls Reservoir due to insufficient data.

In contrast, all the Delaware reservoirs had medians near their long-term levels. Because stream banks and beds are much less susceptible to erosion in the Delaware watersheds, an equal volume of runoff there tends to produce much lower total coliform counts than in the Catskill System.

Figure 3.17 compares the long-term (1998–2007) annual fecal coliform medians with the current (2008) annual median. Not enough data were collected in 2008 to estimate an accurate median for Croton Falls Reservoir. Fecal counts in the Croton reservoirs and controlled lakes were at or below the long-term median, and all were well below 20 CFU 100mL^{-1} (the SWTR limit for source waters). Reasons for the low counts are not clear although there was a scarcity of runoff events from September through November.

Fecal counts in the Catskill and Delaware Systems (including Kensico and West Branch) were very close to or lower than their historical long-term levels in 2008. West Branch did experience a brief spike in December coinciding with drawdown and elevated bird counts.

3.11 Which basins were coliform-restricted in 2008?

Coliform bacteria are used by water suppliers as indicators of pathogen contamination. To protect its water supply, New York City has promulgated regulations (the “Watershed Rules & Regulations”) that restrict potential sources of coliforms in threatened water bodies. These regulations require the City to perform an annual review of its reservoir basins to decide which, if any, should be given “coliform-restricted” determinations.

Coliform-restricted determinations are governed by two sections of the regulations, Section 18-48(a)(1) and Section 18-48(b)(1). Section 18-48(a)(1) applies to all reservoirs and Lakes Gilead and Gleneida ("non-terminal basins") and specifies that coliform-restricted assessments of these basins be based on compliance with NYS ambient water quality standard limits on *total* coliform bacteria (6 NYCRR Parts 701 and 703). Section 18-48(b)(1) applies to "terminal basins," those that serve, or potentially serve, as source water reservoirs (Kensico, West Branch, New Croton, Ashokan, and Rondout). The coliform-restricted assessments of these basins is based on compliance with federally-imposed limits on *fecal* coliforms collected from waters within 500 feet of the reservoir's aqueduct effluent chamber.

Terminal basin assessments. In 2008, assessments were made for all five terminal basins, and none received a restricted assessment (Table 3.5). Currently, coliform-restriction assessments are made using data from a minimum of five samples each week over two consecutive six-month periods. The threshold for fecal coliform is 20 CFU $100mL^{-1}$. If 10% or more of the effluent samples measured have values ≥ 20 CFU $100mL^{-1}$, and the source of the coliforms is determined to be anthropogenic (man-made), the associated basin is deemed a coliform-restricted basin. If fewer than 10% of the effluent keypoint samples measure ≥ 20 CFU $100mL^{-1}$, the associated basin is deemed "non-restricted".

Table 3.5: Coliform-restricted basin status as per Section 18-48 (b) (1) for terminal reservoirs in 2008.

Reservoir Basin	Effluent Keypoint	2008 Assessment
Kensico	CATLEFF and DEL18	Non-restricted
New Croton	CROGH	Non-restricted*
Ashokan	EARCM	Non-restricted
Rondout	RDRRCM	Non-restricted
West Branch	CWB1.5	Non-restricted

* The site CROGH was only sampled from June through October due to shutdown of the Croton Aqueduct. Therefore, site CRO1T (at the intake near the dam—sampled daily) was used for this assessment.

Non-terminal basin assessments. Section 18-48(a)(1) requires that non-terminal basins be assessed according to 6NYCRR Part 703 for total coliform. These New York State regulations are specific to the class of the reservoir. A minimum of five samples must be collected per month on each basin. Both the median value and >20% of the total coliform counts for a given month need to exceed the values ascribed to the reservoir class to exceed the standard. Table 3.6 provides a summary of the coliform-restricted calculation results for the non-terminal reservoirs. A detailed listing of these calculations is provided in Appendix D.

Table 3.6: Coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008). 6NYCRR Part 703 requires a minimum of five samples per month. Both the median value and >20% of the total coliform counts for a given month need to exceed the stated values for a reservoir to exceed the standard.

Reservoir	Class	Standard monthly median/>20% (CFU $100mL^{-1}$)	Number of months that exceeded the standard/ Number of months of data
Amawalk	A	2400/5000	0/8
Bog Brook	AA	50/240	0/8
Boyd Corners	AA	50/240	3/8
Croton Falls	A/AA	50/240	1/4
Cross River	A/AA	50/240	1/8
Diverting	AA	50/240	2/3
East Branch	AA	50/240	1/8
Lake Gilead	A	2400/5000	0/8
Lake Gleneida	AA	50/240	0/8
Kirk Lake	B	2400/5000	0/7
Muscoot	A	2400/5000	0/8
Middle Branch	A	2400/5000	0/8
Titicus	AA	50/240	2/8
Pepacton	A/AA	50/240	0/8
Neversink	A	50/240	0/8
Schoharie	A	50/240	7/8
Cannonsville	A/AA	50/240	1/8

Note: The reservoir class is defined in 6NYCRR Parts 815, 862, 864, and 879. For those reservoirs that have dual designations, the higher standard was applied.

There were nine reservoirs that never exceeded the Part 703 standard for total coliform in 2008. These include Amawalk, Bog Brook, Lake Gilead, Lake Gleneida, Kirk Lake, Middle Branch, Muscoot, Pepacton, and Neversink. Schoharie Reservoir, however, exceeded the standard for seven out of eight months. The remaining reservoirs exceeded the standard for one to three months of the sampling season.

Total coliform originate from a variety of natural and anthropogenic sources. Therefore, it is not possible to utilize total coliform counts alone to perform non-terminal basin assessments. The NYC Watershed Rules and Regulations state that the source of the total coliforms must be proven to be anthropogenic to receive coliform-restricted status. Since other microbial tests for identification of potential sources were not performed on these samples, these results are only presented as an initial assessment of total coliform for the non-terminal basins in 2008.

3.12 How did reservoir water conductivity in 2008 compare to previous years?

Specific conductivity is a measure of the ability of water to conduct an electrical current. It varies as a function of the amount and type of ions that the water contains. The ions which typically contribute most to reservoir conductivity include: calcium (Ca^{+2}), magnesium (Mg^{+2}), sodium (Na^{+1}), potassium (K^{+1}), bicarbonate (HCO_3^{-1}), sulfate (SO_4^{-2}), and chloride (Cl^{-1}). Dissolved forms of iron, manganese, and sulfide may also make significant contributions to the water's conductivity given the right conditions (e.g., anoxia). Background conductivity of water bodies is a function of the watershed's bedrock, surficial deposits, and topography. For example, watersheds underlain with highly soluble limestone deposits will produce waters of high conductivity compared with watersheds comprised of relatively insoluble granite. If the topography of a watershed is steep, deposits tend to be thin and water is able to pass through quickly, thus reducing the ability of the water to dissolve substances. This type of terrain will also produce waters of low conductivity. Such is the case with NYC's water supply reservoirs.

Catskill and Delaware System reservoirs have displayed uniformly low median conductivities in the past as well as in 2008 (Figure 3.18). These reservoirs are situated in mountainous terrain underlain by relatively insoluble deposits, which produce relatively low conductivities in the 25 to 100 $\mu S\ cm^{-1}$ range. Because West Branch and Kensico generally receive most of their water from the Catskill and Delaware reservoirs, the conductivities of West Branch and Kensico are also low, usually in the 50 to 100 $\mu S\ cm^{-1}$ range. Reservoirs of the Croton System have higher baseline conductivities than those of the Catskill and Delaware Systems. In part this is due to the flatter terrain of the Croton watershed, as well as to the occurrence of soluble alkaline deposits (e.g., marble and/or limestone) within the watershed. Urbanization pressure is also higher in the Croton System, which contributes to its higher conductivity. One reason for this is that the higher percentage of paved surfaces within more urbanized areas facilitates transport of runoff to waterways and also yields higher salt concentrations due to roadway de-icing operations.

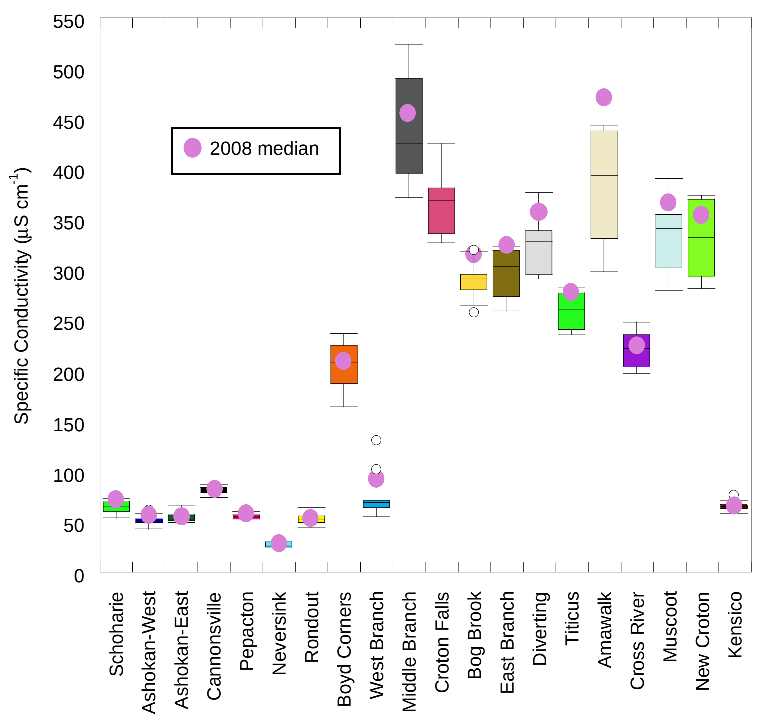

Figure 3.18 Annual median specific conductivity in NYC water supply reservoirs (2008 vs. 1998–2007).

Note: In general, data were obtained from multiple sites and depths, and at routine sampling frequencies (1 or 2x per month), from April through December. Medians were not calculated in 2008 for Croton Falls Reservoir due to insufficient data.

With the exception of West Branch, conductivity in all Catskill and Delaware System reservoirs (including Kensico) were all very close to their historical median levels. Conductivity in West Branch, however, increased 33% compared to its historical median. West Branch is typically a blend of Rondout and the more conductive Boyd Corners Reservoir. However, in 2008, the Delaware Aqueduct was occasionally shut down and West Branch was often in “float” mode. This led to a greater contribution from Boyd Corners, causing an increase in conductivity. Similar situations occurred in 2002 and 2003 as indicated by the two outliers associated with the West Branch boxplot in Figure 3.18.

Conductivity median values in the Croton System were higher for most reservoirs in 2008 as compared to the past 10 years (Figure 3.18). Sufficient data were not available to report on Croton Falls and the controlled lakes. Bog Brook, East Branch, Diverting, Titicus, and Muscoot were close to their long-term maxima, while Amawalk exceeded its previous maximum of 443 µS cm^{-1} by 27 µS cm^{-1}. The increase in conductivity corresponds to an increase in chloride concentrations. Major sources of chloride include salt for de-icing roads, salt from water softener discharge, and even deposition from coastal storms. Additional investigation of weather patterns, de-icing operations, and other factors are necessary before these Croton System conductivity trends can be explained.

3.13 How did water quality in terminal reservoirs compare with regulatory standards in 2008?

The NYC reservoirs and water supply system are subject to the federal SWTR standards, NYS ambient water quality standards, and DEP's own target values. In this section these standards are compared with 2008 sampling data encompassing a variety of physical, biological, and chemical analytes for the terminal reservoirs (reservoirs that serve, or potentially serve, as source waters—Kensico, New Croton, Ashokan, Rondout and West Branch). Note that these standards are not necessarily applicable to the individual samples and medians described herein. Placing the data in the context of these standards assists in understanding the robustness of the water system and water quality issues.

Table 3.7 shows the 2008 median reservoir sampling values along with the standard for each of the physical, chemical, and biological analytes. Appendix A gives additional statistical information for the four reservoirs investigated here and on other reservoirs in the system. During the review of the summary statistics, the full data set was also reviewed to determine the extent to which the standards were exceeded (data not shown).

Table 3.7: Reservoir-wide median values for a variety of physical, biological, and chemical analytes for the five terminal reservoirs in 2008.

ANALYTES	Standards	Kensico	New Croton	Ashokan East Basin	Ashokan West Basin	Rondout	West Branch
PHYSICAL							
Temperature (C)		11.4	10.9	10.5	9.5	10.4	13.8
pH (units)	6.5-8.5[1]	7	7.5	7.1	6.7	7	7.2
Alkalinity (mg/l)		10.6	60	9.9	10.1	6.5	17.9
Conductivity		67	353	56	55	53	95
Hardness (mg/l)[2]		19	88	16	18.1	14	22.1
Color (Pt-Co units)	-15	10	20	9	12	12	15
Turbidity (NTU)	(5)[3]	1.1	2	1.6	3.6	0.9	1.4
Secchi Disk Depth (m)		4.8	2.6	4.2	3.1	5.3	3.6

Table 3.7: (Continued) Reservoir-wide median values for a variety of physical, biological, and chemical analytes for the five terminal reservoirs in 2008.

ANALYTES	Standards	Kensico	New Croton	Ashokan East Basin	Ashokan West Basin	Rondout	West Branch
BIOLOGICAL							
Chlorophyll a (µg/l)	7 [4]	4.3	12	1.9	2.18	2.3	4.45
Total Phytoplankton (SAU)	2000 [4]	260	540	170	180	155	440
CHEMICAL							
Dissolved Organic Carbon (mg/l)		1.5	2.9	1.5	1.3	1.5	2.0
Total Phosphorus (µg/l)	15 [4]	6	14	8	8	7	9
Total Nitrogen (mg/l)		0.29	0.48	0.29	0.30	0.34	0.26
Nitrate+Nitrite-N (mg/l)	10 [1]	0.19	0.21	0.18	0.222	0.26	0.131
Total Ammonia-N (mg/l)	2 [1]	<0.01	0.04	0.02	<0.02	<0.02	<0.010
Iron (mg/l)	0.3 [1]	0.02	0.07	0.03	0.05	0.02	0.06
Manganese (mg/l)	-0.05	na	na	na	na	na	na
Lead (µg/l)	50 [1]	<1	<1	<1	<1	<1	<1
Copper (µg/l)	200 [1]	<3	<3	<3	<3	<3	<3
Calcium (mg/l)		5.4	23	5	5.5	4.1	5.8
Sodium (mg/l)		5.4	33	3.8	3.79	3.6	8.80
Chloride (mg/l)	250 [1]	9	67	6.7	6.6	6.9	19.0

Note: See Appendix A for water quality standards footnotes.

New Croton Reservoir water quality was noticeably different from the other terminal reservoirs. The median pH in New Croton was higher, as is often the case owing to its underlying geology and greater primary production. The latter can at times cause the pH to rise above the water quality standard of 8.5, especially in the upper waters during summer blooms. The median pH readings in WOH reservoirs were circumneutral. As a result of low alkalinity, however, readings can drop below the standard of 6.5, which they occasionally did in 2008. Alkalinity provides a buffer for acidic precipitation. Another factor contributing to lower pH values at depths below the thermocline is the acidifying effect of respiration.

Color readings in New Croton were approximately double that of the other terminal reservoirs and virtually all samples collected in 2008 exceeded the color standard of 15 units. Background color in New Croton is high, due in part to a relatively high percentage of wetlands compared to the WOH watersheds. The highest color readings were observed in bottom samples during summer, when iron and manganese were released from sediments and further discolored the water.

Median turbidity levels in all terminal reservoirs were well below the standard of 5.0 NTU. Relatively few turbidity values surpassed the standard in 2008. In New Croton, turbidity greater than 5 NTU mostly occurred in summer when hypolimnetic waters released metals from the sediments. Turbidity readings in Ashokan surpassed the standard in the spring and during rain events in October. Only one excursion was observed at Kensico in 2008 and it was associated with a minor October turbidity event originating in Ashokan. Rondout had no samples above 5.0 NTU.

The Croton System typically has greater nutrient inputs than the WOH reservoirs, which results in higher phytoplankton counts and chlorophyll *a* levels. Although the median phytoplankton count did not exceed the WQ guidance value in 2008, New Croton Reservoir had several events in the spring and summer where samples exceeded a total phytoplankton count above the 2000 SAU standard. Chlorophyll *a* for New Croton was usually above 7 µg L^{-1} all year, although it was a relatively low productivity year as reflected in the trophic status plot (Figure 3.15). Rondout and Ashokan Reservoirs did not exceed 5.2 µg L^{-1} of chlorophyll *a* while Kensico exceeded 7 µg L^{-1} in April and just surpassed this criterion in October and November. These three reservoirs did not exceed 2000 SAU for phytoplankton in 2008. West Branch Reservoir infrequently exceeded 2000 SAU, primarily in the Site 4 basin which is influenced more from local streams rather than from Rondout.

Median total phosphorus was lower than the water quality guidance value of 15 µg L^{-1} for each source water reservoir in 2008. There were no observations that surpassed this value in Rondout for 2008. Kensico exceeded the standard in 4 samples that were mostly associated with one local runoff event in late November. The East Basin of Ashokan exceeded the guidance value in 3 bottom samples, probably the result of anoxic sediments during late summer. None of the samples in the West Basin exceeded the TP guidance value. West Branch Reservoir infrequently exceeded the guidance criteria, again, primarily in the Site 4 basin. Nitrate was uniformly low in all reservoirs with no samples approaching the standard of 10 mg L^{-1}. Ammonia was very low for WOH terminal reservoirs and no excursions above the standard were evident. Although concentrations did not exceed the 2 mg L^{-1} health standard at New Croton, there were occasions when ammonia exceeded 1 mg L^{-1} in anoxic bottom samples.

No excursions for lead or copper were observed at any of the terminal reservoirs in 2008. Most samples were below the instrument detection limit.

Chloride levels in New Croton were approximately 10 times those observed in the WOH reservoirs. However, the highest, 69 mg L^{-1}, was still much lower than the standard of 250 mg L^{-1}. mocline is the acidifying effect of respiration.

3.14 Has DEP monitoring of watershed streams revealed any changes to the macroinvertebrate community?

DEP has been performing water quality assessments of watershed streams based on resident benthic macroinvertebrate assemblages since 1994, using protocols developed by the DEC's Stream Biomonitoring Unit (DEC 2002). Streams are sampled in areas of riffle habitat, using the traveling kick method; collected organisms are preserved in the field and later identified, and a series of metrics generated from the tallies of macroinvertebrates found to be present. The metric scores are converted to a common scale and averaged, to produce a single water quality assessment score of 0-10 for each site, corresponding to non (7.5-10), slightly (5-7.5), moderately (2.5-5), or severely (0-2.5) impaired. A change (or lack of change) to the macroinvertebrate community, as reflected in the water quality assessment score, can provide important information to DEP managers. This is because sites are often selected to evaluate impacts from land use changes or BMPs, or to assess conditions in major reservoir tributaries.

Through the close of the 2008 sampling season, DEP had established 162 sampling sites in streams throughout the water supply watershed, with the greatest number in the Catskill System, followed by Croton and Delaware. Many of these sites have been sampled for only a few years, because sampling began at later dates at some sites than at others, and because only routine sites are sampled annually. To investigate changes to the macroinvertebrate community, only sites with a 5-year-or-better record that were sampled in 2008 were examined, to reduce the chances that short-term variation, or aberrant samples, might cloud the analysis. (For sites with a five-year-or-better record not sampled in 2008, see DEP 2007a.) Twenty-seven (27) sites met the 5-year criterion, 11 in the Croton System, 9 in Catskill, and 7 in Delaware (Fig. 3.19). Of these, all but three were routine sites (generally, major tributaries to receiving reservoirs).

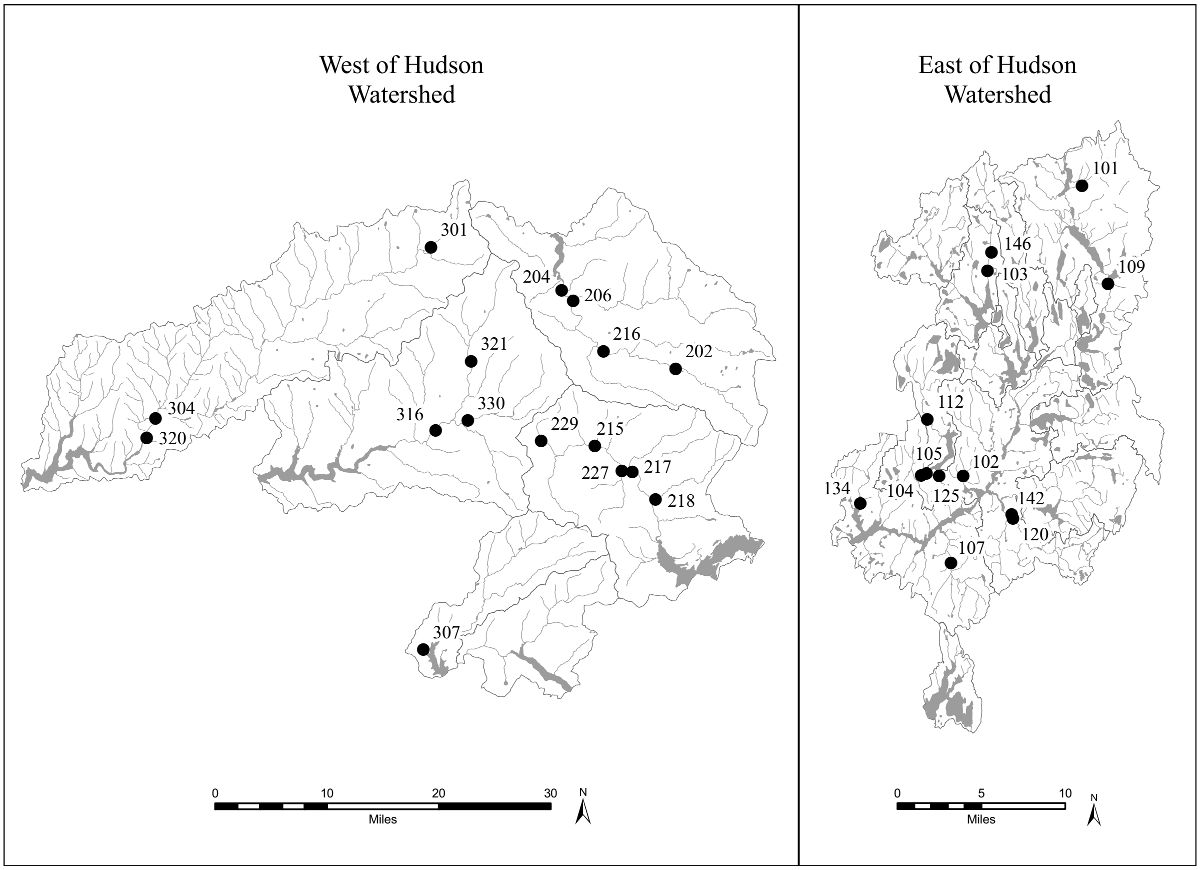

Figure 3.19 Stream biomonitoring sites with a 5-year-or-better record.

The data are plotted in Figures 3.20 and 3.21 for the East of Hudson and West of Hudson watersheds, respectively. With the exception of sites on Hallocks Mill Brook, located above and below the recently-upgraded Yorktown Heights wastewater treatment plant (see Section 3.15 for details), long-term changes to the macroinvertebrate community were not observed. At Site 109 on the East Branch of the Croton River, the upward trend in scores characterized by two non-impaired assessments in the previous three years (2005 and 2007) did not continue. The 2008 score, however, while resulting in a slightly impaired assessment, was nevertheless the third highest score ever recorded at the site. The return of the tolerant caddisfly *Cheumatopsyche* sp. to the high levels observed from 1995-2004 was largely responsible for the lower score and assessment in 2008. The reason for these fluctuations in *Cheumatopsyche* numbers is not known.

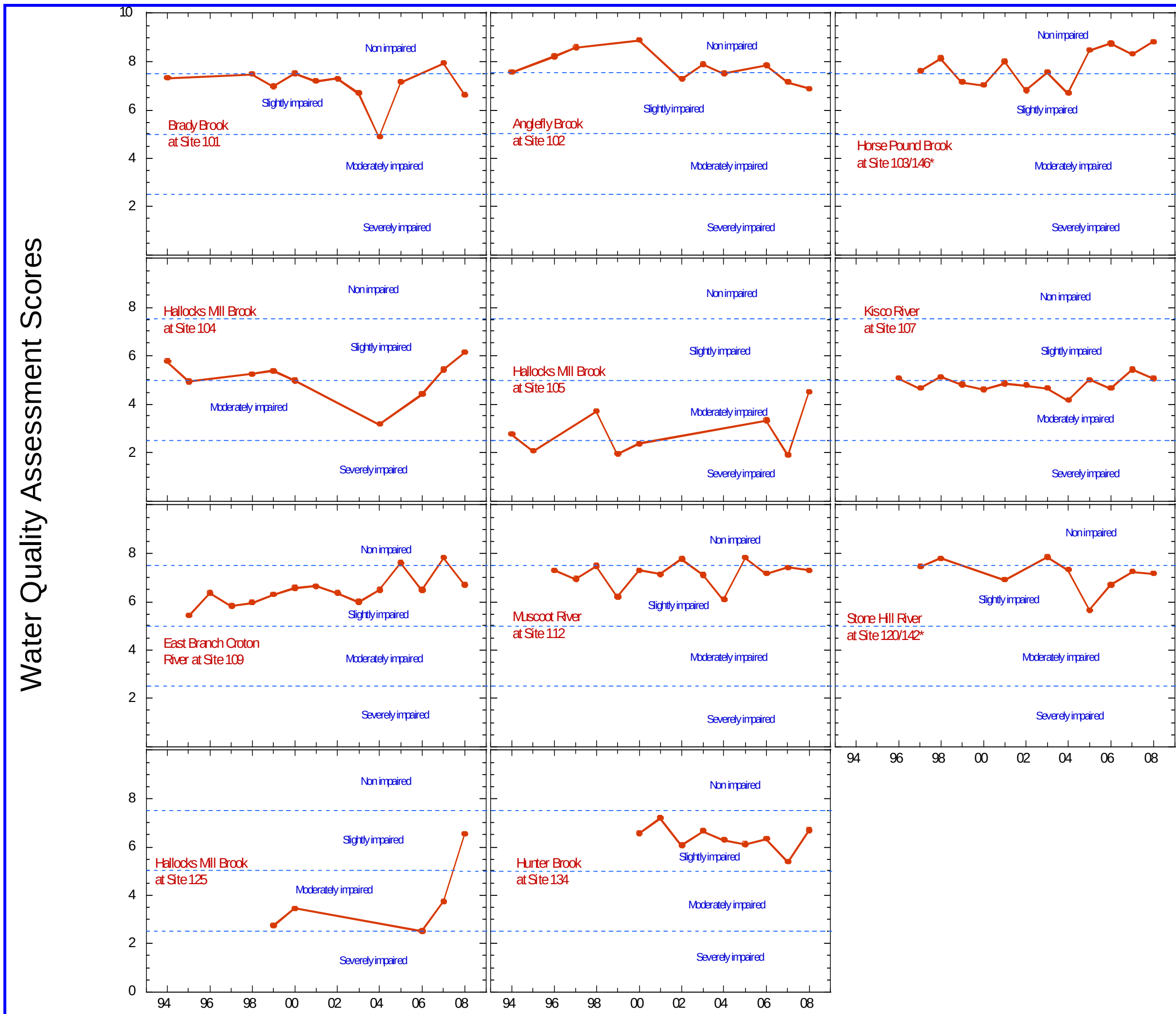

Figure 3.20 Water Quality Assessment Scores based on stream biomonitoring data for East of Hudson streams with a 5-year-or-better record.

*The Horse Pound Brook site was moved from Site 103 to Site 146 in 2004. The Stone Hill River site was moved from Site 120 to Site 142 in 2003. In both cases, data for the combined sites are plotted as a single graph.

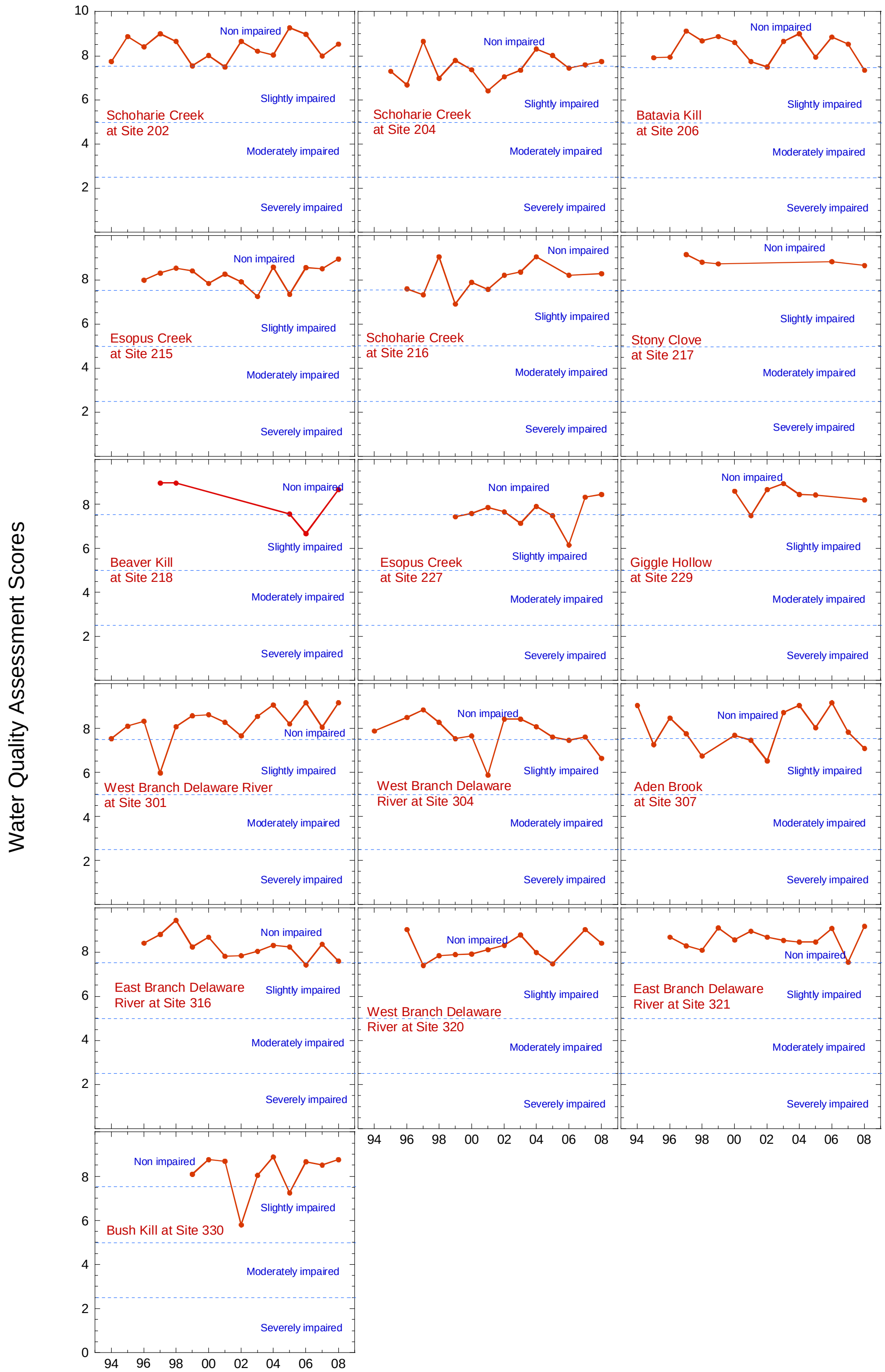

Figure 3.21 Water Quality Assessment Scores based on stream biomonitoring data for West of Hudson streams with a 5-year-or-better record.

At the Beaver Kill (a tributary to Esopus Creek in the Ashokan Reservoir watershed), the sharp decline in scores observed in recent years was reversed in 2008, after the mayfly *Acentrella turbida* returned to historical levels of abundance (43% of the total assemblage in 2006, 5.5% in 2008). The increase in *Acentrella* in 2006 depressed the taxa richness metric that year and probably the mayfly/stonefly/caddisfly richness metric as well. Spikes in *Acentrella* have occurred in Catskill streams before, often (but not always) during periods of high flows. Following such events, numbers of this mayfly usually retreat to previous levels, as they did in 2008, with concomitant increases in the two richness metrics.

3.15 What can sampling a stream's macroinvertebrate community tell us about the effectiveness of wastewater treatment plant upgrades?

Stream water quality plays a large role in the composition of benthic macroinvertebrate communities: unpolluted streams generally harbor more sensitive organisms and a more diverse assemblage than streams whose water quality is poor. Since upgrades to wastewater treatment plants often result in improved water quality to the receiving stream, the effectiveness of these enhancements can often be measured by sampling the stream's macroinvertebrate community and noting any changes that might indicate improved community composition. Chief among these would be an increase in the water quality assessment score, derived from applying protocols used by the NYS Stream Biomonitoring Unit (DEC 2002). Other critical measures include an increase in the number of sensitive organisms, like mayflies, caddisflies, and stoneflies, and in the number of total taxa.

In 2008, DEP gathered data providing strong evidence that wastewater treatment plant improvements at the Yorktown Heights wastewater treatment plant in Westchester County, NY, resulted in an improved biotic community in the receiving stream, Hallocks Mill Brook. For many years, the plant's discharge was characterized by high levels of ammonia, a substance which has been shown to cause mortality in a wide range of benthic invertebrates. From 1994-2007, for example, the annual concentration of ammonia, based on DEP's monitoring of the plant's discharge, averaged 21.7 mg L^{-1}. Although the average recorded in Hallocks Mill Brook at DEP's downstream monitoring site during the same period was lower (4.4 mg L^{-1}), it was still far higher than the NYS ambient water quality standard, which ranges from 0.007-0.050 mg L^{-1}, depending on pH and temperature. Concentrations of ammonia in the stream have generally been highest in summer/fall and lowest in winter, with a maximum during the 13-year period of 23.7 mg L^{-1} in October 1998 and a minimum of 0.09 mg L^{-1} in December 1996.

DEP began sampling Hallocks Mill Brook in 1994 to assess the impacts to the macroinvertebrate community of discharges from the treatment plant. Initially (1994, 1995, 1998), sampling was conducted at the DEP water quality monitoring sites above and below the plant (HMILL7 and HMILL4, respectively; biomonitoring Sites 104 and 105). In 1999 and 2000, three sites downstream of Site 105 were added (Sites 125, 126, and 127) in order to complete a longitudinal transect of the stream (Fig. 3.22). In the last three years (2006-2008), samples have been collected at Sites 104, 105, and 125.

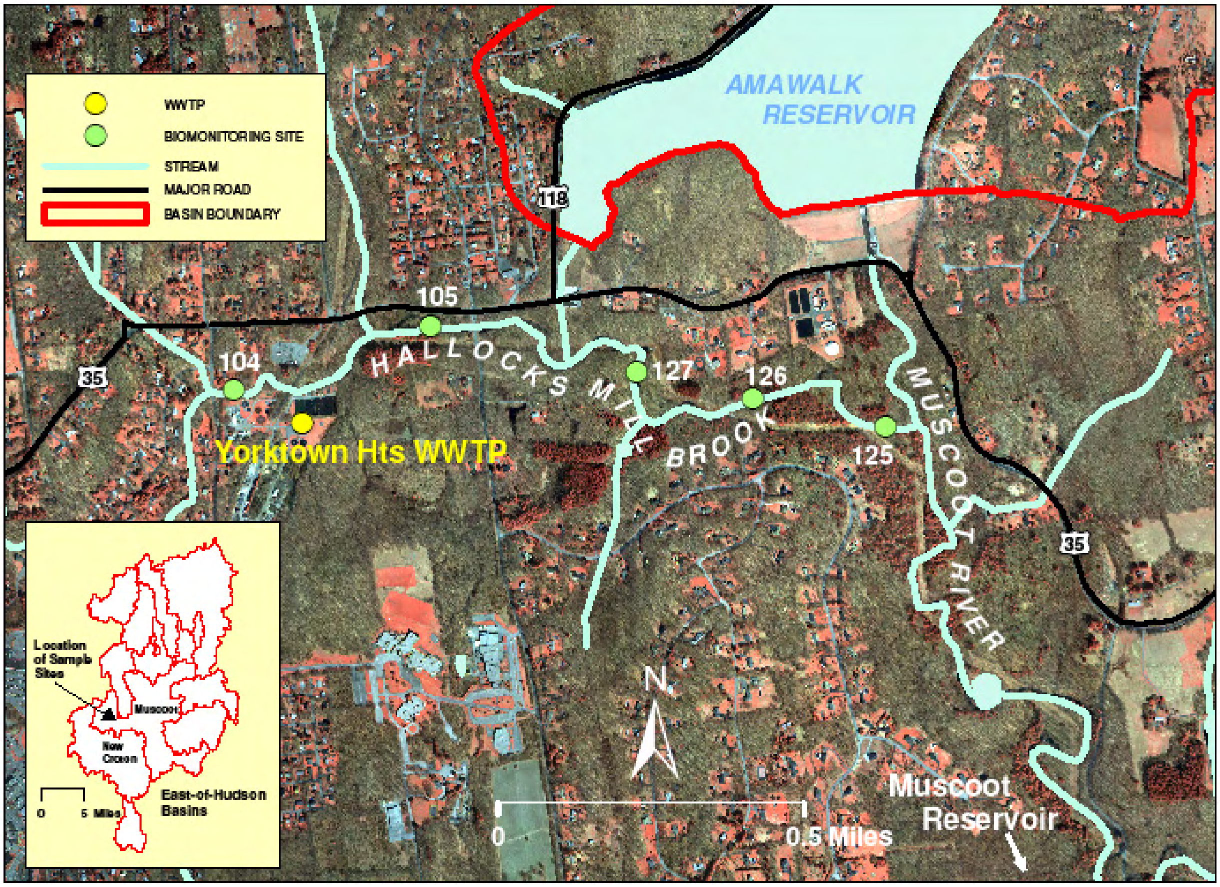

Figure 3.22 Location of Yorktown Heights wastewater treatment plant and biomonitoring sampling sites on Hallocks Mill Brook.

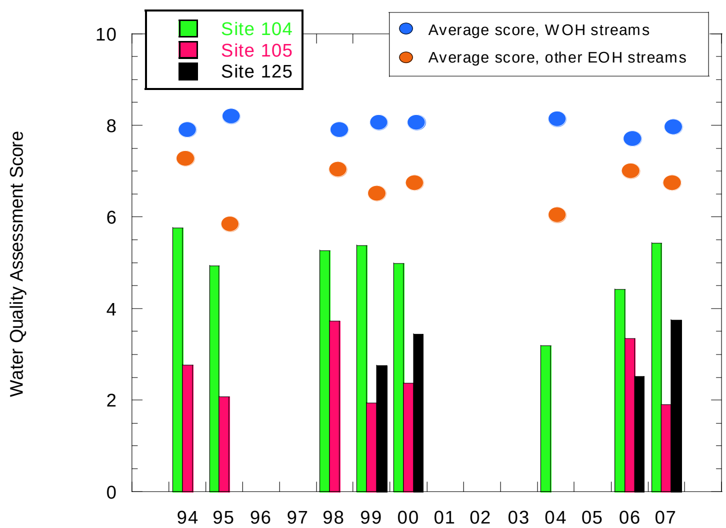

Figure 3.23 Water quality assessment scores at Hallocks Mill Brook biomonitoring sites 104, 105, and 125 compared to average scores for other NYC water supply watershed streams, 1994-2007.

Taken together, the biological assessments at the various sites on Hallocks Mill Brook indicate that, through 2007, it was the most seriously impacted stream in the entire New York City water supply watershed, with scores well below the average for other streams both East and West of Hudson (Fig. 3.23). During this period, no site below the treatment plant ever assessed higher than moderately impaired (the second worst category of impairment), while in the seven years it was sampled, the site directly below the plant (Site 105) assessed as seriously impaired (the worst rating) four times. The benthic community consisted almost entirely of midges and worms, two of the most tolerant macroinvertebrate groups. Only two mayfly individuals were ever collected, one from Site 105 in 1994 and one from Site 126 in 1999. The only other sensitive organism recorded, a glossossomatid caddisfly, was found at Site 105 in 1998.

In September 2007, new equipment was installed to reduce the levels of ammonia in the plant's discharge. The result was dramatic. Between October 1 and November 1, 2007, effluent concentrations dropped from 17 mg L^{-1} to 5.6 mg L^{-1}, eventually reaching 1 mg L^{-1} by April 1 of the following year. In Hallocks Mill Brook, ammonia levels at the biomonitoring site below the treatment plant's outflow (Site 105) showed similar declines—from 8.65 mg L^{-1} in October 2007 to 0.165 mg L^{-1} the following month. By August of the following year, ammonia levels were down to 0.112 mg L^{-1}. At the farthest site downstream (Site 125), data are available for only one pre- and post-reduction month, but the results are similar: 4.056 mg L^{-1} in August 2007 versus 0.012 mg L^{-1} in August 2008.

Figure 3.24 An ephemerellid mayfly, collected from Hallocks Mill Brook in May 2009.

The impact of these changes on the benthic macroinvertebrate community is clearly demonstrated by the biomonitoring samples collected in August 2008, particularly at the site farthest downstream, Site 125. The water quality assessment score at that location rose from 3.74 the previous year to 6.52, placing it in the slightly impaired category (the second highest) for the first time (Fig. 3.20). All four metrics used to calculate the score also improved substantially (Fig. 3.25). Perhaps most remarkable, almost 10% of the sample consisted of ephemerellid mayflies (Fig. 3.24). These organisms, uncommon in any East of Hudson stream, are extremely sensitive to pollution, with a tolerance value of 1 on a scale of 0-10, 0 being the most sensitive. Another 20% of the sample consisted of baetid mayflies. Baetids are more tolerant than ephemerellids, but are nevertheless sensitive organisms. Together, mayflies made up about one-third of the sample, even though none had ever been recorded at the site before (Fig. 3.25). Mayflies, along with caddisflies and stoneflies, are generally considered the best macroinvertebrate indicators of clean water.

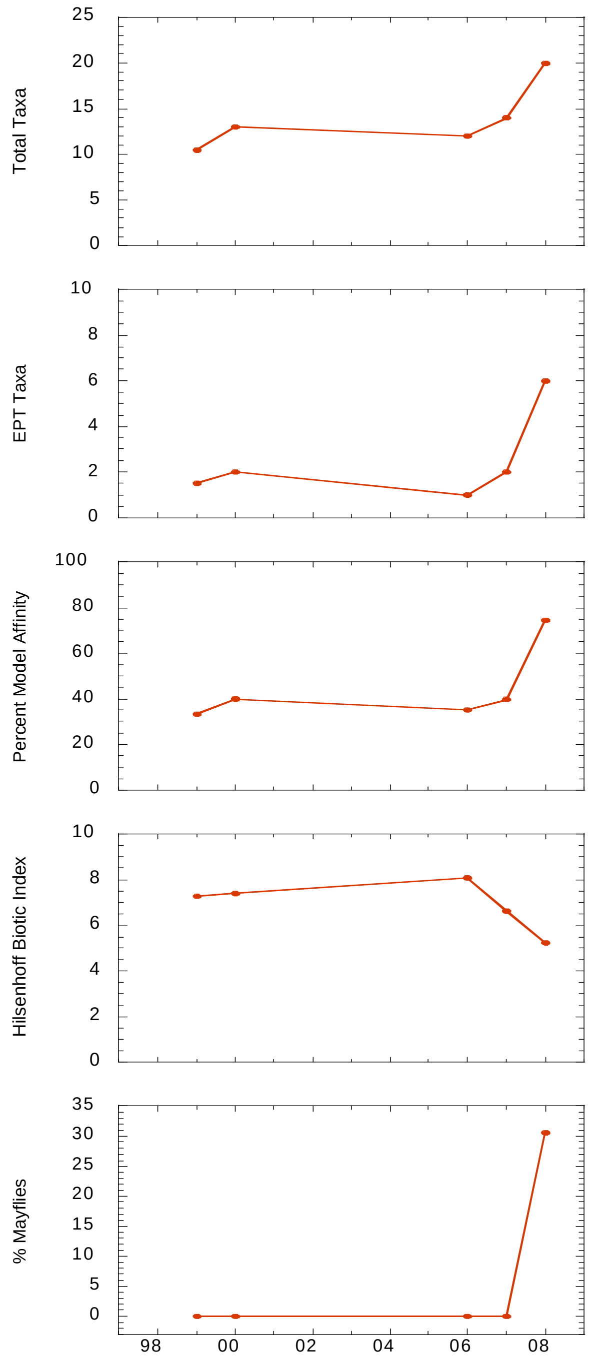

Figure 3.25 Metric scores and percent mayflies recorded at Site 125 on Hallocks Mill Brook, 1998-2008. Total taxa is the total number of taxa present; EPT taxa is the total number of mayflies, stoneflies, and caddisflies; Percent Model Affinity is a measure of the community's similarity to a model non-impacted community as defined by the NYS Stream Biomonitoring Unit; the Hilsenhoff Biotic Index is a measure of organic pollution, with low values indicative of clean water conditions.

DEP went back to the site in May 2009 to determine if these organisms were actually living in Hallocks Mill Brook or had accidentally been washed upstream from the nearby Muscoot River, to which Hallocks Mill is a tributary. Ten late instar ephemerellids were found, indicating they had been living, and growing, in the stream since the previous August, when only early instars had been collected. The continuous presence of these larvae over a period of nine months is strong evidence of the improvement to water quality that has occurred in the stream as a result of modifications to the wastewater treatment plant.

Site 105, the site closest to the plant's discharge, assessed as moderately impaired in 2008 but nevertheless had a record high score of 4.38. No sensitive organisms, however, were found. DEP will return to this site and to Site 125 in 2009 to see if the improved community at the latter site persists and to determine whether sensitive insects like mayflies colonize farther upstream in the wake of the stream's improved water quality.

3.16 What are disinfection by-products, and did organic concentrations in source waters allow DEP to meet compliance standards in the distribution system in 2008?

Disinfection by-products (DBPs) form when naturally occurring acids from decomposing vegetative matter (such as tree leaves, algae, and macrophytes) reacts with chlorine during chlorination of drinking water. The quantity of DBPs in drinking water varies from day to day depending on the temperature, the quantity of organic material in the water, the quantity of chlorine added, and a variety of other factors. Drinking water is disinfected by public water suppliers to kill bacteria and viruses that could cause disease. Chlorine is the most commonly used disinfectant in New York State. For this reason, disinfection of drinking water by chlorination is beneficial to public health.

DEP monitors two important groups of DBPs: trihalomethanes (TTHM) and haloacetic acids (HAA). TTHM are a group of chemicals that includes chloroform, bromoform, bromodichloromethane, and chlorodibromomethane, of which chloroform is the main constituent. HAA are a group of chemicals that includes mono-, di- and trichloroacetic acids and mono- and dibromoacetic acids. USEPA has set limits on these groups of DBPs under the Stage 1 Disinfectant/Disinfection By-Products Rule. The Maximum Contaminant Level (MCL) for TTHM is 80 $\mu g\ L^{-1}$ and the MCL for the five haloacetic acids covered the rule (HAA5) is 60 $\mu g\ L^{-1}$. According to the Stage 1 Rule, monitoring is required to be conducted quarterly from designated sites in the distribution system which represent the service areas and not necessarily the source water for each system. The MCL is calculated as a running annual average based on quarterly samplings over a 12-month period. The 2008 annual running quarterly averages are presented in Table 3.8 and show system compliance for TTHM and HAA5 in both the Catskill/Delaware and Croton Distribution Areas of New York City.

Table 3.8: Results for the Stage 1 annual running quarterly average calculation of distribution system DBP concentrations (µg L^{-1}) for 2008.

	Catskill/Delaware		Croton	
2008 Quarter	TTHM	HAA5	TTHM	HAA5
1st	37	38	46	41
2nd	39	38	49	42
3rd	38	37	46	40
4th	37	38	49	45
MCL	80	60	80	60

4. Pathogens

4.1 How many samples did DEP collect for *Cryptosporidium*, *Giardia* and human enteric viruses in 2008, and what were the occurrences and concentrations in the "source waters"?

DEP conducts compliance and surveillance monitoring for protozoan pathogens and human enteric viruses (HEV) throughout the 1,972-square-mile NYC watershed. DEP staff collected and analyzed a total of 781 routine samples for protozoan analysis during 2008, which does not include 78 additional samples related to special projects. DEP collected 317 HEV samples in 2008. Source water samples (Kensico and New Croton keypoints) comprised the greatest portion of the 2008 sampling effort, accounting for 31.5% of the samples, followed by stream samples, which were 27.4% of the sample load. Upstate reservoir effluents, wastewater treatment plants (WWTPs), storm events, and Hillview Reservoir sampling made up the remaining 41.1% of samples (Figure 4.1).

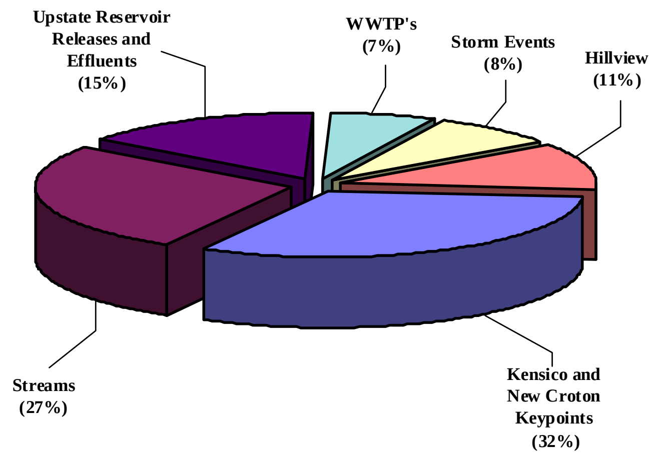

Figure 4.1 DEP sample type distribution for 2008 (includes routine and enhanced monitoring samples).

Under routine reservoir operation, the two influents and the two effluents of Kensico Reservoir and the one effluent of New Croton Reservoir are considered the source water sampling sites for the NYC water supply. Filtration avoidance compliance requires weekly sampling at these five sites for *Cryptosporidium*, *Giardia*, and HEVs. The effluent results are posted weekly on DEP's website (DEP 2006c), monthly in the Croton Consent Decree and USEPA reports, and semi-annually in the Filtration Avoidance Determination reports (DEP 2006d,e).

Catskill Aqueduct

The *Cryptosporidium* oocyst concentration and detection frequency at CATALUM (Catskill influent to Kensico Reservoir) were low, with a mean of 0.13 oocysts $50L^{-1}$ and 7 positive detections out of 52 samples (13.5%) (Table 4.1). The *Cryptosporidium* results at CATLEFF (Catskill effluent of Kensico Reservoir) were also very low, although slightly greater than at CATALUM, with a mean of 0.23 oocysts $50L^{-1}$ and 10 positive detections out of 52 samples (19.2%).

The *Giardia* cyst concentration at CATALUM had a mean of 0.71 cysts $50L^{-1}$ with 20 positive detections out of the 52 samples (38.5%) (Table 4.1). Mean *Giardia* concentrations at CATLEFF were higher than those at CATALUM, with a mean of 2.01 cysts $50L^{-1}$ and 46 positive detections (88.5%).

Table 4.1: Summary of *Giardia*, *Cryptosporidium*, and HEV compliance monitoring data at the five DEP keypoints for 2008 (includes enhanced monitoring samples).

	Keypoint Location	# of samples	# of positive samples	Mean***	Max
Cryptosporidium oocysts $50L^{-1}$	Catskill Influent	52	7	0.13	1.00
	Catskill Effluent	52	10	0.23	2.00
	Delaware Influent*	52	6	0.15	1.98
	Delaware Effluent	52	1	0.02	1.00
	New Croton Effluent**	56	8	0.21	3.00
Giardia cysts $50L^{-1}$	Catskill Influent	52	20	0.71	5.00
	Catskill Effluent	52	46	2.01	7.00
	Delaware Influent *	52	26	1.02	5.00
	Delaware Effluent	52	39	1.69	8.00
	New Croton Effluent **	56	26	0.73	4.00
Human Enteric Viruses $100L^{-1}$	Catskill Influent	52	11	0.42	7.06
	Catskill Effluent	52	3	0.19	5.75
	Delaware Influent*	52	14	0.50	5.76
	Delaware Effluent	52	7	0.16	2.13
	New Croton Effluent **	52	6	0.21	4.46

*Includes alternate sites sampled to best represent DEL17 during "off-line" status.
**Includes alternate sites sampled to best represent CROGH during "off-line" status.
***Zero value is substituted for non-detect values when calculating mean.

Concentration and detection frequency of HEVs at CATALUM were low in 2008 with a mean concentration of 0.42 MPN $100L^{-1}$ and 11 positive detections out of 52 samples (21.2%) (Table 4.1). Similar to previous years, HEV results were somewhat lower at CATLEFF than at CATALUM during 2008, with 0.19 MPN $100L^{-1}$ and 3 positive detections (5.8%) continuing to suggest that the reservoir acts as a sink for viruses.

Delaware Aqueduct

The *Cryptosporidium* oocyst concentration and detection frequency at DEL17 (Delaware influent to Kensico Reservoir) were low, with a mean of 0.15 oocysts $50L^{-1}$ and 6 positive detections out of 52 samples (11.5%) (Table 4.1). *Cryptosporidium* concentrations at DEL18

(Delaware effluent of Kensico Reservoir) were very low, with a mean of 0.02 oocysts $50L^{-1}$ and only 1 positive detection out of 52 samples (1.9%). The mean concentration and detection frequency at DEL18 remain unchanged from 2007 levels.

The *Giardia* cyst concentration at DEL17 had a mean of 1.02 cysts $50L^{-1}$ with 26 positive detections out of the 52 samples (50.0%) (Table 4.1). Mean *Giardia* concentration and detection frequency at DEL18 were higher than those at DEL17, with a mean concentration of 1.69 cysts $50L^{-1}$ and 39 positive detections out of 52 samples (75.0%).

HEV concentration and detection frequency at DEL17 were 0.50 MPN $100L^{-1}$ and 14 positive detections out of 52 samples (26.9%) (Table 4.1). Much like the Catskill Aqueduct and similar to results from previous years, HEV results were somewhat lower at DEL18 than at DEL17 during 2008, with a mean concentration of 0.16 MPN $100L^{-1}$ and 7 positive detections out of 52 samples (13.5%).

New Croton Aqueduct

Protozoan sample results at CROGH (New Croton Reservoir effluent) for 2008 had a mean *Cryptosporidium* concentration of 0.21 oocysts $50L^{-1}$ and 8 positive detections out of 56 samples (14.3%) (Table 4.1). CROGH had a mean *Giardia* concentration of 0.73 cysts 50L and 26 positive detections out of 52 samples (50.0%).

Results for HEV sampling at CROGH were low, with a mean of 0.20 MPN $100L^{-1}$ and 6 positive detections out of 52 samples (11.5%).

As in prior years, a seasonal variation could be detected for *Giardia* at all influent and effluent sites in 2008, with winter and spring having higher concentrations and more frequent occurrences than summer and fall (Figure 4.2). Some seasonality can be seen for *Cryptosporidium* at Kensico Reservoir's Delaware influent and Catskill effluent, as well as at the New Croton Reservoir effluent. In general, *Giardia* occurrences were much more frequent and at higher concentrations than *Cryptosporidium* at the source water sites.

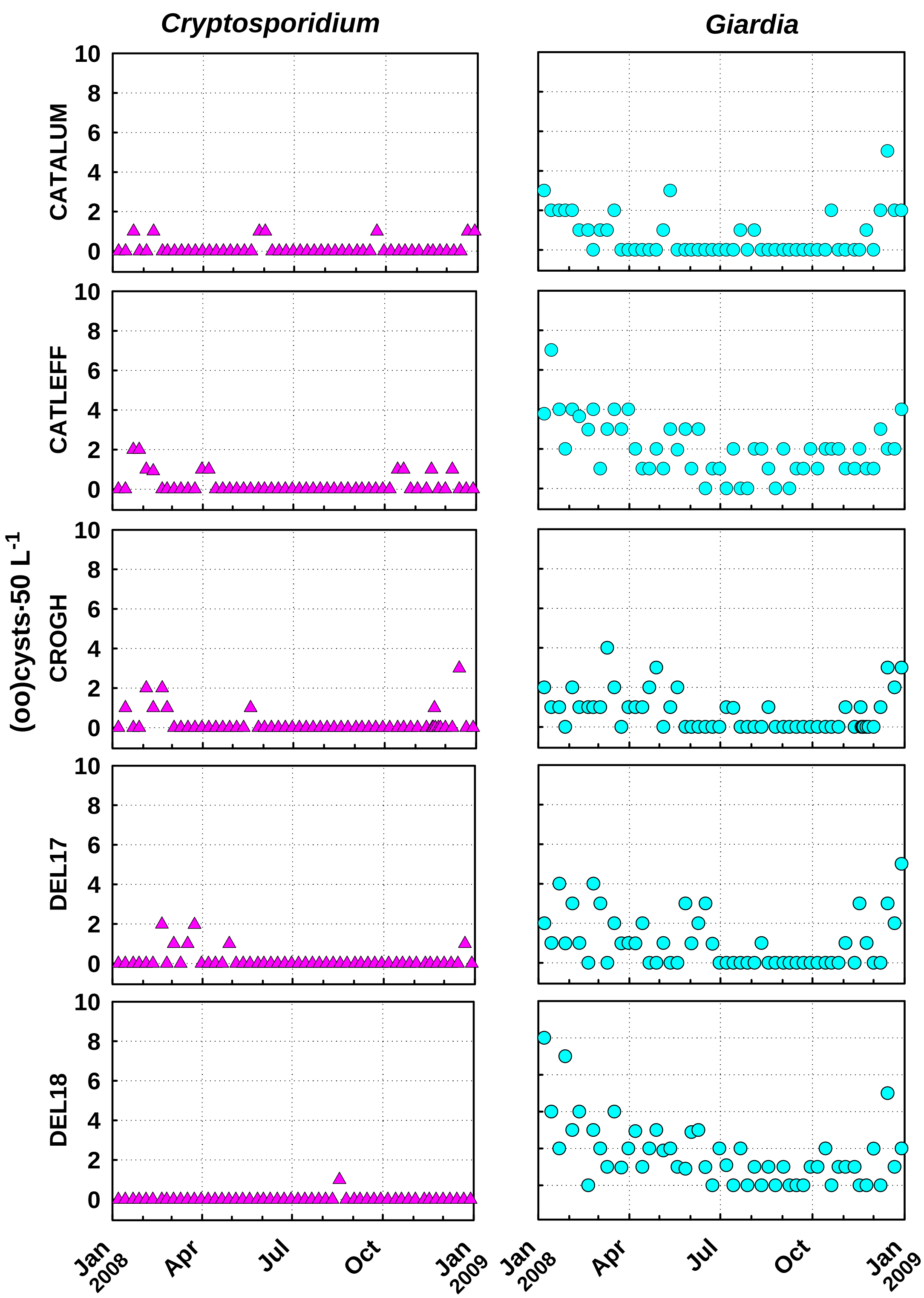

Figure 4.2 Routine weekly source water keypoint monitoring results for 2008.

4.2 How did protozoan concentrations compare with regulatory levels in 2008?

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (USEPA 2006) requires that utilities conduct monthly source water monitoring for *Cryptosporidium* over a two-year period, though a more frequent sampling schedule may be used. The LT2 requires all unfiltered public water supplies to "provide at least 2-log (i.e., 99 percent) inactivation of *Cryptosporidium*." If the average source water concentration exceeds 0.01 oocysts per liter based on the LT2 monitoring, "the unfiltered system must provide at least 3-log (i.e., 99.9 percent) inactivation of *Cryptosporidium*." The average concentration is determined by calculating the mean monthly results for two years, and then calculating the mean of those monthly means. For perspective, results have been calculated here using data from the most recent two-year period (January 1, 2007 to December 31, 2008), including all routine and non-routine samples (Table 4.2).

Table 4.2: Number and type of samples used to calculate the average *Cryptosporidium* concentration under the LT2ESWTR from January 1, 2007 to December 31, 2008.

Aqueduct	# of routine samples	# of non-routine samples	Total N
Croton	105	4	109
Catskill	105	4	109
Delaware	105	2	107

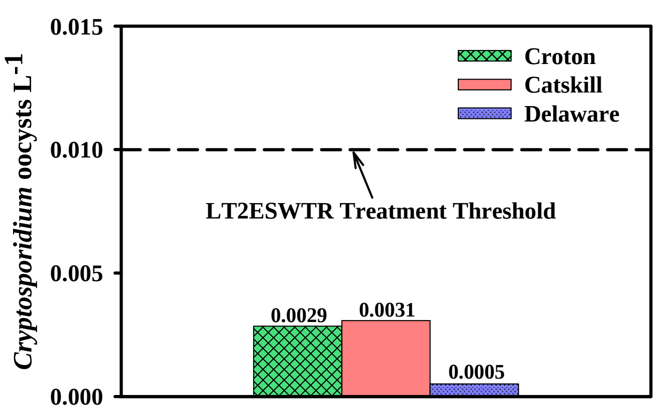

Figure 4.3 The 2007–2008 LT2ESWTR calculated means for *Cryptosporidium* at DEP's three source waters—Croton, Catskill, and Delaware.

The average number of *Cryptosporidium* oocysts at each of the three source waters was below the LT2ESWTR threshold level of 0.01 oocysts per liter, achieving the 99% (2-log reduction) classification level. Unfiltered systems that do not meet this requirement are required to provide at least 3-log inactivation of *Cryptosporidium*. The averages, as shown in Figure 4.3, are as follows: 0.0029 oocysts L^{-1} at the Croton effluent, 0.0031 oocysts L^{-1} at the Catskill effluent, and 0.0005 oocysts L^{-1} at the Delaware effluent.

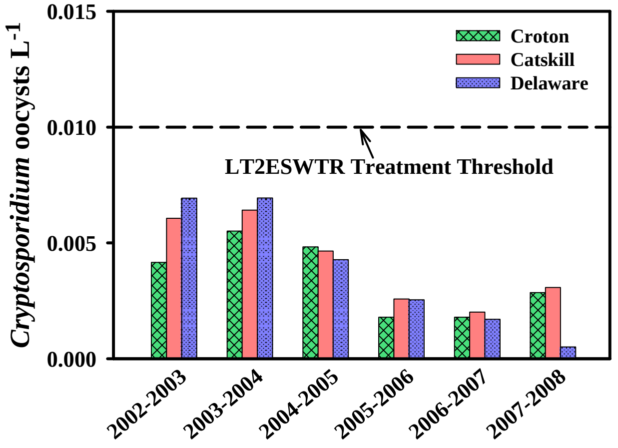

Figure 4.4 The 2002–2008 LT2ESWTR calculated means for *Cryptosporidium* since the start of Method 1623 at DEP's three source waters—Croton, Catskill, and Delaware.

Compared to the previous two-year period (2006–2007), the 2007–2008 Croton and Catskill means were greater, although still lower than the first three two-year calculation periods using Method 1623 (Figure 4.4). Conversely, the Delaware Aqueduct LT2ESWTR means have been decreasing steadily since the 2002–2003 period. The current Delaware LT2ESWTR mean is about 30% of the previous period's mean value.

In addition to calculating the LT2ESWTR means in a given two-year period, a more in-depth investigation of the possibility of operational changes explaining a greater or lesser mean was performed for the Delaware System. For the current two-year period, there were two significant shutdown periods (2/19/2008–3/04/2008 and 10/25/2008–11/25/2008), which may have affected the source water going through the Delaware Aqueduct. Upon comparing the *Cryptosporidium* results during the same periods in previous years, there were no differences (all results during these time periods were non-detects), suggesting that the shutdown did not significantly affect *Cryptosporidium* means for the current two-year period. Other possible reasons for the decline in *Cryptosporidium* over the last several years in the Delaware System may include improvements in upper watershed land use or upgrades of WWTPs, suggesting a positive effect of the Watershed Management Plan. As for the slight increase of *Cryptosporidium* in the Croton and Catskill Aqueducts, no notable operational changes were made that would provide an explanation. The current two-year mean remains well below the means observed from 2002–2005 (Figure 4.4). These slight increases or decreases may ultimately be due to natural variability of oocyst load and weather patterns within the watershed in the studied timeframe.

4.3 How do 2008 source water concentrations compare to historical data?

DEP's source water monitoring is conducted at five sites in the EOH System, four of which represent the Catskill and Delaware influents and effluents of Kensico Reservoir, with New Croton Reservoir's effluent being the fifth site. Water quality can vary at the source water sites depending on several factors in their respective watersheds, such as stormwater runoff, environmental impacts from land use, and the effects of other ecological processes, such as algal blooms. Each source water site has been sampled weekly, using EPA's Method 1623HV since October 2001. This has given DEP a large dataset with several years of samples for the detection of seasonal patterns and long-term changes in protozoan concentrations with respect to public health concerns and risk assessment.

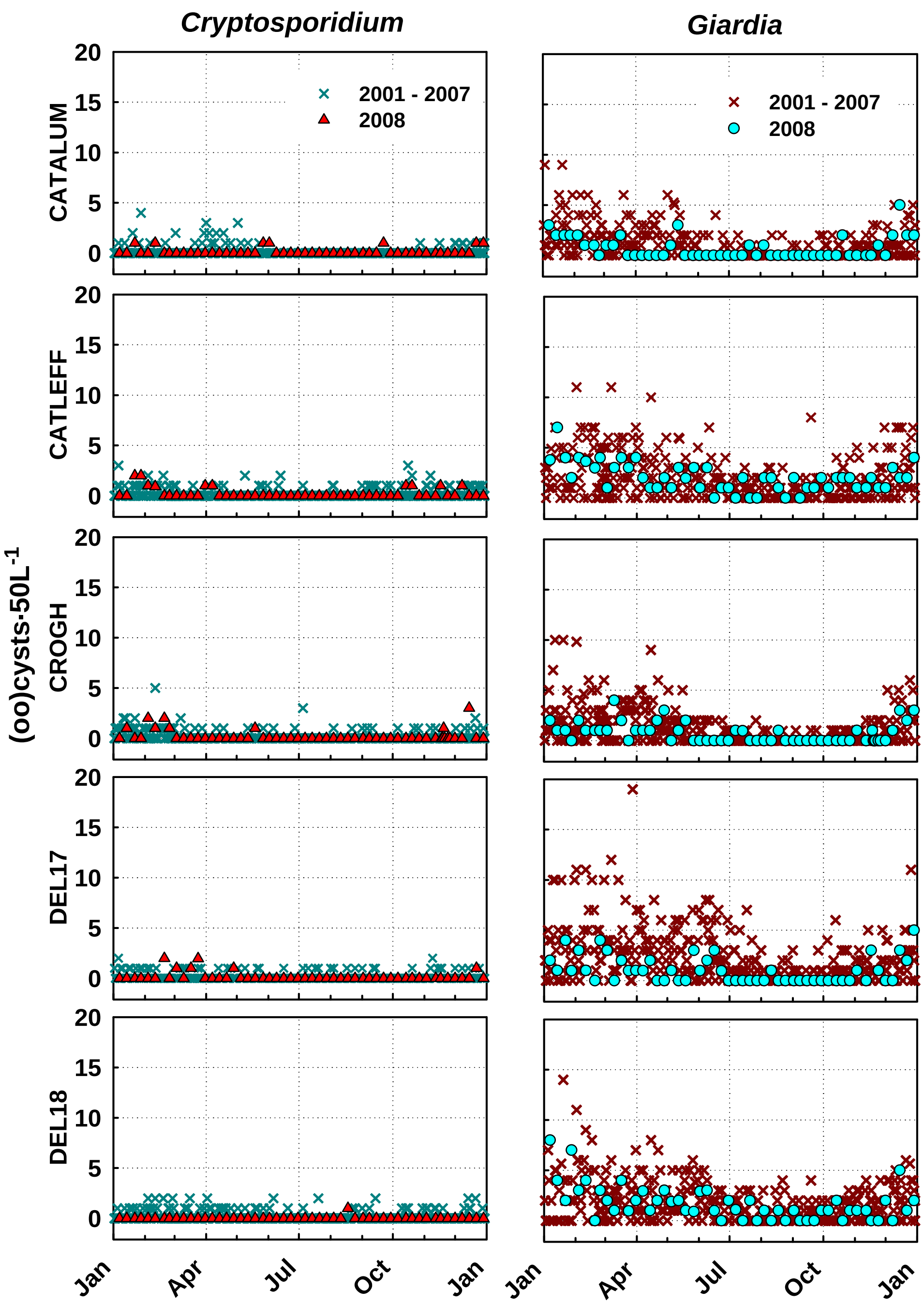

Figure 4.5 Source water keypoint weekly sampling results from October 2001–December 2008. For *Cryptosporidium*, the red triangles represent 2008 and the blue "x"s represent 2001–2007 data (left). For *Giardia*, the blue circles represent the 2008 data, while the red "x"s represent the 2001–2007 data (right).

Pathogen sample data collected in 2008 indicate that concentrations of *Giardia* and *Cryptosporidium* remained relatively low for most of the source water sites. When compared to data collected from 2001 to 2007 at the same sites, the Delaware Aqueduct influent and effluent and the Catskill influent at Kensico Reservoir exhibited lower or similar mean concentrations for both *Giardia* and *Cryptosporidium* in 2008, with a marked drop in the occurrence of *Cryptosporidium* at the Delaware effluent (Figure 4.5). Sampling in 2008 at New Croton Reservoir's effluent showed only slight differences in the occurrence rates and mean concentrations for either protozoan when compared to 1623HV data from all previous years. The Catskill Aqueduct effluent data showed only very slight increases in the mean concentrations for both pathogens compared to the previous years of 1623HV data and only a slight increase in *Giardia* occurrence.

A seasonal pattern is evident for *Giardia* at all source water sites in 2008; however, this seasonal pattern is much less clear, or absent, for *Cryptosporidium*, due to a heavy predominance of non-detects and detects at low concentrations. To more clearly illustrate the presence or absence of this seasonal trend at the different source water sites, a locally weighted scatterplot smooth (LOWESS) curve was plotted through the data points (Figures 4.6 and 4.7). A suggestion of seasonality occurs with *Cryptosporidium* data; however, the events are sporadic and are not statistically significant due to the high number of non-detects. LOWESS curves for *Giardia* sampling show increasing concentrations of cysts generally in the fall and winter months and decreasing concentrations in the spring and summer months. There is some disturbance to this seasonal pattern caused by a change of methods in 2005–2006, during which time a different USEPA-approved stain was used for laboratory analysis.

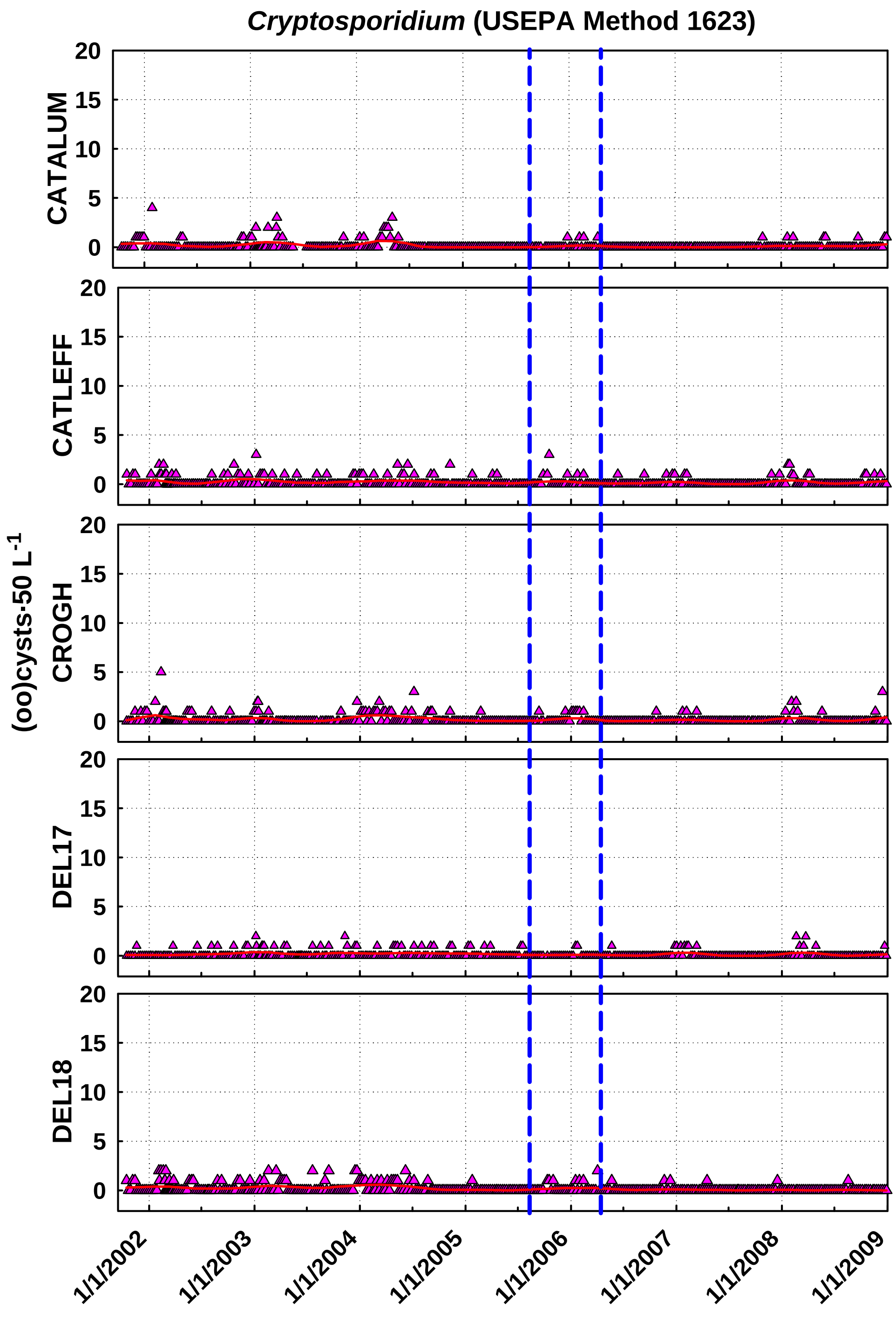

Figure 4.6 Weekly routine source water keypoint results for *Cryptosporidium* (LOWESS smoothed - 0.1) from October 15, 2001 to December 31, 2008. The area between the blue dotted lines indicates the period during which the DEP laboratory temporarily switched to a different USEPA-approved stain (Method Change).

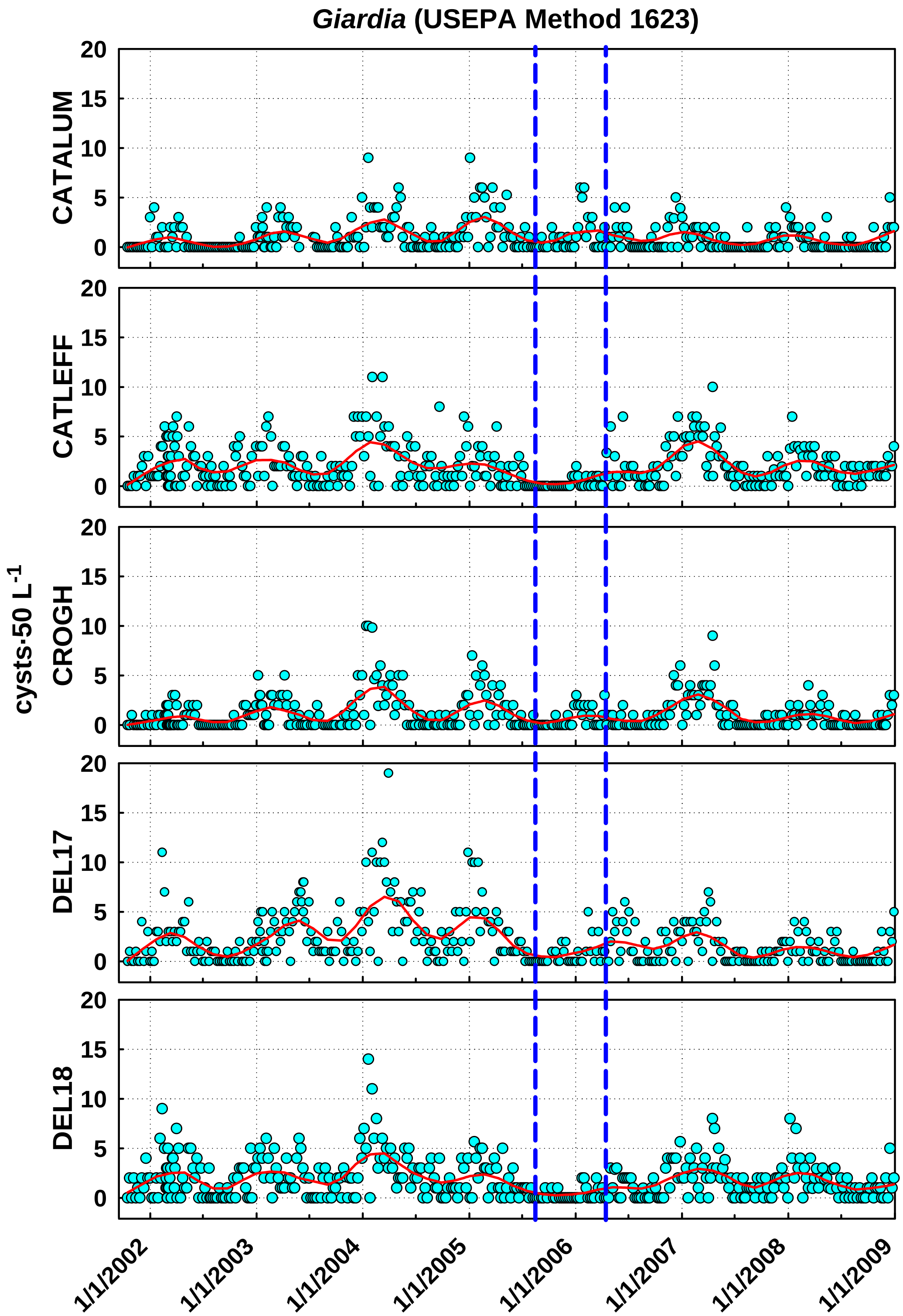

Figure 4.7 Weekly routine source water keypoint results for *Giardia* (LOWESS smoothed - 0.1) from October 15, 2001 to December 31, 2008. The area between the blue dotted lines indicates the period during which the DEP laboratory temporarily switched to a different USEPA- approved stain (Method Change). Note the absence of a seasonal peak during that period.

4.4 What concentrations of *Cryptosporidium* and *Giardia* were found in the various NYC watersheds in 2008?

The NYC Watershed covers 1972 square miles and includes several sub-watersheds, which empty into 19 reservoirs and three controlled lakes. As part of the objectives outlined in the Integrated Monitoring Report (IMR) (DEP 2003a), DEP has monitored the major tributaries and reservoir releases of the various reservoirs to assess and compare the relative pathogen concentrations at each of the watersheds. The various IMR objectives have included both fixed-frequency and event-based pathogen monitoring.

Fixed-frequency Sampling

The monthly fixed-frequency monitoring results indicate very low concentrations of *Cryptosporidium* in the WOH Watershed in 2008 (Figure 4.8). Sites CDG1 and PMSB, which are part of the Cannonsville and Pepacton Reservoir watersheds, respectively, had relatively higher means compared to the other sites, with mean oocyst concentrations of 3.6 and 7.5 $50L^{-1}$, respectively (Figure 4.8). Aside from these two sites, results were similar to 2007 data. The aforementioned sites are among those that have been identified for further monitoring in the new Watershed Water Quality Monitoring Plan (which succeeds the IMR) (DEP 2008a); hence DEP will continue to monitor these sites.

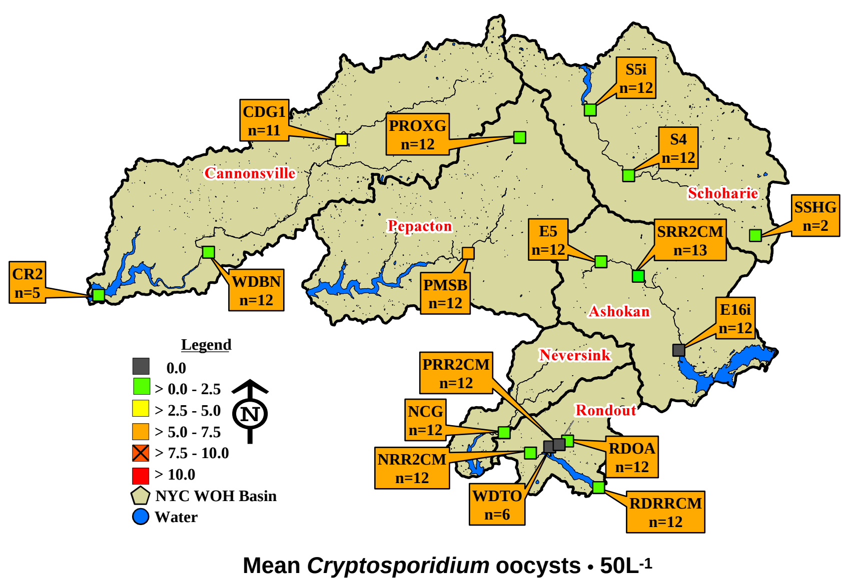

Figure 4.8 Fixed-frequency *Cryptosporidium* monitoring results in the WOH watershed in 2008 (n = sample size).

The 2008 WOH watershed *Giardia* concentrations were consistently higher at WDBN, CDG1, PROXG, and S5i, and resulted in mean values of 70.5, 73.4, 52.0, and 32.0 cysts 50L^{-1}, respectively. These sites are located in the Cannonsville, Pepacton, and Schoharie Reservoir watersheds, respectively, and the results are similar to the 2007 findings. Accordingly, these sites have been identified as locations for future monitoring in the new Watershed Water Quality Monitoring Plan (WWQMP) (DEP 2008a), and will continue to be sampled. The *Giardia* concentrations at the remaining sites range from very low to moderate and are similar to the 2007 results.

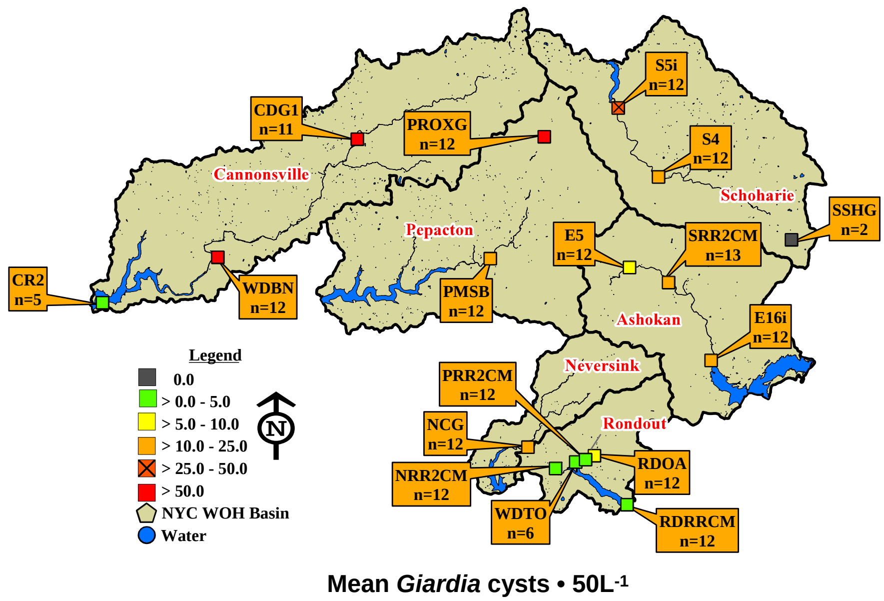

Figure 4.9 Fixed-frequency *Giardia* monitoring results in the WOH watershed in 2008 (n = sample size).

Only 11 of the 12 scheduled monthly samples were obtained at sites CDG1 and CR2/WDTO due to samples freezing while being transported to the laboratory in February. Since the original samples were taken at the end of the month, no resampling was able to be performed before March. In addition to their monthly samples, sites SRR2CM and RDRRCM had one and two enhanced samples, respectively. The SRR2CM resample was in response to the 12/04/08 sample, which had 79 *Giardia*. The resample, performed on 12/30/08, had 58 *Giardia*. Further investigation revealed that operational flow had increased just prior to the time the original sample (79 cysts) was taken, and that surface runoff had been very high around the time of the resample (58 cysts). Results from subsequent sampling returned close to mean levels at this site. It is likely that flow management and precipitation were associated with these elevated results.

Regarding site RDRRCM, in August 2008 the Bureau of Water Supply (BWS) reconfigured the sample collection piping at the Rondout Effluent Chamber keypoint site by extending the piping from the lower valve chamber up to the basement level. This modification was made to address sampler safety concerns. This change did not affect the location of water withdrawal; it only affected the location of the sample collection point. BWS did not consider this a sample site change; however, to confirm that the new piping had no effect on results, a side-by-side comparison was performed at the upper and lower locations. The results of these paired samples are shown in Table 4.3. Sampling officially began at the new tap location in October of 2008. It should be noted that the new sample collection point is only used for pathogen sampling at this time; all other keypoint sampling is being performed at the original location in the lower valve chamber.

Table 4.3: Side-by-side *Cryptosporidium* and *Giardia* results obtained to verify the equivalence of the existing sample site and the proposed sample site at RDRRCM. RDRR = proposed sample site. MS = Matrix Spike Sample.

Date	Site	*Cryptospordium* oocysts $50L^{-1}$	*Giardia* cysts $50L^{-1}$
8/27/08	RDRRCM	0	0
8/27/08	RDRR	0	0
9/29/08	RDRRCM	1	0
9/29/08	RDRR	0	0
9/29/08	RDRR-MS	57%	59%

Sample site SSHG was only sampled twice in 2008. This site was sampled as part of a storm water monitoring project, and these data were part of the baseline sampling component.

Sample sites in the Croton watershed were sampled monthly. Mean *Cryptosporidium* concentrations were found to be very low, except for the Willow Farm (WF) site , which is located in the East Branch watershed (Figure 4.10). This site had a moderate mean *Cryptosporidium* concentration of 8 oocysts $50L^{-1}$. Two especially high sample results were obtained on 6/10/08 and 11/21/08 (29 and 54 oocysts $50L^{-1}$, respectively). The WF site is sampled pursuant to the Croton Consent Decree and will continue to be monitored in the future.

Mean *Giardia* concentrations were found to be very low to low, except for sites HH7 and EBCR3, which had mean *Giardia* concentrations of 40.5 and 31.3 cysts $50L^{-1}$, respectively (Figure 4.11). These are both located in the East Branch watershed. One especially high *Giardia* result (exceeding the 95th percentile) was obtained at both HH7 and EBCR3 in 2008 (188 and 193 cysts $50L^{-1}$, respectively).

Enhanced sampling occurred at HH7, WF, and CROFALLSR this year. The extra sample at HH7 was a resample following the 188 *Giardia* cysts found on 8/12/08. The resample was collected on 8/29/08 and yielded 20 cysts. Site WF was resampled twice in 2008. The first was on 6/17/08, following 29 *Cryptosporidium* oocysts discovered on 6/10/08. Protozoan results for this resample were 8 oocysts and 31 cysts. The second WF resample in 2008 was on 12/3/08 after 54 oocysts and 28 cysts were recovered on 11/21/08. Results of this resample were 4 oocysts and 21 cysts. Contrary to HH7and WF, enhanced sampling at CROFALLSR this year was not a result of following up on elevated counts of cysts or oocysts. Seven enhanced samples were taken from CROFALLSR as a result of an operational change which resulted in the utilization of the release hydraulic pump at CROFALLSR. The enhanced sampling results were all very low: only one *Cryptosporidium* oocyst was found on 11/03/08 and one *Giardia* cyst on 10/27/08 and 12/08/08.

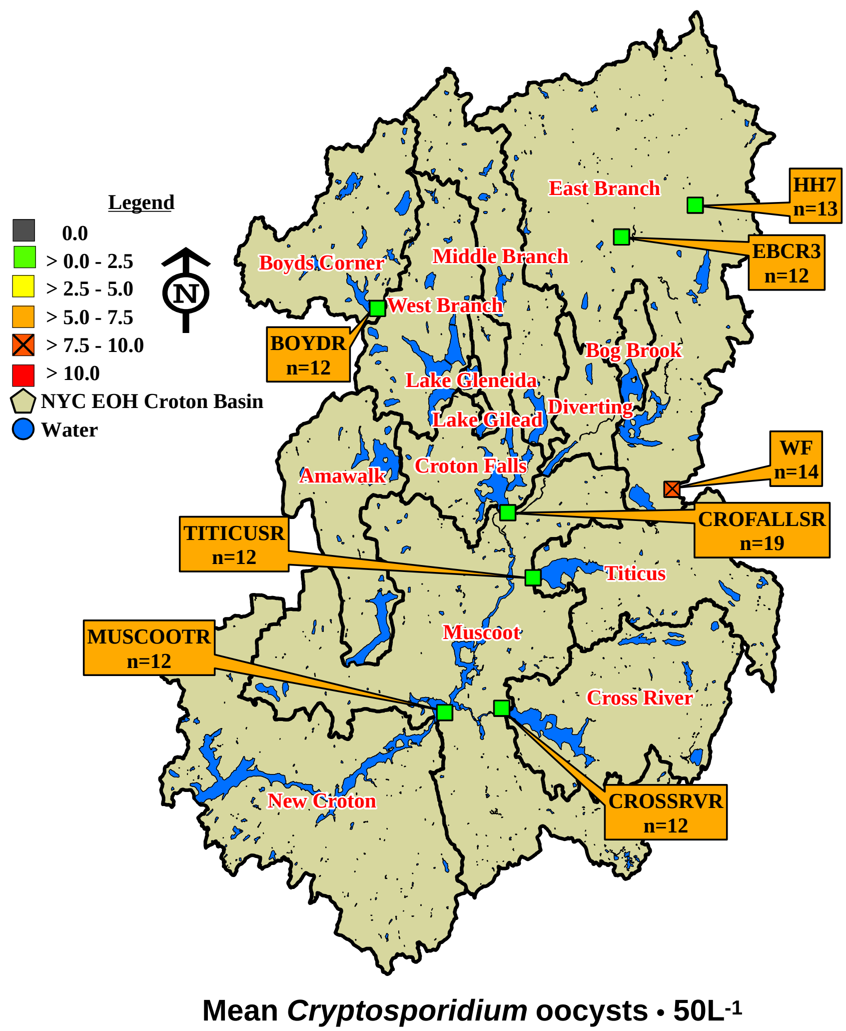

Figure 4.10 Fixed-frequency *Cryptosporidium* monitoring results in the Croton watershed in 2008 (n = sample size).

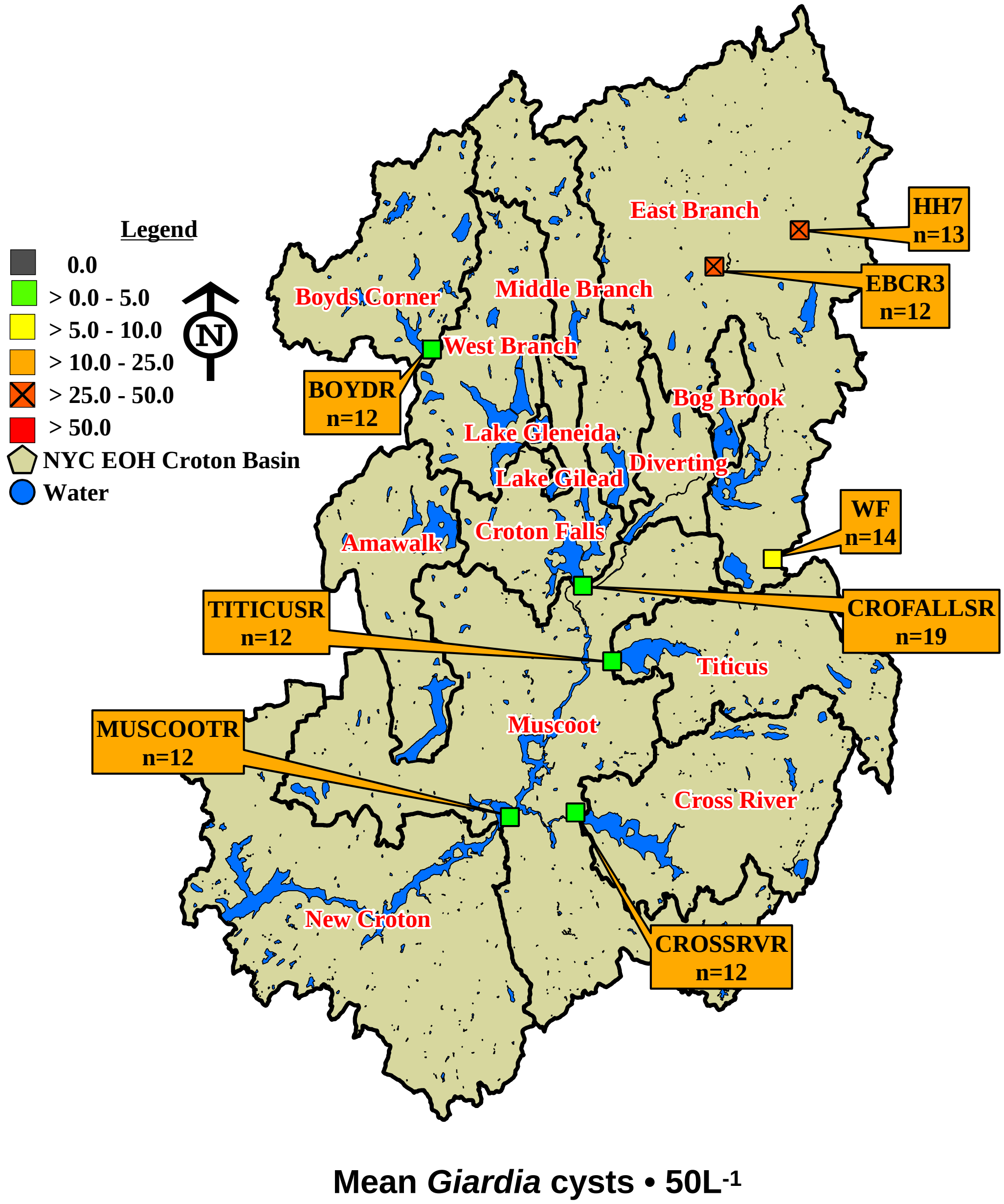

Figure 4.11 Fixed-frequency *Giardia* monitoring results in the Croton watershed in 2008 (n = sample size).

The Kensico watershed stream sites are sampled bi-monthly, except for site MB-1, which is sampled monthly due to its proximity to the Catskill Aqueduct. Mean *Cryptosporidium* concentrations were found to be very low at all sites. These results are similar to those obtained in 2007 (Figure 4.12).

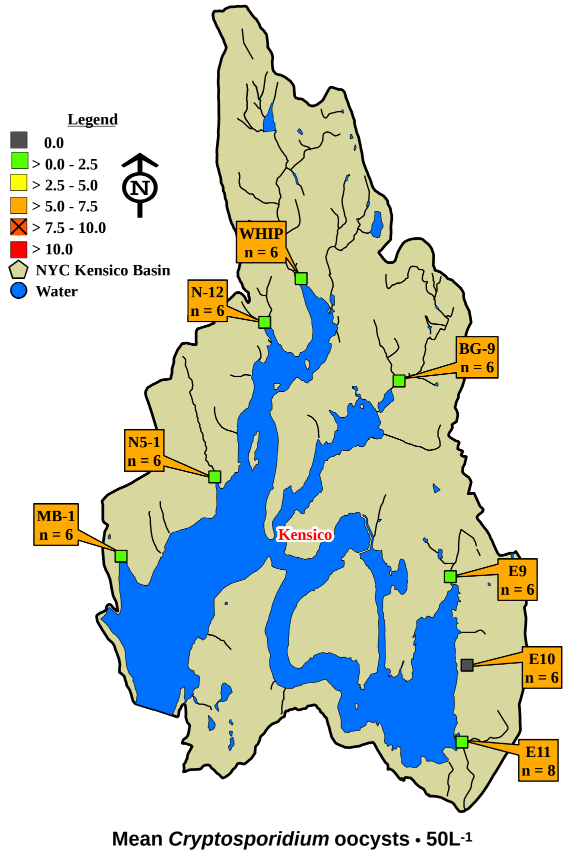

Figure 4.12 Fixed-frequency *Cryptosporidium* monitoring results in the Kensico watershed in 2008 (n = sample size).

Mean *Giardia* concentrations were found to be very low to moderate, except for site E11, which had a mean *Giardia* concentration of 112.2 cysts $50L^{-1}$(Figure 4.13). While the 2008 mean was much higher, E11 also had the highest mean *Giardia* concentration in 2007. For the other sites, the 2008 mean *Giardia* concentrations were similar to, or lower than, the 2007 results.

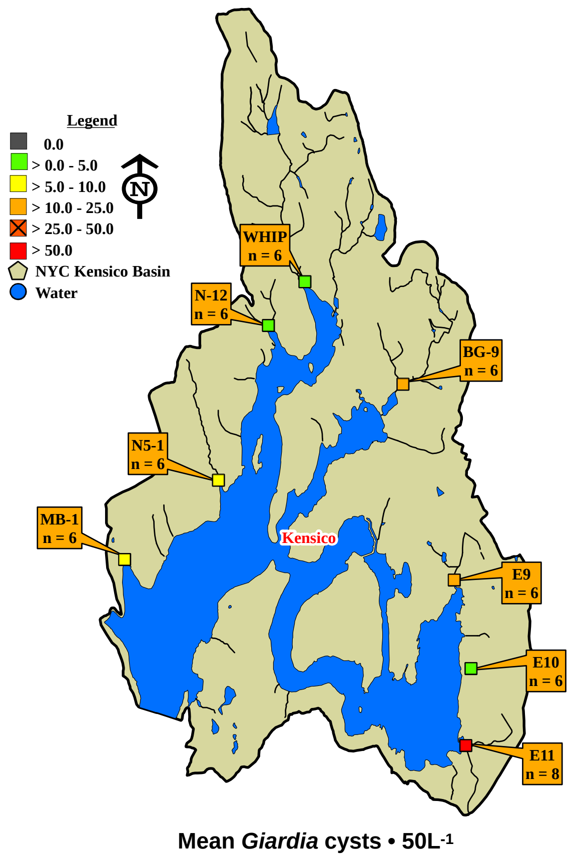

Figure 4.13 Fixed-frequency *Giardia* monitoring results in the Kensico watershed in 2008 (n = sample size).

The high mean at site E11 can be attributed to one extremely high count of 590 cysts $50L^{-1}$ found in a sample taken on 6/03/08. The E11 sample site is a BMP effluent located in the southeast portion of the Kensico watershed between I-684 and Westchester County Airport. Enhanced samples were subsequently obtained at the BMP influent and effluent sites (E11, E11 N1, and E11 S1) as well as from the sediment of the BMP inlet and main basin (Table 4.4). The enhanced sample results were low at all locations, and did not suggest any chronic environmental contamination.

Table 4.4: Enhanced monitoring results at E11 in response to an elevated result.

Sample Date	Site	Sample Volume (L)	*Cryptosporidium* (# oocysts)	*Giardia* (# cysts)
11-Jun-08	E11	50	0	26
	E11N1	50	1	4
	E11S1	50	0	3
26-Jun-08	E11*	n/a	0	0

Table 4.4: (Continued) Enhanced monitoring results at E11 in response to an elevated result.

Sample Date	Site	Sample Volume (L)	*Cryptosporidium* (# oocysts)	*Giardia* (# cysts)
	E11 MAIN*	n/a	0	0
	E11N INLET*	n/a	0	0
	E11	30	1	0
	E11N1	50	0	7
	E11S1	50	0	6

* Sediment samples.

According to the WWQMP, all Kensico streams will be sampled monthly (rather than bi-monthly) to be consistent with sampling at MB-1, which is already sampled monthly. These results will be included in future reports.

Event-based sampling

As per the 2003 IMR objective outlining event-based monitoring strategies for reservoirs, DEP performed storm event sampling at three WOH sites (SSHG, S4, and S5i) and 5 EOH sites (E10, MB-1, N5-1, N5-1 Main, and N5-1 Trib) in 2008. The WOH sites are located along Schoharie Creek, which empties into Schoharie Reservoir, and the EOH sites are located on tributaries to Kensico Reservoir. The EOH sites represent two pre-BMP stream sites (N5-1 Main and N5-1 Trib) and two post-BMP stream sites (N5-1 and MB-1), in addition to a site on an unmodified stream system (E10).

In general, *Cryptosporidium* concentrations were very low to low, except at N5-1 (Table 4.5). This mean concentration is much higher than the fixed-frequency sampling results and is consistent with previous results**,** which found that event-based monitoring pathogen concentrations were consistently higher than baseline results.

Mean *Giardia* concentrations were low to moderate except for N5-1, which was high (Table 4.5). N5-1 is the BMP outlet, which is fed by N5-1 Main and N5-1 Trib. Previous results suggest that the current in-line BMP design does not always attenuate protozoan pathogen concentrations and this N5-1 result is consistent with this finding.

As suggested in previous findings, event-based (oo)cyst concentrations at the WOH sites along Schoharie Creek, which begin at the headwaters (SSHG), showed notably higher mean concentrations at the mid-tributary site, S4 (Table 4.5); however, this result is based on a sample size of only 2. Previous sampling results indicate that (oo)cyst concentrations tend to increase with increased distance downstream.

Table 4.5: Event-based *Cryptosporidium* and *Giardia* monitoring mean results per 50L.

Watershed	Site	N	*Cryptosporidium* oocysts $50L^{-1}$	*Giardia* cysts $50L^{-1}$
Kensico (EOH)	E10	13	0.7	10.8
Kensico (EOH)	MB-1	11	0.8	17.2
Kensico (EOH)	N5-1	12	11.7	37.8
Kensico (EOH)	N5-1MAIN	13	0.0	12.5
Kensico (EOH)	N5-1TRIB	11	4.8	18.5
Schoharie (WOH)	S5I	2	0.0	2.8
Schoharie (WOH)	S4	2	2.0	20.4
Schoharie (WOH)	SSHG	2	0.0	0.0

4.5 What levels of protozoa and HEVs were found in WWTP effluents?

DEP began monitoring pathogens and HEVs at 10 WOH WWTPs in July 2002 as part of the IMR. Since then sampling at each plant's final effluent has been conducted a minimum of four times annually. As in 2007, the WWTPs sampled in 2008 were Hunter Highlands, Delhi, Pine Hill, Hobart, Margaretville, Grahamsville, Grand Gorge, Tannersville, Stamford, and Walton (Figure 4.14). In addition, the East of Hudson Brewster Sewage Treatment Plan (BSTP) was sampled monthly for *Cryptosporidium* and *Giardia* and bimonthly for HEVs to satisfy the requirements of the Croton Consent Decree (CCD).

West of Hudson

A total of 42 *Cryptosporidium* and *Giardia* samples were taken at the 10 WOH WWTP sites. Of these, 40 were routine samples and two were enhanced follow-up samples based on routine sample results. Of the 42 samples taken, none (0.0%) were positive for *Cryptosporidium* and 11 (26.2%) were positive for *Giardia*. A total of two enhanced samples were taken, one at Hunter Highlands on 2/25/08 and one at Walton on 12/22/08. Over the years of sampling WWTPs, there has been evidence that positive results at some of the sites could be attributed to wildlife at uncovered chlorine contact tanks or grates. Consequently, sites of this design with a history of positive detects do not automatically warrant a resample for concentrations that are within the low to mid range of historical data. For example, Grahamsville has been documented as having issues with *Cryptosporidium* or *Giardia* detection. It is hypothesized that the source is from an open chlorine contact tank prior to the sample point, which is susceptible to use by wildlife, and wildlife have been observed at this location. Since the results were within the range of historical data, no follow-up enhanced sampling was conducted at this site. However, at the Walton WWTP, no wildlife exposure was initially suspected, hence an additional sample was taken when one *Giardia* cyst was detected in a 50L sample. However, in retrospect, this resample would not have been collected at this concentration because it has now been determined that wildlife may have access to this site. The other resample, which occurred at the Hunter Highlands WWTP, was in response to a *Giardia* result that was on the higher end of the spectrum of historical results, and taken despite the suspected exposure to wildlife (Figure 4.14). In both enhanced follow-up samples, no *Giardia* or *Cryptosporidium* were detected. As part of the monitoring under the WWQMP, sampling will be conducted prior to the point of potential wildlife exposure at the Grahamsville WWTP, which has had the greatest issue with protozoan pathogen detection.

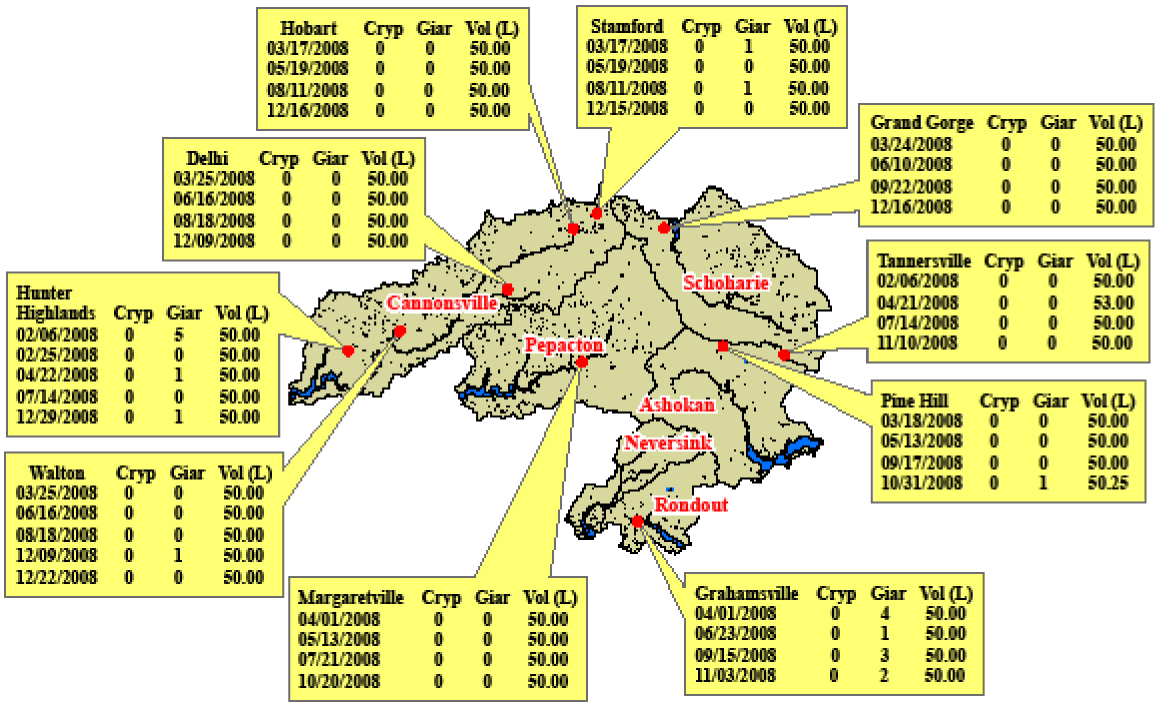

Figure 4.14 2008 *Cryptosporidium* and *Giardia* sample results for Catskill and Delaware System WOH WWTPs.

A total of 40 HEV samples were taken at the 10 WWTPs, which satisfies the minimum set at each site. In addition, two resamples were taken, one at DTP on 6/24/08 and one at SGE, also on 6/24/08. The DTP resample was taken because the chlorine residual exceeded the 0.09 mg L^{-1} upper limit set by the DEP Field Standard Operating Procedure for the ICR HEV sampling method. The SGE resample was attributed to an issue with shipping, which caused the sample to arrive at the contract analytical lab beyond the 4-day hold time.

None of the samples taken for any of the WWTPs were positive for HEVs, which is consistent with the 2007 data. HEV will continue to be monitored at the WWTPs selected as part of the new 2009 WWQMP.

East of Hudson

In addition to the WOH WWTP sites, DEP monitors the EOH Brewster Sewage Treatment Plant monthly for *Cryptosporidium* and *Giardia* and bimonthly for HEVs as required by the CCD. In total, 12 *Cryptosporidium* and *Giardia* and 7 HEV samples were taken (Table 4.6). Only one sample was positive for *Giardia*. One virus resample was collected on 01/22/08 because a scheduled QC sample was not collected on the 1/08/08 sample run.

Table 4.6: Monitoring results for *Cryptosporidium*, *Giardia*, and HEV results at Brewster Sewage Treatment Plant in 2008.

Date	*Cryptosporidium* oocysts $50L^{-1}$	*Giardia* cysts $50L^{-1}$	HEVs MPN $100L^{-1}$
08-Jan-08	0	0	0
22-Jan-08	nsr	nsr	0
12-Feb-08	0	0	nsr
11-Mar-08	0	0	0
08-Apr-08	0	1	nsr
13-May-08	0	0	0
17-Jun-08	0	0	nsr
08-Jul-08	0	0	0
12-Aug-08	0	0	nsr
09-Sep-08	0	0	**
14-Oct-08	0	0	0
10-Nov-08	-110	-110	-110
21-Nov-08	0	0	0
10-Dec-08	0	0	nsr

nsr = no sample required.
-110 = field error, sample frozen.
** = sample was inadvertently omitted from the schedule.

Since 2008 was the fifth and final year under the 2003 IMR, certain sample sites have changed according to the long term WWTP monitoring objectives set forth in the 2009 WWQMP. In addition, the issue of potential wildlife exposure causing pathogen contamination after membrane filtration has been addressed with the relocation of certain sample sites to after membrane filtration, but prior to the end of the treatment train, to reduce the potential wildlife issue. These data will be covered in the next annual report.

4.6 What concentrations of *Cryptosporidium* and *Giardia* were found at the effluents of various NYC reservoirs in 2008?

DEP's pathogen monitoring program provides for sampling at upstate reservoirs and streams in the NYC watershed to help identify the sources of potential protozoan contamination and to assist with estimation of the variability of concentrations between watersheds. Sampling at the upstate reservoir outlets also helps to evaluate the effect of each reservoir and its role in reduction of pathogen concentrations as water flows to terminal reservoirs.

In 2008, *Cryptosporidium* levels remained very low in the WOH watersheds, with all WOH reservoir outlets showing mean concentrations below 0.2 oocysts 50 L^{-1} (Figure 4.15). EOH reservoir *Cryptosporidium* levels remained low, with Boyd Corners and Croton Falls mean concentrations also below 0.2 oocysts 50 L^{-1}. Three of the five EOH reservoirs sampled (Cross River, Muscoot, and Titicus) had slightly higher mean concentrations; however, all averaged under 0.7 oocysts 50 L^{-1}. The mean *Cryptosporidium* concentration at Titicus Reservoir rose in 2008, from zero in 2007 (n=12), to six in 2008 (n=12). In the fall of 2008, nine additional samples were taken at the release of Croton Falls Reservoir when water was being pumped from this reservoir into the Delaware Aqueduct to supplement the system during a shutdown of the Rondout-West Branch Tunnel. Two of these nine samples froze during transport and both were re-sampled within two days.

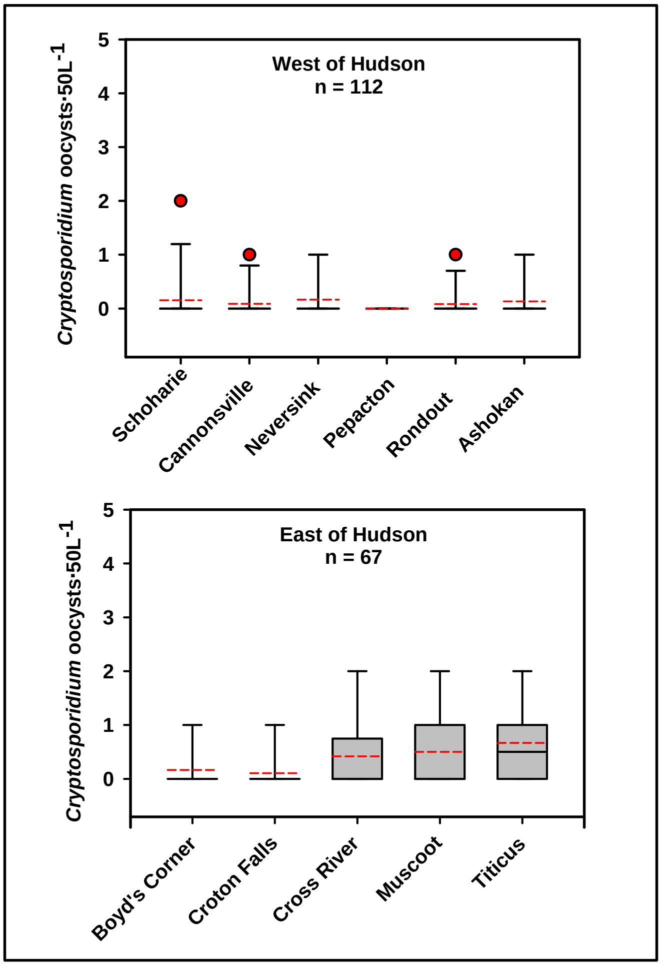

Figure 4.15 2008 summary of *Cryptosporidium* distribution among WOH and EOH watersheds (--- Mean, ___ Median, ● outliers).

Giardia concentrations at WOH reservoirs remained low during 2008, with most sites averaging below 1.3 cysts 50 L^{-1}, with the exception of Schoharie Reservoir (Figure 4.16). Schoharie had a mean *Giardia* concentration of 15.1 cysts 50 L^{-1}, mainly driven by two high results on December 4 and 30 of 79 and 58 cysts 50 L^{-1}, respectively. Mean *Giardia* concentrations for 2008 at reservoir effluents in the EOH watershed remained below 2.7 cysts 50 L^{-1}, with the exception of Muscoot Reservoir, which averaged 5 cysts 50 L^{-1}. Mean *Giardia* concentrations were higher than those of *Cryptosporidium* at most locations, sometimes by as much as two orders of magnitude (e.g., SRR2CM, 15.08 and 0.15 (oo)cysts 50 L^{-1}, respectively). Both *Giardia* and *Cryptosporidium* concentrations were slightly higher in the EOH watershed in 2008 than they were West of Hudson (Figure 4.17).

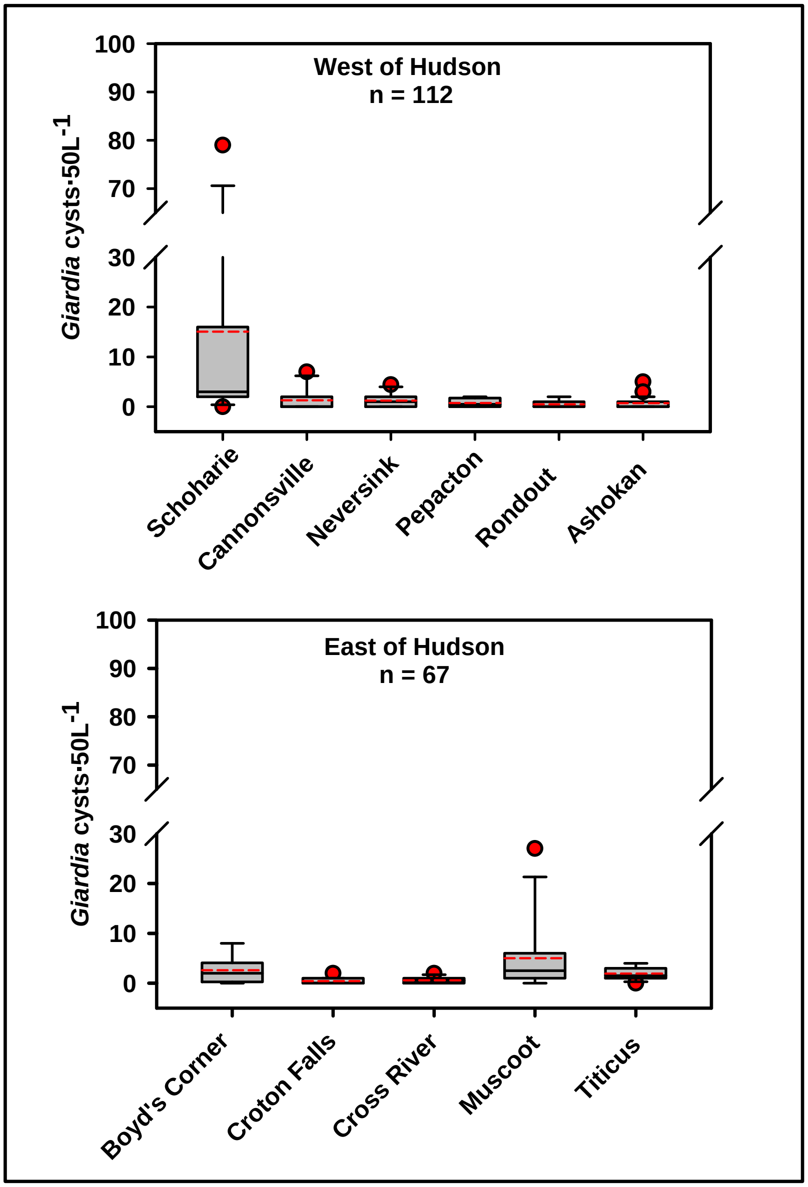

Figure 4.16 2008 summary of *Giardia* distribution among WOH and EOH watersheds (--- Mean, ___ Median, ● outliers).

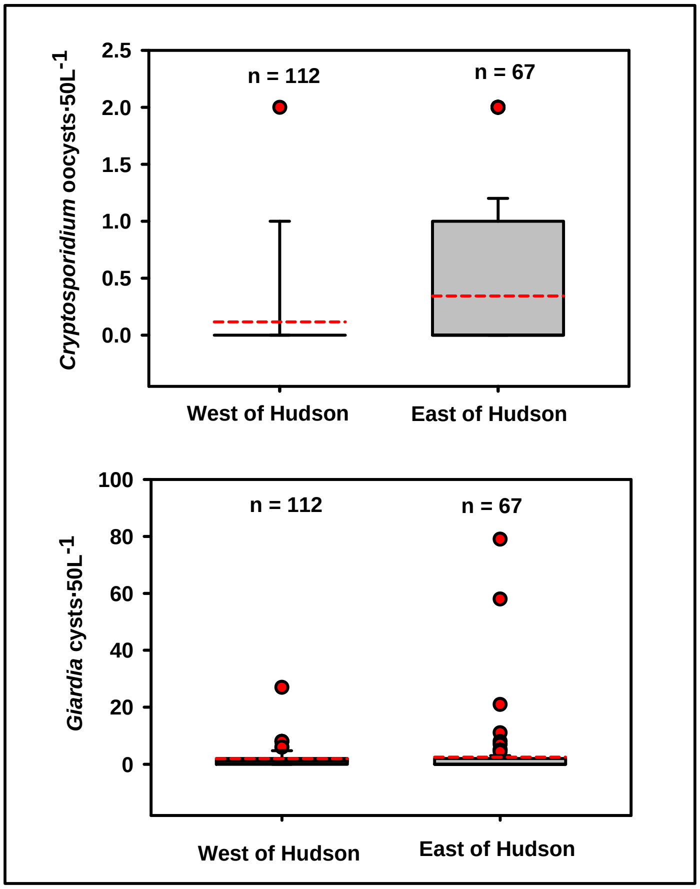

Figure 4.17 Comparison of WOH and EOH *Cryptosporidium* and *Giardia* concentrations $50L^{-1}$.

4.7 What is the status of DEP's Hillview Reservoir protozoan monitoring project?

The LT2ESWTR contains a mandate requiring systems with an uncovered finished water storage facility to either 1) cover the uncovered finished water storage facility, or 2) treat the discharge to achieve inactivation and/or removal of at least 4-log removal for viruses, 3-log removal for *Giardia lamblia*, and 2-log removal for *Cryptosporidium*.

Hillview Reservoir (Figure 4.18), part of NYC's water supply located in Yonkers, New York, fits the description of an uncovered finished water storage facility under the LT2, and as a result, NYC was required to respond to the rule's mandate to cover the reservoir or treat the discharge. To that end, DEP initiated a study in September of 2006. The sampling scheme included sites along both the Catskill and Delaware Aqueducts, which flow through and bypass Hillview Reservoir, respectively. Sample collection was carried out in two sampling periods: September 12, 2006–September 29, 2007 and March 4–August 28, 2008.

Figure 4.18 Aerial view of Hillview Reservoir.

The primary objective of this study was to collect and analyze samples along both the Catskill and Delaware Aqueducts, prior to and following Hillview Reservoir, to see if there was a significant difference in the occurrence of *Giardia* spp. or *Cryptosporidium* spp. at these locations. The focus of this work was to assess whether there are outside sources of pathogens entering the uncovered reservoir after the inlet, yet prior to the outlet to determine if the data supported the LT2ESWTR requirement. Sampling was performed at four keypoints surrounding Hillview Reservoir, as follows:

Site 1 - Uptake No. 1, the Catskill Uptake at Hillview Reservoir.
Site 2 – Uptake No. 2, the Delaware Uptake at Hillview Reservoir.
Site 3 – Downtake No. 1, the Catskill Downtake at Hillview Reservoir.
Site 58 – Downtake No. 2, the Delaware Downtake at Hillview Reservoir.

The first sampling period demonstrated that the Delaware Aqueduct system showed no increase in protozoa from Site 2 to Site 58, which was not unexpected considering that this aqueduct routinely bypasses the reservoir basin. For the Catskill Aqueduct sites, additional matrix spike and duplicate sampling was necessary to provide a clearer picture of all factors possibly influencing the results in order to properly test whether a higher occurrence of protozoa was exiting Hillview Reservoir. Traditional parametric and nonparametric analyses indicated a possible significant increase depending on the test used (sign test p=0.048; sign-ranked test p=0.051). However, the dataset was highly censored (many zeroes) with several tied data pairs; therefore, traditional paired parametric testing was inappropriate due to the inability to correct for normality. Moreover, traditional paired nonparametric statistics could not provide a fair assessment of the outcome because a high percentage of the data (i.e., 82% tied data pairs for *Cryptosporidium* at Site 1 and Site 3) was excluded from the analysis, which could lead to an over-inflation of the Type I error and false positive results (Fong et al. 2003).

Therefore, the effort during the second sampling period was focused on Catskill Site 1 and Site 3 only, with increased matrix spike samples and the addition of sample duplicates. This sampling scheme was designed to help clarify whether the possible difference (if any) was attributed to recovery differences or inherent variability. In addition, DEP contracted a statistician to determine whether a more appropriate analysis was available to deal with censored datasets with many tied pairs. A nonparametric test proposed by Fong et al. (2003) (modified sign test), which incorporated tied data pairs in the analysis, resulted in no statistically measurable difference in the occurrence of *Cryptosporidium* or *Giardia* (oo)cysts from the influent (Site 1) to the effluent (Site 3) of Hillview Reservoir (Table 4.7).

Table 4.7: Results from the comparison of Catskill Site 1 and Site 3.

Parameter	statistical question	proportion of ties	sign test, ties excluded (*p*-value)	sign-ranked test, ties excluded (*p*-value)	modified sign test, corrected for ties (*p*-value)
Cryptosporidium	Site 3 > Site 1?	80/98	0.048	0.051	0.5
Giardia	Site 3 > Site 1?	54/98	0.913	0.975	0.5

Note: Statistical significance $p<0.05$.

Additionally, enhanced MS recovery data, duplicate data, and supporting water quality do not provide support for, or against, significantly greater protozoan concentrations at Hillview Reservoir effluents than at the influents.

In summary, the data do not support the idea that Hillview Reservoir is a significant source of protozoa (DEP 2008c).

5. Watershed Management

5.1 What watershed management programs are required for filtration avoidance and how do they protect the water supply?

Several of DEP's watershed management programs are described in the 2007 Filtration Avoidance Determination (USEPA 2007) and summarized below.

Waterfowl Management

The Waterfowl Management Program includes three activities: avian population monitoring, avian harassment activities (motorboats, air boats, and pyrotechnics) and avian deterrence (depredation of nests and eggs, bird exclusion wires, and netting at critical intake chambers.) The objective of the program is to minimize the fecal coliform loading to the reservoirs that result from roosting birds during the migratory season.

Land Acquisition

The Land Acquisition Program seeks to prevent future degradation of water quality by acquiring sensitive lands to ensure that undeveloped, environmentally-sensitive watershed lands remain protected and that the watershed continues to be a source of high quality drinking water to the City and upstate counties.

Land Management

The responsibilities of the Land Management Program include property management, natural resources management, implementing/administering the recreational use program, monitoring water supply lands, monitoring and enforcing conservation easements, maintaining a watershed land information system (GIS), and developing a forest management plan.

Watershed Agricultural Program

The overall objective of the Watershed Agricultural Program is to prevent pollution and improve water quality by reducing pollutants leaving farms through the implementation of best management practices (BMPs).

Watershed Forestry Program

The Watershed Forestry Program is a voluntary partnership between New York City and the forestry community that supports and maintains well-managed forests as a beneficial land use in the watershed. The primary objective of the program is to maintain unfragmented forested land and promote the use of management practices to prevent nonpoint source pollution during timber harvests. The program provides resources for logger training, forest management planning, implementation of management practices, research, demonstration projects, and educational opportunities.

Stream Management

The objective of the Stream Management Program is to protect and restore stream stability through the development and implementation of stream management plans and demonstration projects, and the enhancement of long-term stream stewardship through increased community participation resulting from partnerships, education, and training. Stabilizing stream reaches provides multiple environmental benefits including overall water quality improvement and turbidity reduction through decreased streambank erosion.

Riparian Buffer Protection

The Riparian Buffer Protection Program represents a new initiative under the 2007 FAD, committing the City to continue its riparian buffer protection efforts through existing programs (e.g., Land Acquisition, Watershed Agricultural, Stream Management, and Forestry programs) as well as initiating selected program enhancements. The enhancements focus on improving riparian buffer protections along privately-owned stream reaches. For example, within the context of the Stream Management Program, DEP is strengthening its landowner agreements by acquiring enhanced management agreements for the protection of riparian buffers for all current and future stream restoration projects. In addition, riparian landowners have access to technical assistance targeted to their needs. Specifically, enhanced education and training focus on proper streamside management, including development and design assistance with plans for riparian plantings.

Wetlands Protection

The Wetlands Protection Program includes research and mapping programs, such as the National Wetlands Inventory (NWI), wetland status and trends, and wetland monitoring and functional assessment. All of these support protection programs such as wetland permit review, land acquisition, and watershed agricultural programs. Wetlands play a major role in watershed protection because of their ability to maintain good surface water quality in watercourses and reservoirs and to improve degraded water. Wetlands also moderate peak runoff, recharge groundwater, and maintain baseflow in watershed streams.

East of Hudson Non-Point Source Pollution Control Program

DEP has developed a comprehensive nonpoint source program for the West Branch, Boyd Corners, Croton Falls, and Cross River Reservoir basins located east of the Hudson. Program elements in these basins include an agricultural program, forestry program, new septic and stormwater initiatives, and cooperative planning efforts by the City and Westchester and Putnam Counties. These efforts provide for integrated watershed management to protect and improve water quality in the West Branch, Boyd Corners, Croton Falls, and Cross River Reservoir basins. In addition, DEP addresses many concerns in the East of Hudson watersheds through the aggressive implementation of the Watershed Rules and Regulations and continued increased involvement in project reviews, as well as through a grant program to assist stormwater districts or municipalities reduce stormwater pollutant loading to the Croton Falls and Cross River basins.

Kensico Water Quality Control

Because Kensico Reservoir provides the last impoundment of Catskill/Delaware water prior to entering the City's distribution system, protection of this reservoir is critically important to maintaining filtration avoidance for the City. Since the early 1990s, DEP has prioritized watershed protection in the Kensico watershed. FADs (USEPA 1997, 2002) built a foundation of expanded watershed protection and pollution prevention initiatives for the Kensico watershed. Under the 2007 FAD, DEP is instituting new watershed protection and remediation programs designed to ensure the continued success of past efforts while providing for new source water protection initiatives that are specifically targeted toward stormwater and wastewater pollution sources.

Catskill Turbidity Control

The Catskill Turbidity Control Program includes analysis and implementation of engineering, structural, and operational alternatives to address elevated turbidity in the Catskill Watershed.

5.2 How can watershed management improve water quality?

The close relationship between activities in a drainage basin and the quality of its water resources forms the underlying premise for all watershed management programs. As discussed above, DEP has a comprehensive watershed protection program that focuses on implementing both protective (antidegradation) and remedial (specific actions taken to reduce pollution generation from identified sources) initiatives. Protective programs, such as the Land Acquisition Program, protect against potential future degradation of water quality from land use changes. Remedial programs, such as the Wastewater Treatment Plant (WWTP) Upgrade Program and the Streambank Stabilization Program, are directed at existing sources of impairment (Figure 5.1). A brief summary of the watershed protection program is provided in the section below. More information on the management programs and water quality analysis can be found in the 2006 Watershed Protection Program: Summary and Assessment report (DEP 2006f). Information on research programs in the watershed can be found in the 2006 Research Objectives Report (DEP 2007b).

Figure 5.1 Remediation of an eroded watercourse in the East of Hudson watershed.

5.3 What are DEP's watershed management efforts in the Catskill/Delaware Systems?

- *Watershed Agricultural Program*. Since 1992, the Watershed Agricultural Program has developed pollution prevention plans (also known as Whole Farm Plans), on more than 390 small and large farms in the Catskill, Delaware, and Croton watersheds. To date, more than 94.4% of the 307 large farms in the Catskill/Delaware watersheds have Whole Farm Plans. Of these, 97% have commenced implementation and 86.9% have substantially completed implementation. The Conservation Reserve Enhancement Program (CREP) has protected more than 185 stream miles with riparian forest buffers.

- *Land Acquisition*. Between 1997 and the end of 2008, the City secured more than 91,000 acres in the Catskill/Delaware systems (including fee simple and conservation easements acquired or under contract by DEP, and farm easements acquired by the Watershed Agricultural Council). This brings the total land area (excluding reservoirs) throughout the Catskill/Delaware systems under City ownership for purposes of protecting drinking water to over 126,000 acres, which is more than triple the land area held before the program began.
- *Wastewater Treatment Plant (WWTP) Upgrades*. The five City-owned WWTPs in the Catskill/Delaware Systems were upgraded in the late 1990s. Of the total flow from all non-City-owned Catskill/Delaware plants, 97.8% emanates from plants that have so far been upgraded.
- *New Infrastructure Program (NIP)*. Five new WWTPs and one collection system/force main project have been completed in communities with failing or likely-to-fail septic systems. In 2008, the addition of the Hubbell's Corners collection system to the Roxbury collection system/force main NIP project transitioned from the study phase to the design phase. Construction on the Hubbell's Corners collection system is to commence in 2009. A wastewater treatment facility for the Hamlet of Phoenicia in the Town of Shandaken was still under consideration by the Town in 2008.
- *Partnership Programs*. Partnering with DEP, the Catskill Watershed Corporation administers a number of watershed protection and partnership programs, including the Septic Program, the Community Wastewater Management Program, and the Stormwater Retrofit Program (Figure 5.2). The Septic Program funded the remediation of 258 failing septic systems in 2008. (Since 1997, more than 2,864 failing septic systems have been repaired or replaced.) Through the Community Wastewater Management Program, one community (DeLancey) has established a septic maintenance district, while another (Bovina) has completed a community septic system. In addition, 2008 saw construction proceed on two additional community septic systems (Hamden and DeLancey), and two other communities (Boiceville and Ashland) continued work on design plans for WWTPs. Over 60 stormwater retrofit projects have been funded through 2008 by the Catskill Watershed Corporation, resulting in the construction and implementation of stormwater BMPs throughout the WOH Watershed. In addition, 30 facilities that store road deicing materials have been upgraded.

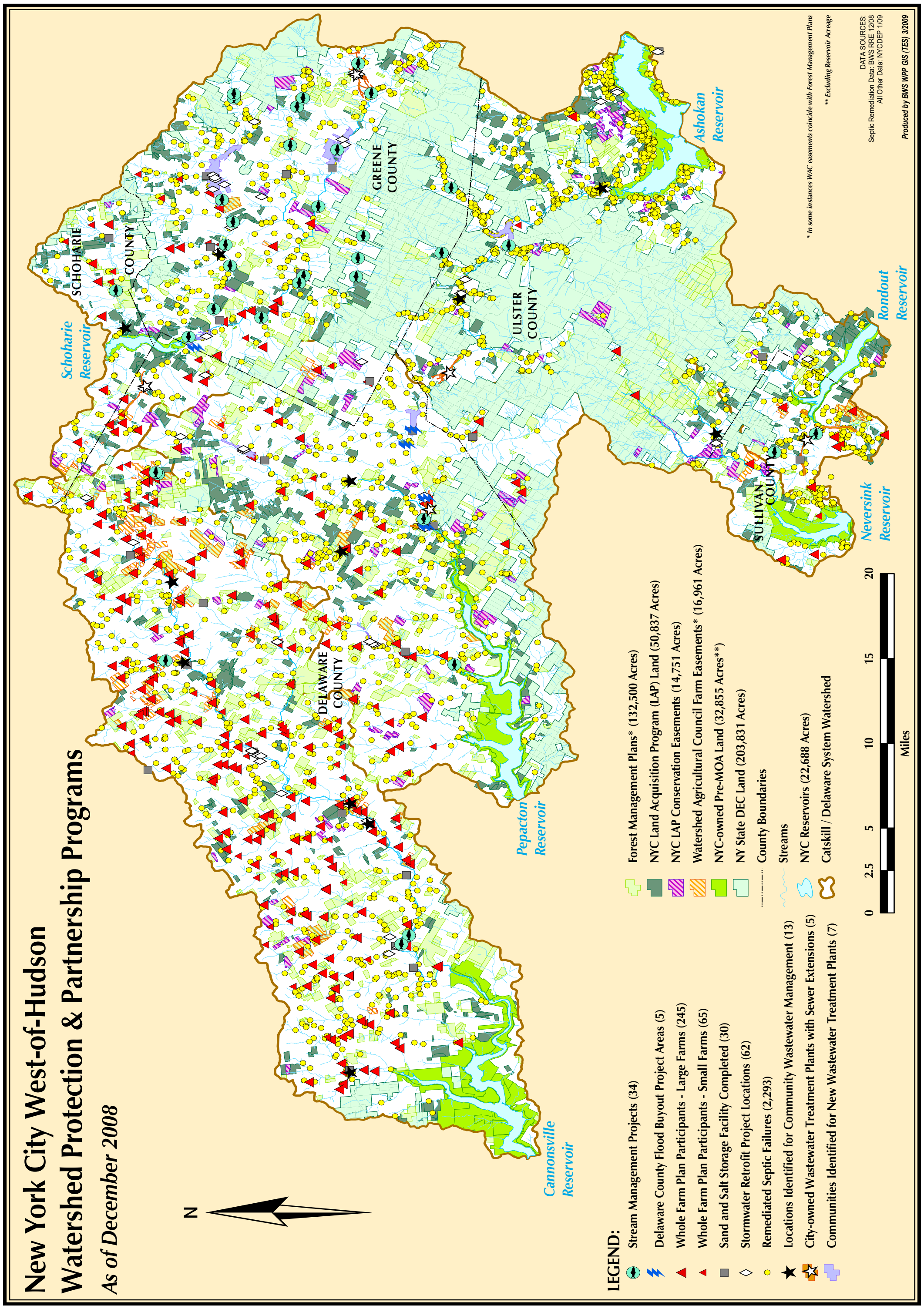

Figure 5.2 New York City West of Hudson Watershed Protection and Partnership Programs as of December 2008.

5.4 How has DEP tracked water quality improvements in the Catskill/ Delaware Systems?

Water quality has been and continues to be excellent in the Catskill and Delaware Systems. From1993–2008, many improvements in water quality have been observed. The most dramatic change has been the reduction in phosphorus in the Catskill/Delaware watersheds due to WWTP upgrades. As an example, Figure 5.3 shows phosphorus loads and flows from WWTPs in the Cannonsville watershed. The reduction in total phosphorus loads between 1994 and 1999 can be attributed to the intervention and assistance of DEP at the Village of Walton's WWTP and at Walton's largest commercial contributor, Kraft. The substantial additional reductions in phosphorus loads realized after 1999 can be attributed to final upgrades of five plants and the diversion of another. As a result, Cannonsville Reservoir was taken off the phosphorus-restricted basin list in 2002.

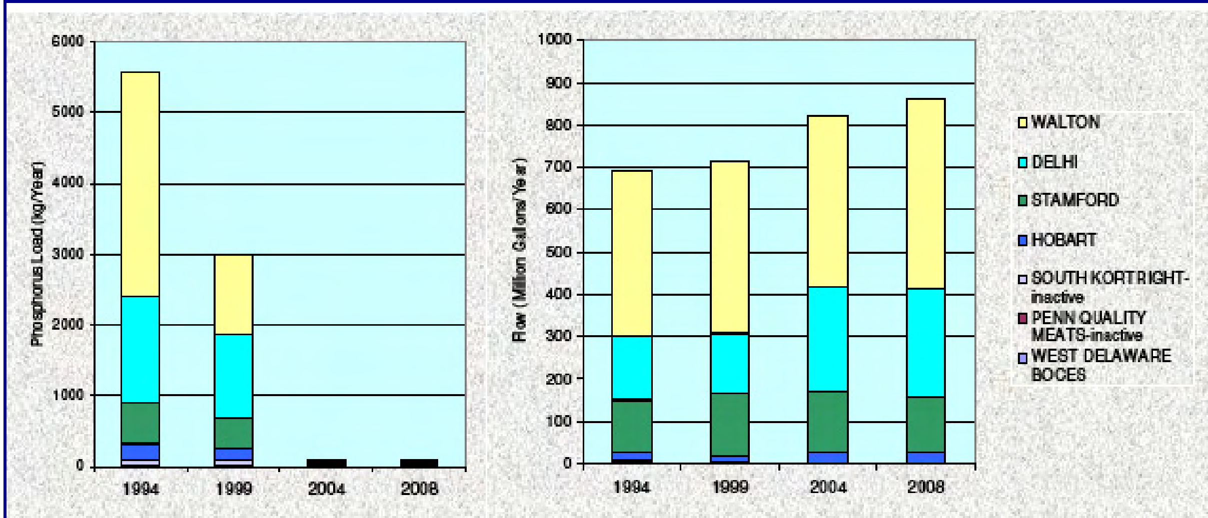

Figure 5.3 Wastewater Treatment Plant TP loads and flow in the Cannonsville watershed, 1999–2008.

5.5 What are the watershed management efforts in the Croton System to improve water quality?

The watershed management programs are designed somewhat differently in the Croton System from those in the Catskill and Delaware Systems. Instead of explicitly funding certain management programs (e.g., the Stormwater Retrofit Program), DEP provided funds to Putnam and Westchester Counties to develop a watershed plan ("Croton Plan") and to support water quality investment projects in the Croton watershed. In addition to funding watershed management activities undertaken by the counties and municipalities, DEP has implemented an East of Hudson Nonpoint Source Pollution Control Program to address specific watershed concerns (e.g., stormwater retrofits). Other DEP management programs (e.g., the Wastewater Treatment Plant Upgrade Program, the Watershed Agricultural Program) operate similarly in all systems.

Croton Plan and Water Quality Investment Program

In the Croton System, DEP provided funds to Putnam and Westchester Counties to develop a watershed plan to protect water quality and guide the decision-making process for Water Quality Investment Program (WQIP) funds. Many municipalities have begun implementing actions proposed in the Draft Croton Plans, including zoning modifications, regulatory updates, stormwater retrofits, and wastewater control programs. The counties have continued the distribution of the WQIP funds, which were provided by the City for use on watershed improvement projects. The sum of used and remaining WQIP funds exceeds $100 million. A few notable projects for 2008 are described below.

- *Putnam County Septic Repair Program (SRP)*. Putnam County continued to fund and implement the Septic Repair Program in high priority areas and has repaired over 100 systems to date. Since the program's start, the county has allocated over $4.6 million to rehabilitate systems in close proximity to water bodies.
- *Westchester County Local Grant Program*. Twelve Westchester County municipalities continued the use of $312,500 in grant funding for projects, including sanitary sewer extensions, stormwater improvements, and enhanced storage of highway de-icing materials.
- *Westchester County Septic Program*. Westchester County continues to track septic repairs and pump-outs as well as train and license septic contractors.
- *Putnam and Westchester: Peach Lake Project.* The counties have jointly allocated a total of $12.5 million toward a project that will provide for the wastewater collection and treatment of sewage around Peach Lake.

Wastewater Treatment Plant Upgrade Program

The Croton watershed has a large number of wastewater treatment plants, with the bulk of them serving schools, developments, or commercial properties. Of the 70 non-City-owned WWTPs located EOH, 60 are in the Croton System (totaling 4.99 million gallons per day) and 10 are in the West Branch, Croton Falls, or Cross River watersheds (totaling 1.36 million gallons per day). Sixty-two of the 70 (88.6%) non-City-owned WWTPs located EOH have flows of less than 100,000 gallons per day. Twenty-nine of the 70 WWTPs (80.6% of the permitted flow) have completed their upgrades as of December 2008 and are either ready to start up or have already done so. An additional 38 WWTPs either have commenced construction of the upgrades or are in the design phase. Upgrade plans for three remaining EOH WWTPs (1.5% of the permitted flow) are on hold pending decisions on diversion to existing plants or out of the Croton watershed.

Thirty-three of the 70 non-City-owned WWTPs located EOH are located within the 60-day travel time (57.4% of the permitted flow) and 13 of these (48% of the permitted flow) have completed their upgrades. The flow from the 13 WWTPs equates to 83.7% of the permitted flow within the 60-day travel time. The three WWTPs that are on hold are within the 60-day travel time.

East of Hudson Watershed Agricultural Program

The farms in the EOH District tend to be smaller and more focused on equestrian-related activities than WOH farms, and the EOH Watershed Agricultural Program has been specially tailored to address these issues. At the end of 2007, 38 farms in the Croton System had approved Whole Farm Plans. Thirty-three of these farms have commenced implementation of BMPs, and a total of 277 BMPs have been installed.

Nonpoint Source Management Program

The EOH Nonpoint Source Pollution Control Program is a comprehensive effort to address nonpoint pollutant sources in the four EOH Catskill/Delaware watersheds (West Branch, Croton Falls, Cross River, Boyd Corners). The program supplements DEP's existing regulatory efforts and nonpoint source management initiatives. Data on the watershed and its infrastructure are generated and that information is used to evaluate, eliminate, and remediate existing nonpoint pollutant sources, maintain system infrastructure, and evaluate DEP's programs. Some recent highlights include:

- Stormwater remediation projects continue to be identified and implemented. Small remediation projects are completed annually. The designs and permitting necessary for the larger remediation projects are currently underway.
- Completed the development of a Stormwater Prioritization Assessment, including the establishment of criteria to be used to locate potential future stormwater retrofits in the EOH FAD basins.
- Design, permitting, and survey work were completed for upcoming roadway and drainage improvement projects that will reduce erosion potential and turbidity from unpaved roads. The retrofit project will improve the functionality of the existing stormwater conveyance system along the roadways.

5.6 What are the water quality impacts from waterbirds (Canada geese, gulls, cormorants, and other waterfowl) and how is the problem mitigated?

Following several years of waterbird population monitoring, DEP's scientific staff, consisting of wildlife biologists and microbiologists, identified birds as a significant source of fecal coliform at several NYC reservoirs (e.g., Kensico Reservoir, Figure 5.4). In response, DEP developed and implemented a Waterfowl Management Plan (WMP) using standard bird management techniques (approved by the United States Department of Agriculture, Wildlife Services (USDA) and the New York State Department of Environmental Conservation (DEC)) to reduce or eliminate the waterbird populations inhabiting the reservoir system (DEP 2002b). DEP has also acquired depredation permits from the United States Fish and Wildlife Service (USFWS) and DEC to implement some management techniques.

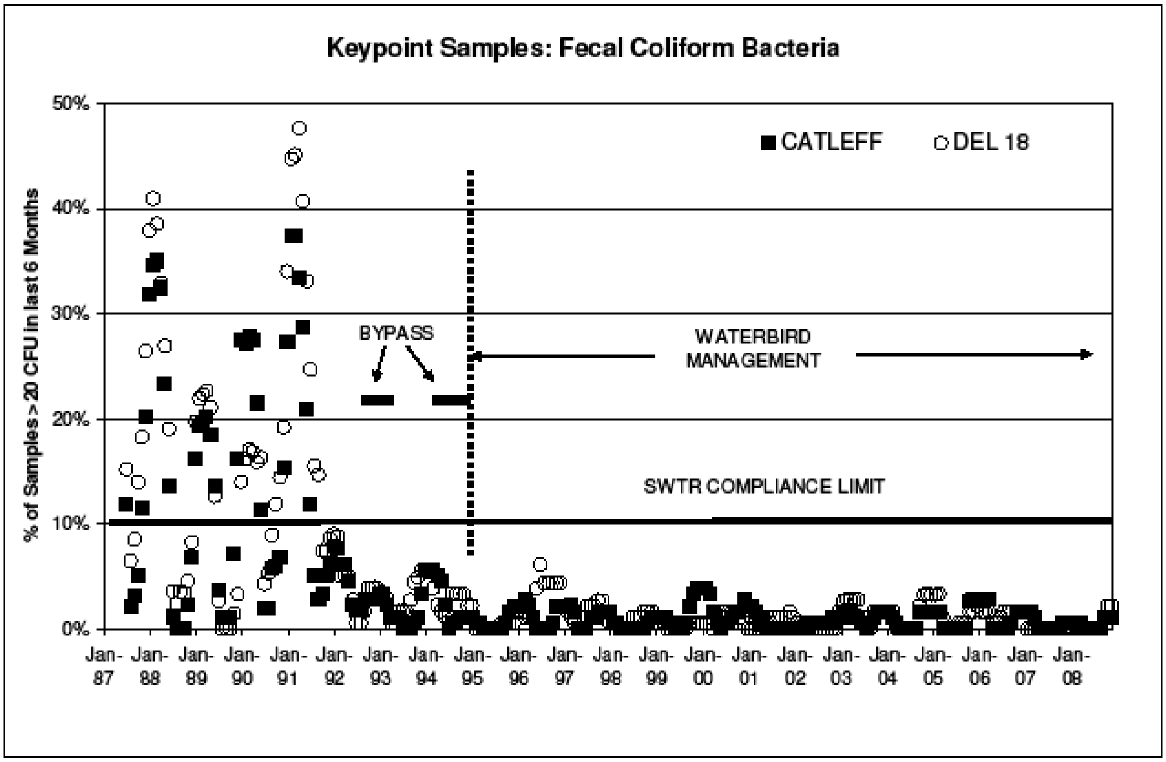

Figure 5.4 Keypoint fecal coliforms at Kensico Reservoir effluents before and after initiation of waterbird management.

Migratory populations of waterbirds utilize NYC reservoirs as temporary staging areas and wintering grounds and therefore significantly contribute to increases in fecal coliform loadings during the autumn and winter, primarily from direct fecal deposition in the reservoirs. These migrant waterbirds generally roost nocturnally and occasionally forage and loaf diurnally on the reservoirs; however, it has been determined that most of the feeding activity occurs away from the reservoir. Fecal samples collected and analyzed for fecal coliform bacteria concentrations from both Canada geese (*Branta canadensis*) and Ring-billed Gulls (*Larus delawarensis*) revealed that fecal coliform concentrations are relatively high per gram of feces (Alderisio and DeLuca 1999). Water samples collected near waterbird roosting locations show that fecal coliforms have increased along with waterbird populations at several NYC reservoirs for several years (DEP 2002b, 2003b, 2004, 2005, 2006g, 2007c, and 2008d). Thus, DEP has determined that waterbirds contributed the most important fecal coliform bacteria load seasonally to Kensico Reservoir and to other terminal reservoirs (West Branch, Rondout, Ashokan) and potential source reservoirs to distribution (Croton Falls and Cross River).

Figure 5.5 Canada geese nesting on the roof of a DEP laboratory building after nest depredation under federal permit.

Bird deterrence measures, which include waterbird reproductive management, shoreline fencing, bird netting, overhead deterrent wires, and meadow management, continued to reduce local breeding opportunities around water intake structures, and eliminate fecundity.

Monitoring the effects that bird dispersal measures have on each reservoir can be achieved through continued routine population surveys and by expanding research that identifies sources of bacteria. Survey results provide inferences about the potential effect of the birds' fecal matter through the spatial and temporal aspects of the birds, and also makes it possible to evaluate the effectiveness of the dispersal measures. DEP will continue implementation of the WMP indefinitely to help ensure the best possible water quality water.

5.7 How has DEP tracked the status and trends of wetlands in the West of Hudson Watersheds?

The DEP contracted the USFWS to conduct a status and trends analysis for wetlands and ponds in the West of Hudson Watershed for two time periods, from the mid-1980s to the mid-1990s, and from the mid-1990s to 2004. The USFWS superimposed 2004, and then mid-1980s National Wetlands Inventory (NWI) data, on mid-1990s aerial photography to identify gains, losses, and cover type changes in vegetated wetlands and ponds over the two time periods (Tiner 2008). Changes in non-vegetated wetlands were annotated separately from vegetated wetlands because their functions differ in many respects. The rate of vegetated wetland loss declined over the two time periods. Pond construction was extensive and accounted for the majority of vegetated wetland losses in both time periods, though the rate of pond construction declined from the 1990s to 2004. From the mid-1980s to the mid-1990s, there was a net loss of approximately 87 acres of vegetated wetlands in the West of Hudson watershed. This represents less than 1% of the West of Hudson wetland base acreage. In addition, there was a net increase of 527 acres of non-vegetated wetlands (ponds). Approximately 94% of the total loss of vegetated wetlands was due to pond construction. From the mid-1990s to 2004, a loss of 15.25 acres of vegetated wetlands was recorded along with a gain of 18.75 acres, resulting in a net gain of 3.5 acres of vegetated wetlands. Much of the gain in vegetated wetlands was due to re-vegetation of ponds. Non-vegetated wetlands (ponds) showed a net increase of approximately 109 acres. Eleven percent of the new ponds were constructed in wetlands, mostly in palustrine emergent systems, accounting for 90% of the loss of vegetated wetlands.

The decreased rate of vegetated wetland loss, coupled with significant, though declining, rates of pond construction, are consistent with findings from prior studies in the Croton watershed (Tiner et al. 1999, Tiner et al. 2005) and from national studies (Dahl 2006). The replacement of vegetated wetlands with ponds represents a shift in wetland function, as ponds do not provide the same range of functions as vegetated wetlands. While this analysis was completed through remote sensing, and, therefore, likely underestimates loss of small wetlands, forested wetlands, and temporarily or seasonally saturated wetlands, it does allow for a cumulative assessment of local, state, and federal wetland protection programs. It also enables wetland managers to target specific geographic regions or activities, such as pond construction, that are impacting vegetated wetlands.

5.8 What is the status of the Forest Science Program's Continuous Forest Inventory and how is it contributing to development of DEP's Forest Management Plan?

The Forest Science Program collects data on forest ecosystems located on water supply lands. For over 10 years, efforts have focused on establishing a system of permanent forest inventory plots throughout the watershed that will help DEP's forest managers understand the dynamics of watershed forests—tree growth, recruitment of young seedlings into the forest stand, and mortality of older or more susceptible species or stands of trees. In 2008, Continuous Forest Inventory (CFI) plots were established and measured in the Pepacton Reservoir watershed. Only the Cannonsville Reservoir watershed remains to be surveyed for baseline data.

Methods used in data collection have served as the testing ground for the U. S. Forest Service inventory of watershed lands that begins in 2009. The forest scientist is able to help troubleshoot and answer questions related to the Northeast Decision model (NED) software being used in that inventory. In addition, data from the CFI plots has been used to compare tree diameter and height relationships built into the software against locally-collected information. CFI plot data will contribute to development of modeling/forecasting tools, ground-truthing of forest stand types mapped from aerial photos, and tracking progress and results of applied management activities over time. This and other analyses will help DEP and the Forest Service as they develop the Forest Management Plan.

5.9 How did trout spawning affect stream reclassification in the East of Hudson Watersheds?

Streams in New York State are classified and regulated by DEC based on existing or anticipated best use standards. The purpose of the stream reclassification program is to enhance the protection of water supply source tributaries by determining best use standards for trout and trout spawning. These standards strengthen compliance criteria for dissolved oxygen, ammonia, ammonium, temperature, and volume permitted under any currently regulated action, and further increase the number of protected streams in the watershed.

Reclassification surveys concentrate on sections of streams with suitable trout habitat, including riffles, pools, and undercut banks. Streams are electrofished and all stunned fish are collected and held for processing (identification, length, and weight). The fish are released when all data are collected. The presence of trout less than 100 mm in length (young-of-the-year fish) is used to indicate the occurrence of trout spawning. Physical and chemical stream data (temperature, depth, width, dissolved oxygen, pH, conductivity, stream gradient, and estimated discharge) are then collected to assess stream conditions suitable for trout spawning. Bottom substrate and land characteristics are also described. Collection reports and reclassification petitions are compiled and submitted to DEC on an annual basis. DEC updates the stream classification based on these petitions.

In 2008 streams in the EOH watersheds were surveyed for the presence of trout or trout spawning. No trout and no evidence of trout spawning were found in 2008. Therefore, no petitions to stream upgrades will be submitted to DEC.

5.10 How do environmental project reviews help protect water quality and how many were conducted in 2008?

DEP staff review a wide variety of projects to assess their potential impacts on water quality and watershed natural resources. Under the New York State Environmental Quality Review Act (SEQRA), DEP is often an involved agency because of its regulatory authority over certain actions. By participating in the SEQRA process, DEP can ensure that water quality concerns are addressed early on in the project planning process. In 2008, DEP staff reviewed a total of 109 SEQRA actions, including Notices of Intent to Act as Lead Agency; Determinations of Action Types; Environmental Assessment Forms; Scoping Documents; Draft, Final, and Supplemental Environmental Impact Statements; and Findings to Approve or Deny.

In addition to projects in the SEQRA process, DEP staff review other projects upon request. Review of these projects helps ensure that they are designed and executed in such a manner as to minimize impacts to water quality. DEP provides its expertise in reviewing and identifying on-site impacts to wetlands, vegetation, fisheries, and wildlife, and makes recommendations on avoiding or mitigating proposed impacts. These reviews also provide guidance on interpreting regulations as they apply to wetlands as well as threatened and endangered species. Approximately 96 of these projects were reviewed and commented on by DEP in 2008. Many of these projects were large, multi-year efforts with ongoing reviews, while others were smaller scale projects scattered throughout the NYC Watershed.

DEP also coordinates review of federal, state, and local wetland permit applications in the watershed for the Bureau of Water Supply. In 2008, approximately 31 wetland permit applications were reviewed and commented on.

5.11 What was the status of WWTP TP loads in the watershed in 2008?

Figure 5.6 displays the sum of the annual total phosphorus (TP) loads from all surface-discharging WWTPs by system from 1999–2008. The far right bar displays the calculated wasteload allocation (WLA) for all these WWTPs, which is the TP load allowed by the State Pollutant Discharge Elimination System (SPDES) permits—in other words, the maximum permitted effluent flow multiplied by the maximum permitted TP concentration. Overall, the TP loads from WWTPs remain far below the WLA. The fact that loads in the Delaware and Catskill Systems remain so far below their respective WLAs reflects the effect of the WWTP upgrade program, which is largely complete WOH. More recently, upgrades of WWTPs in the Croton System are reducing TP loads to levels well below the EOH WLA.

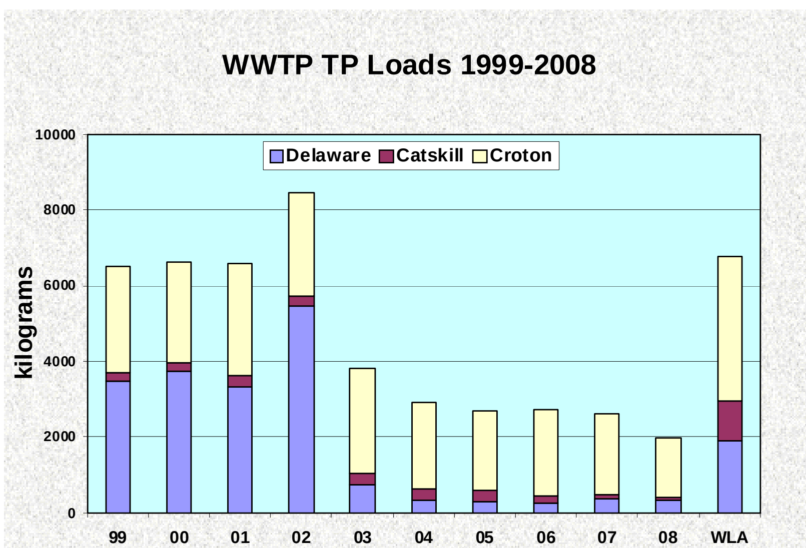

Figure 5.6 Wastewater Treatment Plant TP loads, 1999–2008. The wasteload allocation for the entire watershed is shown in the right-hand bar for comparison.

Upgrades to WWTPs include phosphorus removal and microfiltration to enhance compliance with the Watershed Rules and Regulations. All NYC-owned WWTPs in the watershed have been upgraded, including the Brewster WWTP, which was transferred to the Village of Brewster in 2007 after its upgrade was completed. Several non-NYC-owned WWTPs have already been upgraded, while a number of others are being connected to new plants in the New Infrastructure Program (NIP).

The New Infrastructure Program is another major wastewater management program funded by DEP. The NIP builds new WWTPs in communities previously relying on individual septic systems. Since many of the older septic systems in village centers such as Andes, Roxbury, Windham, Hunter, Fleischmanns, and Prattsville could not be rehabilitated to comply with current codes, this program seeks to reduce potential nonpoint source pollution by collecting and treating wastewater with compliant systems. As new NIPs are completed and sewer districts expand to their full capacities, TP loads are expected to approach the WLAs for the respective systems.

5.12 What does DEP do to protect the water supply from Zebra mussels?

Zebra mussels were first introduced to North America in the mid-1980s, and first identified on this continent in 1988. It is believed that they were transported by ships from Europe in their freshwater ballast, which was discharged into freshwater ports of the Great Lakes. Since their arrival in the United States, zebra mussels have been reproducing rapidly and migrating to other bodies of water at a much faster rate than any of our nation's scientists had predicted. They have been found as far west as California, as far south as Louisiana, as far east as New York State, and north well into Canada. They have been found in all of the Great Lakes and many major rivers in the Midwest and the South. In New York State, in addition to Lakes Erie and Ontario, zebra mussels have migrated throughout the Erie Canal, and are found in the Mohawk River, the St. Lawrence River, the Susquehanna River, and the Hudson River, as well as several lakes.

DEP is concerned about infestation of New York City's reservoirs by this mollusk, because they can reproduce quickly and are capable of clogging pipes. This would seriously impair DEP's operations, preventing an adequate flow of water from the reservoirs to the City and those upstate communities dependent on the New York City water supply. In addition, they create taste and odor problems in the water. To protect the system from zebra mussels, DEP does the following:

- *Monitoring*. As suppliers of water to over nine million people, it is DEP's responsibility to monitor New York City's water supply for zebra mussels, since early identification of a zebra mussel problem will make it possible to gain control of the situation quickly, preserve the excellent water quality of the system, and save money in the long run. DEP has been monitoring NYC's reservoirs for zebra mussels since the early 1990s, via contract with a series of laboratories that have professional experience in identifying zebra mussels. The objective of the contract is to monitor all 19 of New York City's reservoirs for the presence of zebra mussel larvae (veligers) and settlement on a monthly basis in April, May, June, October, and November, and on a twice-monthly basis during the warm months of July, August, and September. Sampling includes pump/plankton net sampling to monitor for veligers, and substrate sampling as well as "bridal veil" (a potential mesh-like settling substrate) sampling to monitor for juveniles and adults. The contract laboratory analyzes these samples and provides a monthly report to the project manager as to whether or not zebra mussels have been detected.

- *Steam cleaning boats and equipment*. DEP requires that all boats allowed on the NYC reservoirs for any reason be inspected and thoroughly steam cleaned prior to being allowed on the reservoir (Figure 5.7). Any organisms or grasses found anywhere on the boat are removed prior to the boat being steam cleaned. The steam cleaning kills all zebra mussels, juveniles, and veligers that may be found anywhere on the boat, thus preventing their introduction into the NYC reservoir system. The steam cleaning requirement applies to all boats that will be used on the reservoirs, whether they be rowboats used by the general public, or motor boats used by DEP. Additionally, all contractor boats, barges, dredges, equipment (e.g., anchors, chains, lines), and trailer parts must be thoroughly steam cleaned inside and out. All water must be drained from boats, barges, their components (including outdrive units, all bilge water (if applicable), and raw engine cooling systems), and equipment at an offsite location, away from any NYC reservoirs or streams that flow into NYC reservoirs or lakes, prior to arrival for DEP inspection.

Figure 5.7 Steam cleaning a boat to prevent transport of zebra mussels.

- *Public Education*. DEP provides educational pamphlets to fishermen on NYC's reservoirs and to bait and tackle shops in NYC's watersheds on preventing the introduction and spread of zebra mussels to bodies of water that do not have them. Fishermen can inadvertently introduce zebra mussels to a body of water through their bait buckets that may have zebra mussels in them (depending upon where the bait was obtained), or by failing to clean equipment that's been used in bodies of water infested with zebra mussels before using it in bodies of water not infested with zebra mussels. The brochures help educate fishermen as to how they can prevent the spread of zebra mussels. In addition, signs are put up throughout the watershed providing information as to how to prevent the spread of zebra mussels.

5.13 What "Special Investigations" were conducted in 2008?

The term "Special Investigation" (SI) refers to limited non-routine collection of environmental data, including photographs and/or analysis of samples, in response to a specific concern or event. In 2008, 5 SIs were conducted. Reports are prepared to document each incident and DEP's response and remedial actions as appropriate. All investigations in 2008 were conducted

East of Hudson. Actual or possible sewage-related problems were the most common incident investigated. Other incidents included an oil spill and an organic sheen. None of the investigations conducted in 2008 identified a pollution problem that was considered an immediate threat to consumers of the water supply. Below is a list of reservoir watersheds in which investigations occurred in 2008, with the date and reason for each investigation.

Muscoot Reservoir
- February 29, a diesel fuel spill adjacent to the Titicus River.

East Branch Reservoir
- August 19, *Cryptosporidium* detection in the Peach Lake watershed.
- February 27, runoff from a horse farm in Pawling, NY.

Cross River Reservoir
- April 25, septic system failure, Cross River, NY.

West Branch Reservoir
- February 2, a surface sheen near Delaware Shaft #9.

6. Model Development and Application

6.1 Why are models important and how are they used by DEP?

DEP uses computer simulation models to aid in short-term water system operational decisions and long-term planning and assessment of the water supply system and watershed management programs.

The DEP modeling system (Figure 6.1) consists of a series of linked models that simulate the transport of water and contaminants within the watersheds and reservoirs that comprise the upstate water supply Catskill and Delaware Systems. Watershed models, including a DEP adapted version of the Generalized Watershed Loading Function (GWLF-VSA) model (Schneiderman et al. 2007), simulate generation and transport of water, sediment, and nutrients from the land surface to the reservoirs. Reservoir models (including the UFI-1D and the CEQUAL-W2 models) simulate the hydrothermal structure and hydrodynamics of the reservoirs, as well as the transport and concentrations of nutrient and sediment within the reservoirs. The water supply system model (OASIS) simulates the operation of the multiple reservoirs that comprise the water supply system. The modeling system is used to explore alternative future scenarios and examine how the water supply system and its components may behave in response to changes in land use, population, climate, watershed/reservoir management, and system operations.

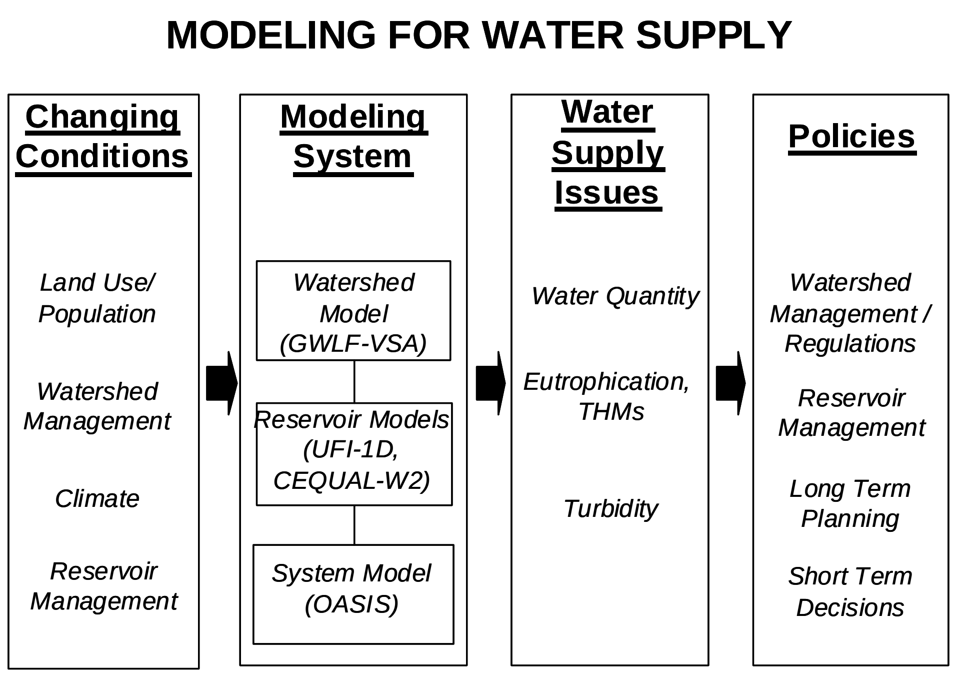

Figure 6.1 Schematic of DEP's Linked Water Supply and Water Quality Modeling System.

Two major model applications conducted during 2008 are discussed in this report. The modeling system was used to begin the first phase of a project to examine the effects of climate change on the water supply (Section 6.3), including climate change effects on turbidity in Schoharie Reservoir, eutrophication in Cannonsville Reservoir, and WOH water quantity. Simulations using the Kensico Reservoir CEQUAL-W2 model were used to recommend aqueduct flow levels so that alum treatment would not be required for a medium-sized storm event during the spring of 2008 (Section 6.4).

During previous years, the models have been used to identify major sources of turbidity and to examine alternative operational rules for use in Schoharie and Ashokan Reservoirs to mitigate the need to use alum to treat elevated turbidity, as part of the CAT211 project (Gannett Fleming and Hazen and Sawyer 2007). Additionally, the effects of changing land use and watershed management on nutrient loading and eutrophication in Delaware System reservoirs (Cannonsville and Pepacton) have been analyzed using linked watershed and reservoir models (DEP 2006f).

6.2 What can models tell us about the effects of 2008's weather on nutrient loads and flow pathways to reservoirs?

Watershed modeling provides insight into the flow paths that water and nutrients take in the watershed. Total streamflow is comprised of direct runoff and baseflow. Direct runoff is water that moves rapidly on or near the land surface during and after storm events, as opposed to much slower-moving baseflow that sustains streamflow between storm events. Direct runoff has a high potential for transporting phosphorus (P) as it interacts with P sources on the land surface. Frequent and intense storm events may produce above-average nutrient loads to reservoirs due to increased direct runoff. Long-term watershed model simulations that include the current year are used to place annual results for 2008 in a historical context.

Figure 6.2 depicts the annual streamflow, direct runoff, and nonpoint source (NPS) dissolved nutrient loads simulated by the GWLF-VSA model for 2008 in relation to long-term simulated annual statistics. These boxplots show that 2008 was wetter than normal with higher than normal modeled streamflow and direct runoff, especially for the Pepacton and Cannonsville watersheds. Consistent with these higher than normal flows, modeled 2008 NPS dissolved nutrient loads were also larger than normal for each of the WOH reservoir watersheds. The relationship between 2008 and long-term annual total dissolved nitrogen (TDN) loads follows a similar pattern as annual streamflow, and the relationship between the 2008 and long-term annual total dissolved phosphorus (TDP) loads closely follows direct runoff.

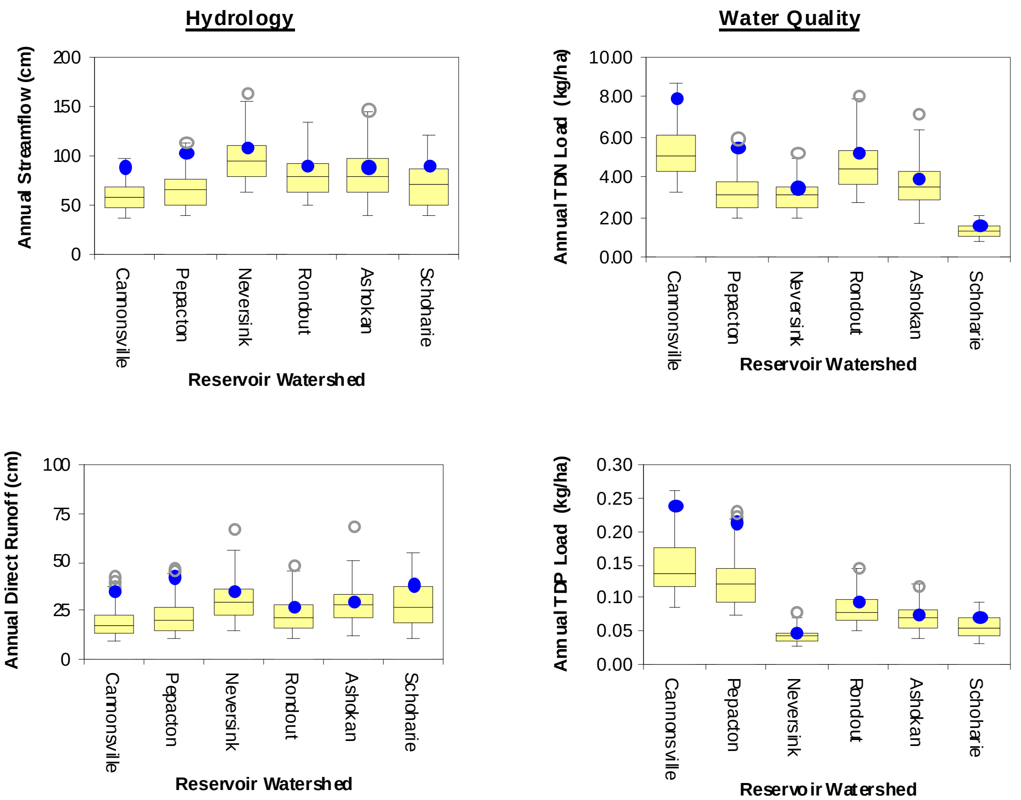

Figure 6.2 Annual streamflow, direct runoff, and nonpoint source dissolved nutrient loads simulated by the GWLF model for 2008 in relation to long-term simulated annual statistics. Boxplots show long-term statistics. Blue dots show 2008 results.

6.3 How is DEP using its modeling capabilities to investigate the effects of climate change on water supply quantity and quality?

DEP is using a suite of simulation models to investigate the effects of climate change on water supply quantity and quality. Preliminary investigations focus on estimating future climate projections; looking 65 years and 100 years forward in the Catskill Mountain WOH watersheds; and using DEP's modeling system (Figure 6.3) to estimate the effects of future climate projections on the hydrology of the WOH watersheds, water quantity in the WOH reservoirs, turbidity in Schoharie Res-

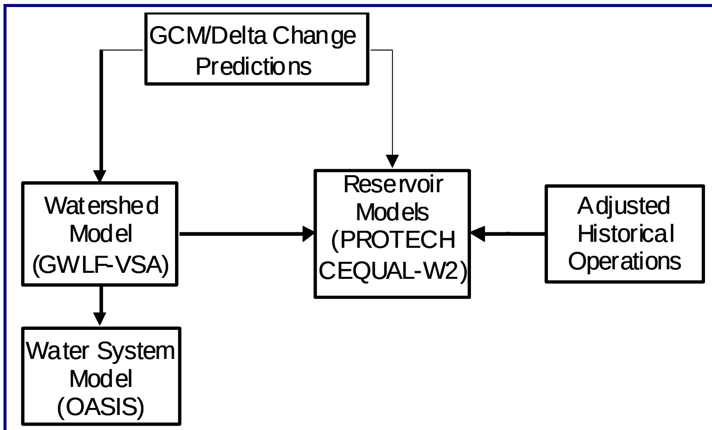

Figure 6.3 DEP's modeling system of water quality and supply system models used for preliminary climate change investigations.

ervoir, and eutrophication in Cannonsville Reservoir. The GWLF-VSA watershed model simulates the effects of future changes in meteorology on streamflow, turbidity, and nutrient inputs to the upstate water supply reservoirs; the OASIS model simulates the operation of the system of reservoirs and the storages and fluxes of water in the system as affected by changing reservoir inputs; and the CEQUAL-W2 and PROTECH reservoir models simulate the effects of changing reservoir inputs on turbidity and eutrophication, respectively, assuming conservatively-adjusted historical reservoir operations.

Future Climate Projections

Preliminary projections of future air temperature and precipitation looking 65 and 100 years forward were developed from three Global Climate Models (GCMs) (Goddard Institute for Space Studies (GISS), National Center for Atmospheric Research (NCAR), and the European Centre Hamburg Model (ECHAM)) and 3 greenhouse gas emission scenarios (A1B, A2, and B1). For each combination of GCM and emission scenario, monthly delta change factors (Figure 6.4) were derived by comparing GCM output for control (1980–2000) versus future prediction periods (2045–2065 and 2080–2100). The boxplots in Figure 6.4 display the changes in average daily air temperature and precipitation by month predicted using the various combinations of GCMs and emission scenarios. Precipitation change factors represent the ratio (unitless) of future to control average daily precipitation by month, while air temperature change factors represent the difference (^{o}C) between future and control. Note that the format of the boxplots in section 6.3 as described in the captions differs from that described in the Appendix key.

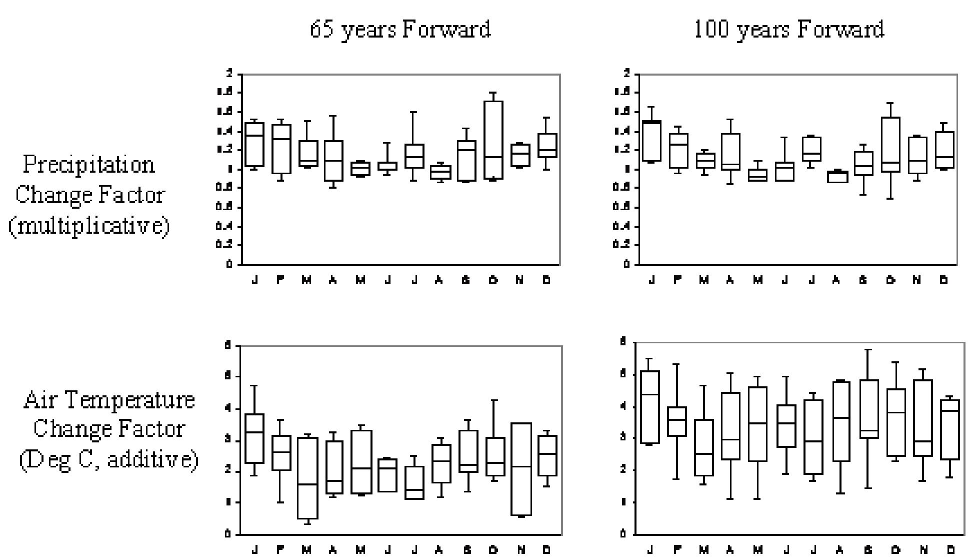

Figure 6.4 Monthly delta change factors for precipitation (unitless) and air temperature (^{o}C). The midway line in the boxes shows the median value for the climate scenarios, the extent of the boxes shows the range of the middle six scenarios, and the whiskers show the range of all scenarios.

Analysis of monthly delta changes indicates that while these GCM/emission scenarios vary somewhat in their predictions (the ranges depicted in the boxplots), there is a clear and significant predicted increase in air temperature, and a somewhat less certain predicted increase in precipitation, particularly in winter. It must be pointed out that the delta change methodology used is a first cut procedure that does not account for possible changes in the frequency and severity of storms, for which more sophisticated methods are under development.

Hydrology of WOH Watersheds

The GWLF-VSA watershed model for each WOH reservoir watershed was run for a baseline scenario representing current conditions, eight climate change scenarios looking 65 years ahead, and eight scenarios looking 100 years ahead. The baseline scenario uses historical inputs of precipitation and temperature from 1966 through 2004. The climate change scenarios were developed by applying the appropriate delta change factors—additively for air temperature and multiplicatively for precipitation—to the historical daily precipitation and temperature data to derive inputs for the watershed model.

The watershed model simulates the water balance of the watershed and the timing of streamflow, reflecting the effects of the projected changes in precipitation and air temperature due to climate change. Figure 6.5 depicts the mean daily water balance by month for the historical baseline data (solid line) and eight climate scenarios (boxes) as projected by the GWLF-VSA watershed model. Projected increases in air temperature (a) and precipitation (b) are accompanied by increased evapotranspiration (c); decreasing snowfall (d) and a much reduced snowpack (e); and a change in the timing of streamflow (f), with higher flows in the late fall and early winter, and a transfer of the traditional high snowmelt related flows of March and April to earlier in the year.

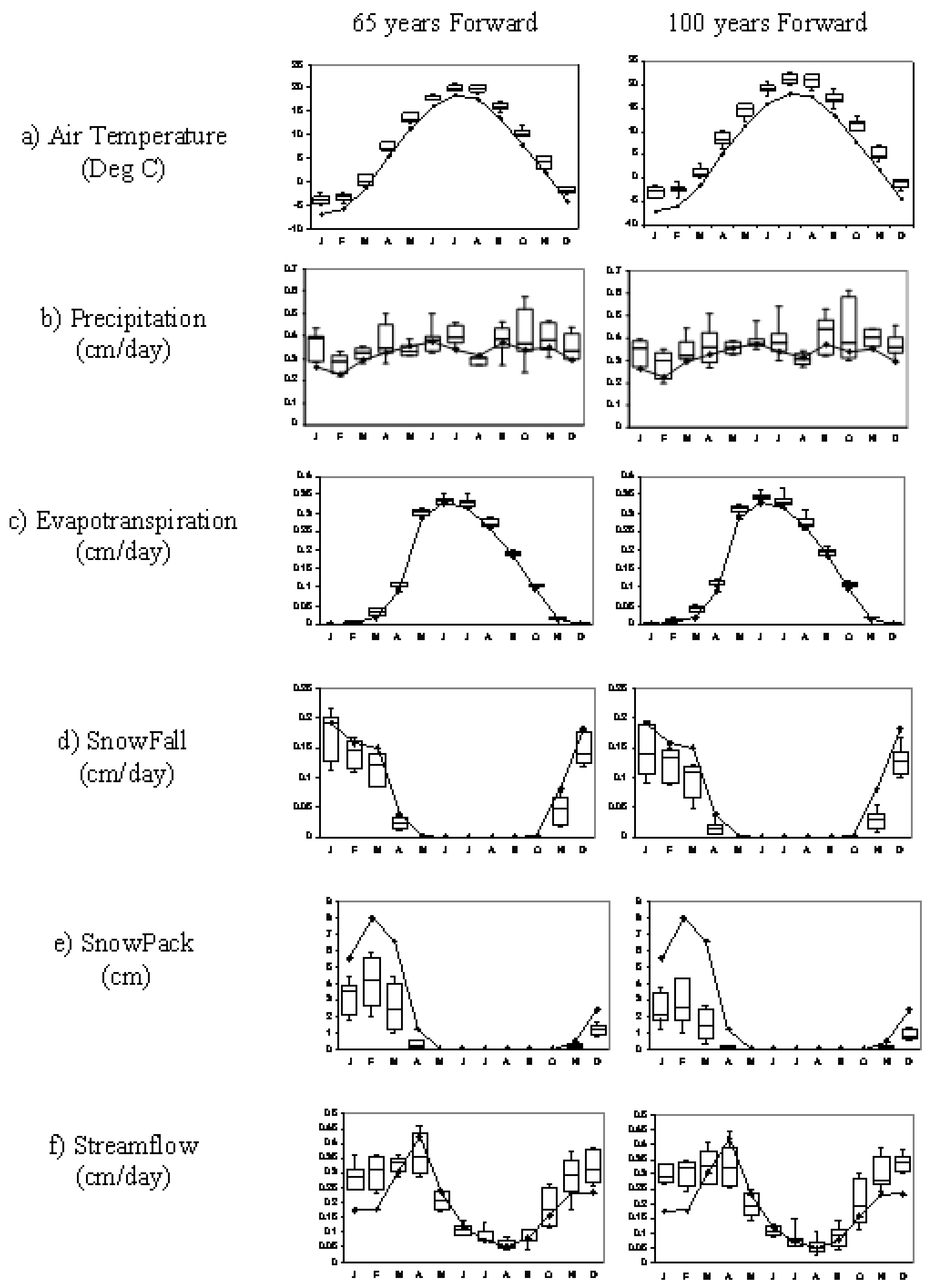

Figure 6.5 Water balance components for WOH watersheds for baseline (solid line) and eight scenarios (boxes), simulated by GWLF-VSA model. The midway line in the boxes shows the median value for the climate scenarios, the extent of the boxes shows the range of the middle six scenarios, and the whiskers show the range of all scenarios.

Water Quantity in WOH Reservoirs

The potential impact of climate change on water quantity in the WOH reservoir system was investigated by running the OASIS Water System Model driven by streamflow inputs to reservoirs as simulated by the watershed model for baseline and climate change scenarios. The OASIS model simulates water supply system operations, and provides assessments of supply status and system operating policies.

The model results for total WOH reservoir storage, releases, and spills (Figure 6.6) illustrate the effects of the changes in input streamflow. In general, the reservoirs are fuller during the late fall and early winter due to the increased input streamflow during this period. Reservoir storage during the growing season remains largely unchanged. Similarly, the reservoir releases and spills increase during the same late fall and early winter period, as the reservoirs are fuller and streamflow increases. Spills and releases during the late winter and early spring show a wide variation under varying scenarios.

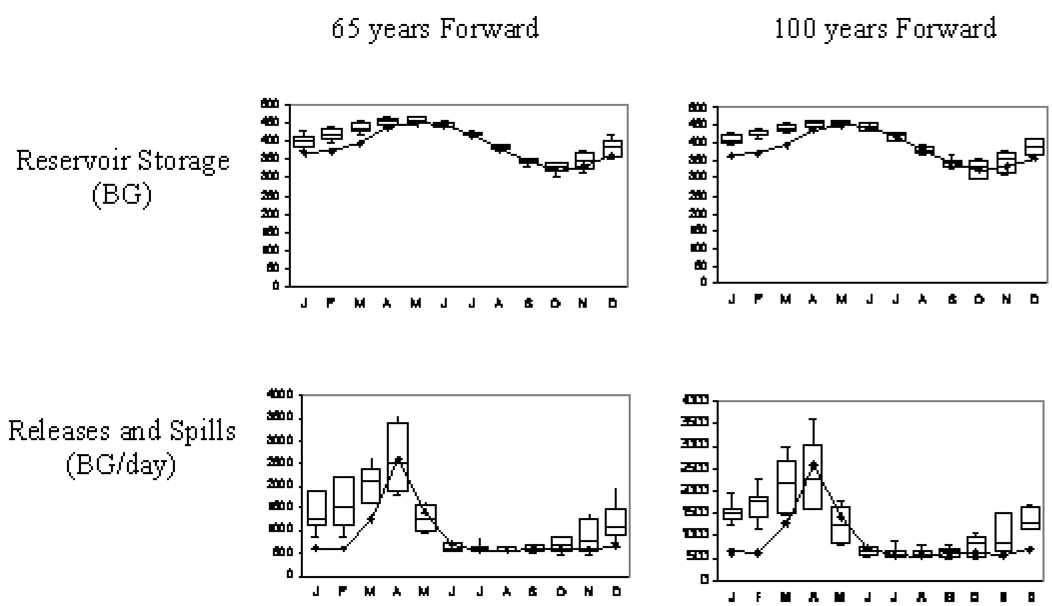

Figure 6.6 Monthly mean WOH reservoir storages (BG), releases, and spills (BG/day) for baseline and eight scenarios for the 65-year future and 100-year future scenarios. The midway line in the boxes shows the median value for the climate scenarios, the extent of the boxes shows the range of the middle six scenarios, and the whiskers show the range of all scenarios.

Turbidity in Schoharie Reservoir

The CEQUAL-W2 model was used for preliminary investigation of climate change effects on turbidity in Schoharie Reservoir. CEQUAL-W2 simulates turbidity transport within the reservoir and has been used extensively to simulate turbidity levels and to guide long-term planning.

Watershed model flow results and turbidity loads based on a turbidity rating curve were input into the CEQUAL-W2 reservoir model developed for Schoharie Reservoir. To simulate operations of the reservoir, a model preprocessor was developed. This preprocessor used Shandaken Tunnel flows from the historical record and reduced these flows when withdrawal exceeded available reservoir storage so that withdrawal levels were consistent with scenario reservoir inflows. The baseline scenario is based on an historical simulation of flows and loads for 1948 through 2004.

The mean monthly turbidity load for the baseline and climate change scenarios is shown in Figure 6.7a. Similar to the streamflow pattern (Figure 6.5f), turbidity loads increase in the late fall and early winter. Turbidity loads are especially increased in the fall, due to relatively large and variable increases in streamflow. Figure 6.7b shows the effects of the increased load on Shandaken Tunnel turbidity, with increases in late fall and early winter, and decreases in the late winter and early spring. These results are directly related to the changes in streamflow timing due to the changes in snowpack development and melting.

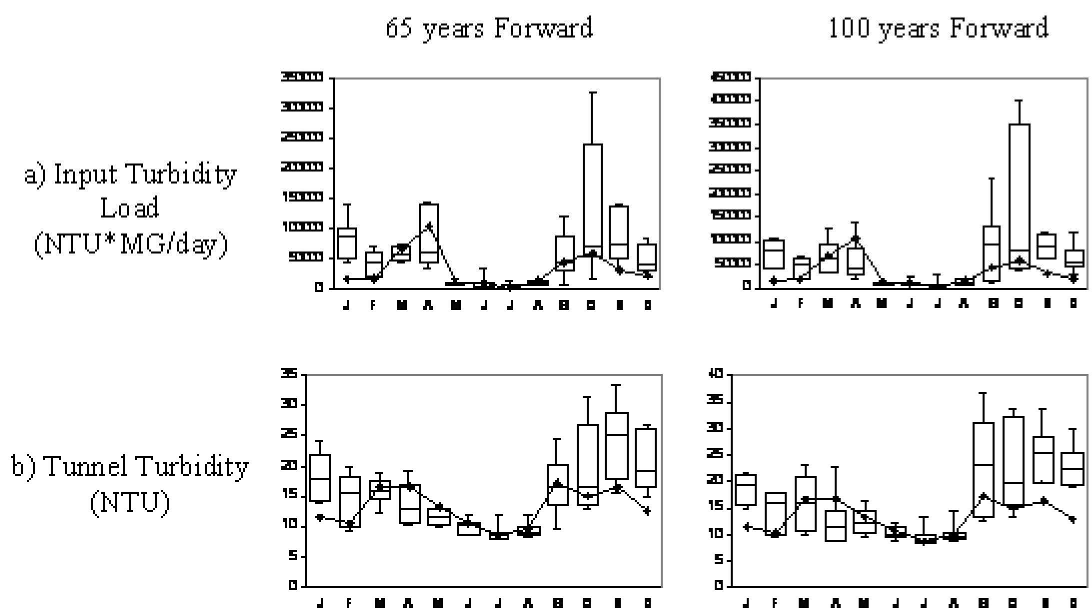

Figure 6.7 Monthly mean input turbidity load (NTU * MG/day) to Schoharie Reservoir (a), and monthly mean turbidity in the Shandaken Tunnel (NTU) (b), for baseline and eight scenarios. The midway line in the boxes shows the median value for the climate scenarios, the extent of the boxes shows the range of the middle six scenarios, and the whiskers show the range of all scenarios.

Eutrophication in Cannonsville Reservoir

Climate change effects on eutrophication in Cannonsville Reservoir were investigated using the PROTECH model. Future climate scenario watershed model flow and nutrient loads were input into the PROTECH reservoir model. In addition, the climate change scenario air temperatures were used to affect changes in thermal stratification and input stream temperatures. As with the Schoharie simulations above, the operations of the reservoir were simulated with a model preprocessor to estimate scenario aqueduct flows. The historical record was generally used for aqueduct flows, which were reduced when withdrawal exceeded available reservoir storage, to ensure that these flows were consistent with scenario reservoir inflows.

Mean monthly inputs of dissolved phosphorus are shown in Figure 6.8a. These inputs follow the patterns in streamflow with increased loads in the fall and early winter and decreased loads in the early spring. In addition to the changes in loads, the effects of temperature changes on the thermal stratification of the reservoir are shown to be important in affecting phytoplankton development. The lake temperature is increased to greatest in the fall (Figure 6.8b). This increase in temperature also coincides with a longer and more intense period of thermal stratification in the reservoir (Figure 6.9).

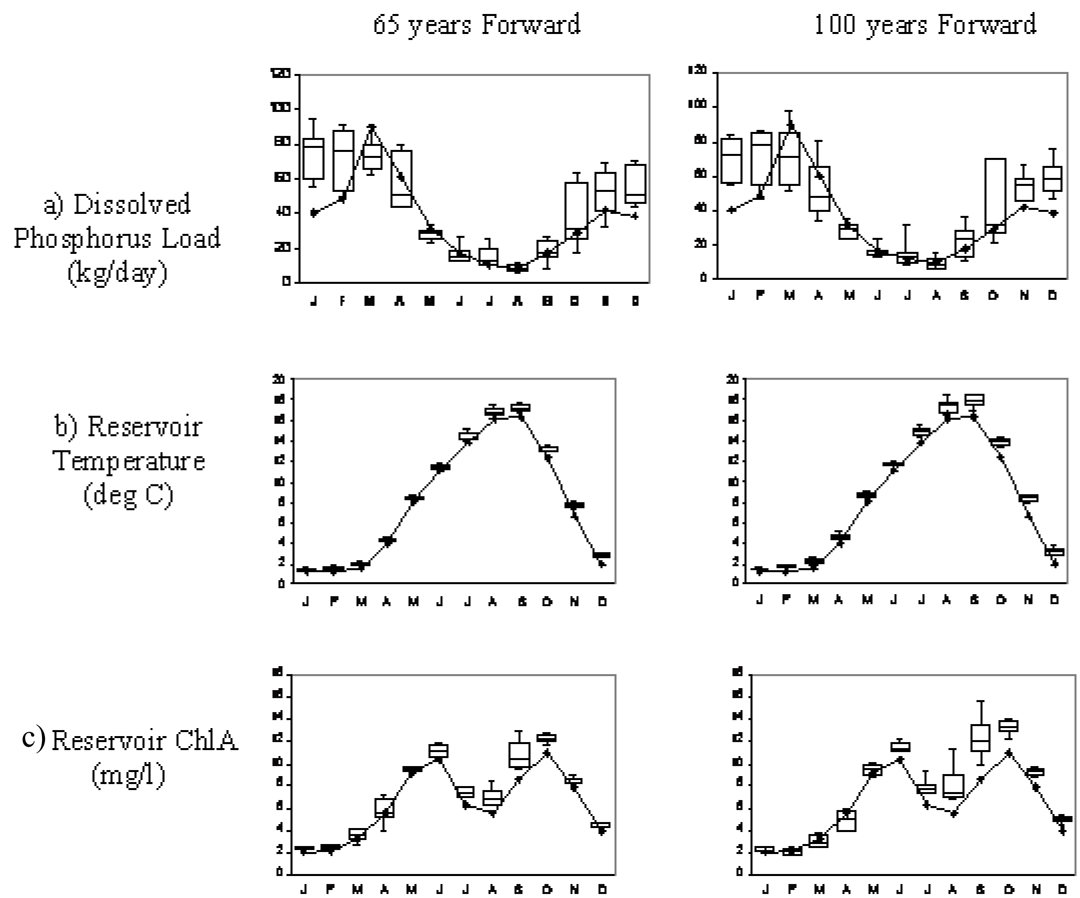

Figure 6.8 Monthly mean dissolved phosphorus (P) input (kg/day) (a), reservoir water temperature (^{o}C) (b), and chlorophyll *a* (mg/l) (c) in Cannonsville Reservoir for baseline and 8 scenarios. The midway line in the boxes shows the median value for the climate scenarios, the extent of the boxes shows the range of the middle six scenarios, and the whiskers show the range of all scenarios.

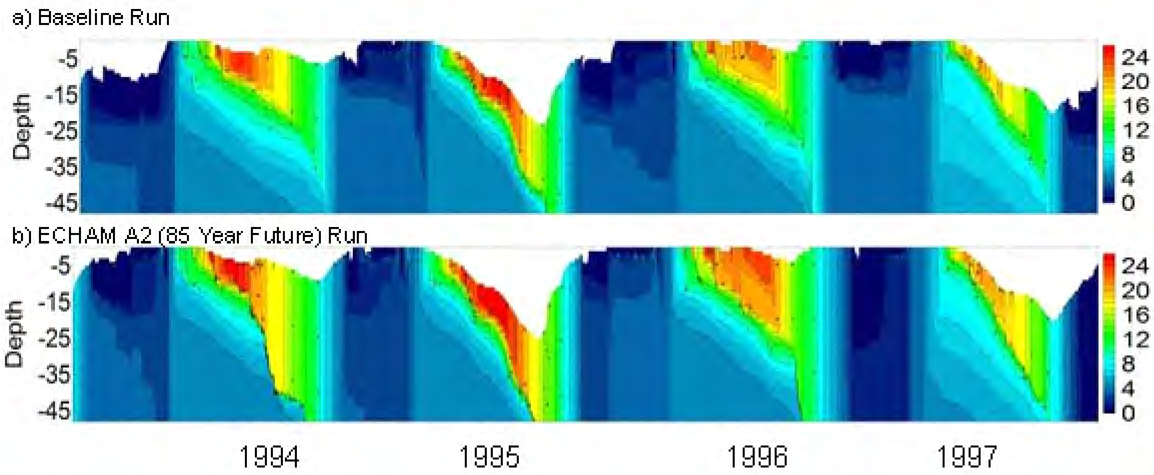

Figure 6.9 Example of time series of PROTECH model thermal profile for Cannonsville Reservoir for the baseline scenario (a) and the ECHAM A2 85 year future scenario (b). The thermal stratification starts earlier in the spring, ends later in the fall, and is more intense for the future climate scenario, as compared with the baseline scenario.

The changes in phosphorus loading and thermal stratification pattern have discernible effects on phytoplankton development (Figure 6.8c). In the baseline scenario, there are two distinct peaks in phytoplankton levels, one in the spring and one in the fall, typical of northern mid-latitude lakes. For the climate change scenarios, each of these peaks increases. In particular the fall bloom increases more intensely due to a combination of the stronger thermal stratification and the increased nutrient loads.

Summary

DEP's watershed, reservoir, and system models have been combined to perform a preliminary investigation of the effects of potential climate change on water quantity and quality in the NYC water supply. Initial results of this analysis suggest that increased air temperatures may result in less snow, more winter rain, and smaller snowpack accumulation. This may, in turn, lead to increased late fall and winter streamflows and decreased spring snowmelt. Both turbidity and nutrient loads will increase in winter due to increased flows. Additionally, reservoir thermal stratification is expected to last longer and be more intense under future conditions. The combination of increased nutrient loads and stronger thermal stratification may lead to increases in phytoplankton production, especially in the fall. Increases in turbidity loads during winter and fall will potentially lead to greater reservoir turbidity levels.

The results presented here are preliminary for a number of reasons: (1) climate change projections using delta change method do not account for possible changes in storm frequency, intensity, and spatial variability; (2) the reservoir operations adjustments need to be integrated with the OASIS system model results; (3) feedback between reservoir operations and water quality needs to be incorporated (as illustrated in the Schoharie turbidity results); (4) further model testing and sensitivity analyses are needed to understand model predictions, especially at extreme present climate and future climate conditions. These limitations will be addressed in future work.

6.4 How did DEP use model simulations in 2008 to support turbidity management and avoid alum treatment?

DEP has a suite of models that can be used to predict the transport of turbidity and levels of turbidity throughout the Catskill system of reservoirs, including Kensico Reservoir (Fig 6.10). Kensico Reservoir is of great importance for the water supply since it is the location where water from the WOH Catskill and Delaware Systems mix prior to final transport to the drinking water distribution system. Water leaving Kensico Reservoir must, as specified by the Surface Water Treatment Rule, remain below the turbidity limit of 5 NTU. Naturally occurring, episodic inputs of turbid water (e.g., Fig 6.11) do increase turbidity levels in Ashokan Reservoir and the Catskill System water withdrawn from it, and this water could in turn affect turbidity levels in Kensico Reservoir.

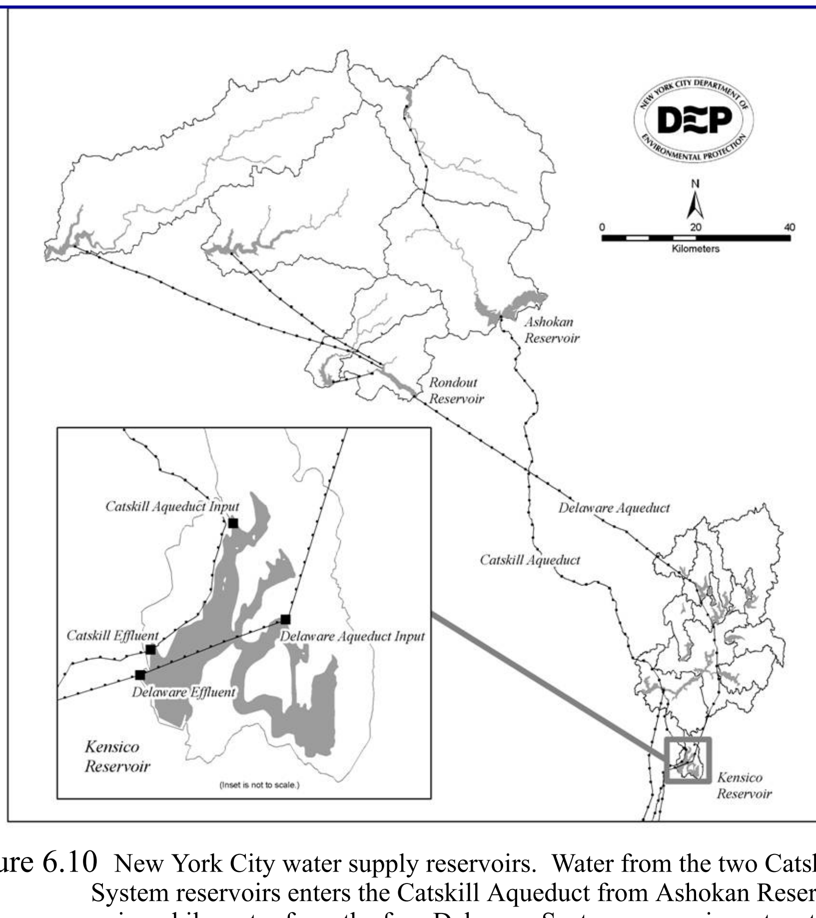

Figure 6.10 New York City water supply reservoirs. Water from the two Catskill System reservoirs enters the Catskill Aqueduct from Ashokan Reservoir, while water from the four Delaware System reservoirs enters the Delaware Aqueduct from Rondout Reservoir. Inserts show details of inflows and outflows in Ashokan and Kensico Reservoirs.

The data shown in Figure 6.11 document the only occasion during 2008 when increases in Catskill System turbidity potentially threatened Kensico Reservoir water quality. This series of storms, beginning in February 2008 and culminating in two closely spaced storm events from March 5-12, 2008, increased Ashokan Reservoir turbidity levels and the turbidity of water entering the Catskill Aqueduct. Peak turbidity levels measured in Esopus Creek, just upstream of the confluence with Ashokan Reservoir, exceeded 250 NTU, which led to an increase in Ashokan Reservoir turbidity to between 6 and 8 NTU at the Catskill Aqueduct effluent (Figure 6.11). To safeguard Kensico Reservoir water quality, Catskill Aqueduct flow was reduced during this event, while the withdrawal of low turbidity Delaware System water was increased. Model simulations were used to help define safe levels of Catskill Aqueduct flow as turbidity changed over the course of the event.

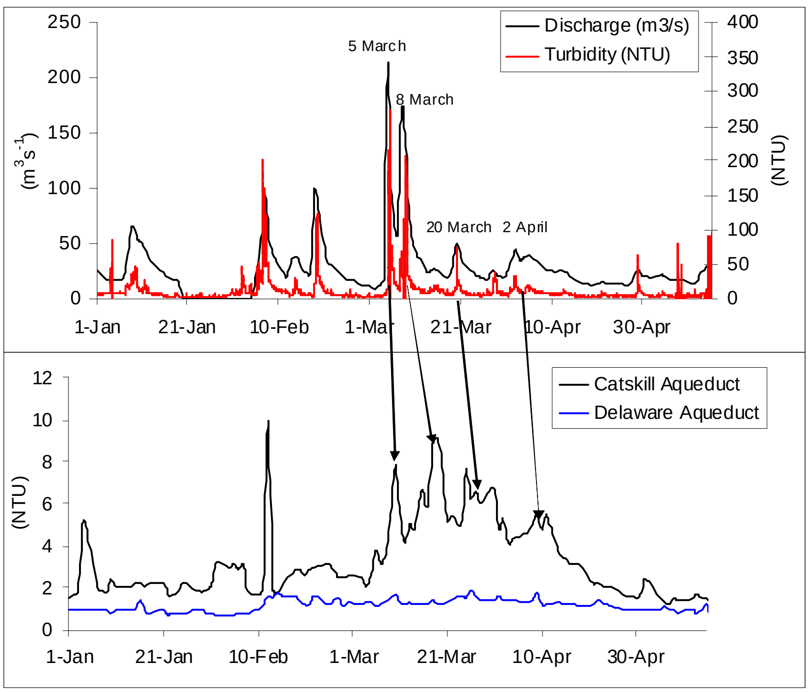

Figure 6.11 Conditions leading up to and following the March 2008 turbidity event. The top panel shows the discharge and turbidity measured in Esopus Creek near its confluence with Ashokan Reservoir. The bottom panel shows the turbidity levels measured in the Catskill and Delaware Aqueduct withdrawals from Ashokan and Rondout Reservoirs. The arrows show the correspondence between the storm event turbidity inputs to Ashokan Reservoir and the change of turbidity in the Catskill Aqueduct effluent withdrawn from the East Basin of Ashokan Reservoir.

Table 6.1: Steady state inputs used for Kensico modeling forecasts during the March 2008 turbidity event. This is a subset of a larger number of combinations of aqueduct flow and turbidity used to provide multiple forecasts during the event.

Kensico Aqueduct flows				Kensico input turbidity	
Cat In MGD	Del In MGD	Cat Out MGD	Del Out MGD	Cat In NTU	Del In NTU
600	500	400	700	15	1.5
300	800	400	700	15	1.5

An example of a model-based forecast of the turbidity levels in the water withdrawn from Kensico Reservoir is shown in Figure 6.12. This forecast was made on March 7 as the turbidity event unfolded. For these simulations the model was initially run using measured aqueduct inputs of water and turbidity to Kensico Reservoir and measured outputs of water from the reservoir. Comparison of the simulated output turbidity levels with those measured by DEP leading up to the event suggested that the model was capable of predicting the pre-event turbidity levels within the margin of error related to uncertainty in particle sinking. Following this initial "spin up" period, future inputs to the reservoir were based on the need to satisfy a demand of 1100 MGD and to maintain a mass balance of water within Kensico Reservoir. Two forecasts are illustrated here. In the first, the total demand was apportioned between the Catskill and Delaware Systems in an approximately equal manner, which would be typical of normal operating conditions, and in the second the Catskill Aqueduct flow was reduced by half, while increasing the Delaware flow. Delaware reservoir turbidity levels were assumed to be at 1.5 NTU, as was measured at the time of the event (Figure 6.11). Catskill System turbidity levels were assumed to vary between 6-20 NTU, based on the trend in Ashokan Reservoir withdrawal turbidity (Figure 6.11). For the forecast described here, a turbidity level of 15 NTU was chosen, which at the time of the simulations was a reasonable estimate of a maximum "worst case" turbidity. The forecast input levels are given in Table 6.1. These were held constant for one month into the future following the model spin up period. During the actual event multiple simulations were run using a range of input turbidity levels.

The results suggested that at a normal flow of 600 MGD Catskill Aqueduct turbidity inputs would likely lead to Kensico effluent turbidity levels exceeding the 5 NTU regulatory limit. Reducing the Catskill Aqueduct flow to 300 MGD, while increasing the Delaware Aqueduct flow by the same amount, almost completely eliminated the possibility of turbidity levels exceeding 5 NTU.

The example forecast shown in Figure 6.12 illustrates how model simulations were used to define acceptable aqueduct flow rates to Kensico Reservoir during periods of elevated Catskill System turbidity. Based on this and related simulations it was suggested that under current operating conditions Catskill input turbidity levels up to, but not exceeding, 10 NTU could be tolerated.

Further reductions in Catskill Aqueduct flow to at least 300 MGD would be required if turbidity exceeded 10-15 NTU, in order to maintain a reasonable margin of safety in approaching the 5 NTU regulatory limit. Actual Catskill Aqueduct turbidity levels remained below 10 NTU, but on a number of occasions peaked close to this value (Figure 6.11). Given that DEP had the capability to reduce the Catskill flows and that Catskill turbidity levels were approaching a level that could lead to increases in Kensico effluent turbidity, a decision was made to reduce Catskill Aqueduct flows by approximately 50 percent on March 11, 2008.

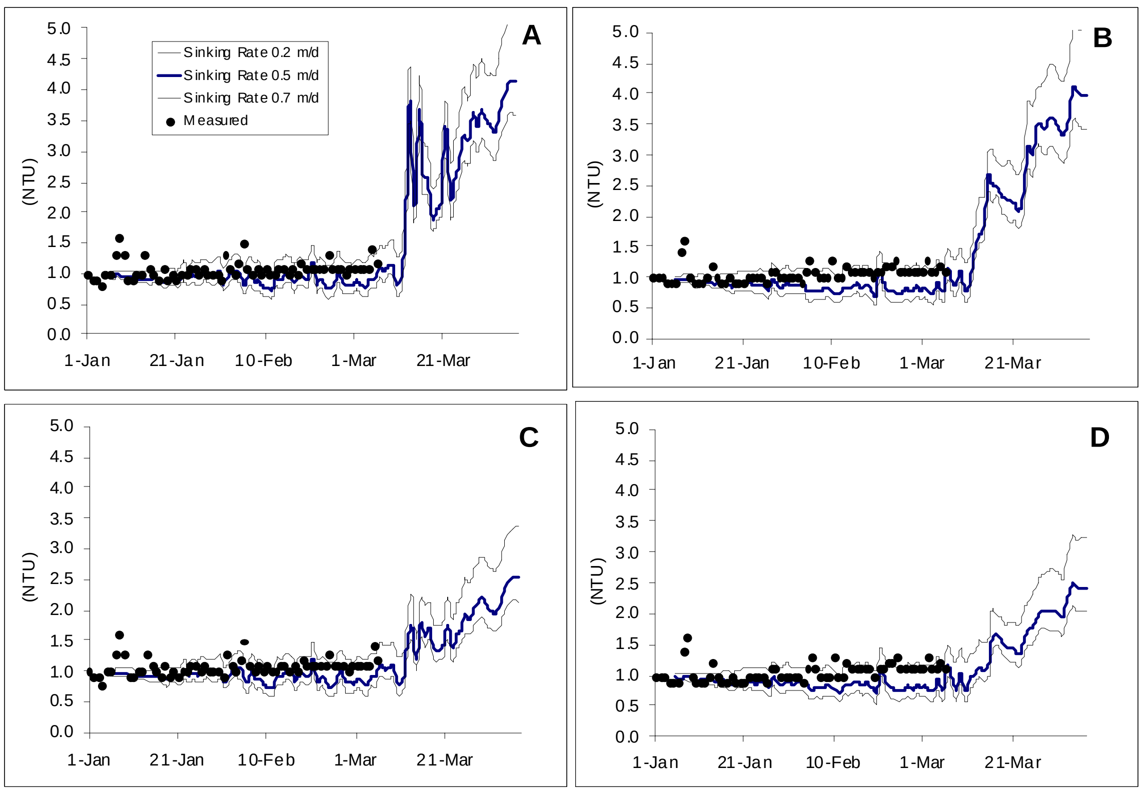

Figure 6.12 Simulated Kensico Reservoir effluent turbidity levels assuming a constant 15 NTU turbidity in the Catskill Aqueduct input to the reservoir. In the top portion of the figure the predicted turbidity at the Catskill (A) and Delaware (B) effluents are shown assuming a Catskill Aqueduct flow of 600 MGD. In the bottom portion of the figure the predicted turbidity in the Catskill (C) and Delaware (D) effluents are shown when the Catskill Aqueduct flow was reduced to 300 MGD and the Delaware Aqueduct flow was increased to 800 MGD. The three lines show a range in simulated turbidity that results from reasonable variations in the settling rate of the turbidity-causing particles. The points are measured turbidity during the period prior to the forecasts.

The March-April 2008 event described above was a moderate event that led to elevated turbidity levels in Catskill System water. Turbidity increases were not extreme enough to require alum treatment. Rather, it was possible to mitigate the effects of elevated Catskill turbidity, by cutting back on the Catskill System flow entering Kensico Reservoir. The use of models to optimize reservoir operations helped DEP choose aqueduct flow rates while at the same time accounting for reservoir system turbidity levels.

6.5 How does DEP obtain and make use of future climate simulation data?

For long-term planning, DEP requires future climate simulations as inputs to an integrated suite of models (Section 6.1) to examine the potential effects of climate change on the quantity and quality of water in the NYC water supply.

Since the future climate is unknown and uncertain, future climate scenarios are simulated, and scientists around the world use a number of possible scenarios to cover the uncertainty. A number of methods are available to obtain future climate simulations. DEP uses Global Climate Model (GCMs) simulations for possible emission scenarios (called SRES A1B, SRES B1, and SRES A2). GCMs are complex mathematical models, which simulate the behavior of the global climate system, its components, and their interactions. The components include the atmosphere, the hydrosphere (liquid water), the cryosphere (ice and snow), the lithosphere (rock and soil), and the biosphere (plants and animals, including humans). Nonlinear interactions between components occur through physical, chemical, and biological processes. The GCM simulations are at global scale (40,000 km^2), so DEP processes them to get local future climate conditions at the watershed scale (2000 km^2) using various downscaling techniques. The methodologies used by DEP are widely used by policy makers, scientists, and other experts for assessing the causes of climate change and its potential impacts.

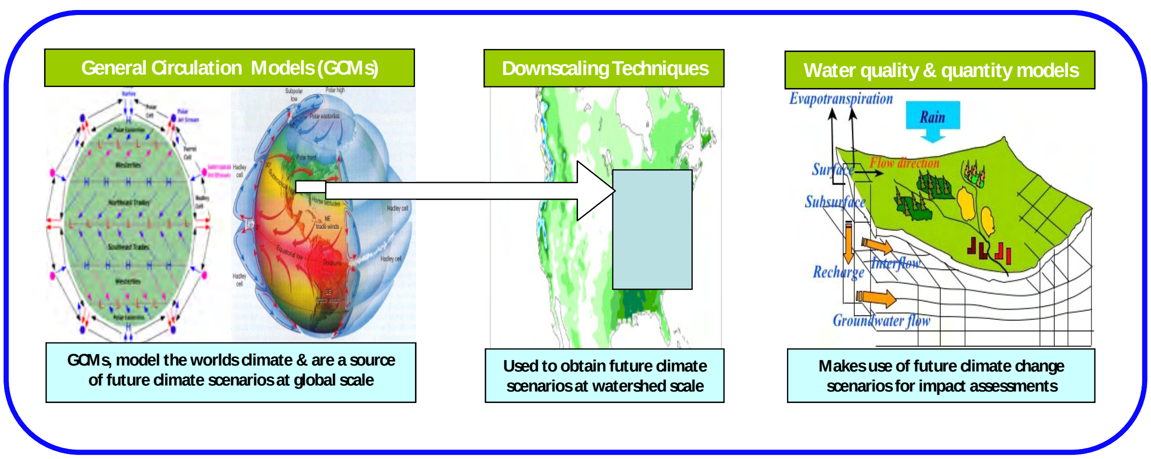

Figure 6.13 Overview of processing future climate simulation data to produce data sets that can be used with DEP's watershed and reservoir models.

7. Further Research

7.1 What research is DEP currently or prospectively engaged in that will extend its water quality monitoring capabilities?

In 2008, DEP completed studies intended to enhance understanding of pathogens during storm events and in transport at Hillview Reservoir. At the same time, DEP continued its development of models that elucidate and quantify the effects of climate, watershed management, and reservoir operations on the quality and reliability of the NYC water supply system. These projects are described more fully below.

Pathogens

Storm Water Monitoring

In 2008, DEP completed a multi-year project funded by DEP and a United States Army Corps of Engineers Water Resources Development Act (WRDA) grant. The project began in August 2005 and continued through May 2008, and included sites in the NYC watershed both east and west of the Hudson River.

Results from the project have provided more detailed information concerning pathogens and storm events in the watershed. DEP was able to develop automated systems to continuously monitor storm water flows and collect samples for pathogen analysis at multiple sites around the reservoir system, with enough flexibility to assess pathogen concentrations during different phases of the storm. DEP was also able to identify optimal pathogen sample collection time throughout the storm within the stream storm hydrograph; identify pathogen occurrence, concentration, and load during storm events from site to site; and compare pathogen concentrations and loads during storm events to available base flow conditions. Additionally, DEP studied the relationship between pathogen concentration and storm event size, as well as the effect of stream size and water resource protection projects—such as storm water retention basins—on pathogen occurrence, transport, and loading. These studies provide insight into how and when monitoring and protection of the water supply should be performed.

<u>West of Hudson</u>. The West of Hudson data indicate that storm events have greater pathogen concentration, loading, and weighted loading rate compared to base flow data at all sites for the two sub-basins studied, Esopus Creek in the Ashokan Reservoir watershed and Schoharie Creek in the Schoharie Reservoir watershed. Similarly, *Giardia* was consistently greater than *Cryptosporidium* for concentration (approximately 1 order of magnitude), loading (approximately 2-3 orders of magnitude), and weighted loading index (approximately 1-2 orders of magnitude). This consistency may be useful if it is found to apply to the entire NYC Watershed, since it could lead to the development of a rough estimate of *Giardia* and *Cryptosporidium* ratios during storm events.

In addition to comparing the sub-basins, the pathogen data were used to help identify whether protozoan pathogens originated from point or non-point sources. Esopus Creek—the primary tributary of Ashokan Reservoir—did not reveal any evidence of protozoan pathogen point sources, except for SRR2CM, which represents the outflow of Schoharie Reservoir via the Shandaken Tunnel. On the other hand, the Schoharie Creek sub-basin data suggest both a point and non-point origin, based on the abundance of protozoan pathogens and land use. The data indicate a relatively significant increase in both *Cryptosporidium* and *Giardia* between an upstream site (SSHG) and a midstream site (S4), while both the baseline and storm event data suggest that the abundance of *Cryptosporidium* and *Giardia* in the Schoharie Creek sub-basin is greater than in the Esopus Creek sub-basin. A comparison of land use between the sub-basins indicates that the Schoharie Creek sub-basin has significantly more livestock farming, population centers, and WWTPs than the Esopus Creek sub-basin, and that these land uses occur more frequently close to Schoharie Creek. A more detailed look at the land use between SSHG and S4 indicates that two population centers (Tannersville and Hunter) and nine WWTPs occur in close proximity to Schoharie Creek. The next step to determine the specific sources of the protozoa would be to conduct a more exhaustive land use analysis, with ground truthing and sampling at the WWTPs that are not currently monitored, for both base flow and storm events.

East of Hudson. As with data from the West, East of Hudson data indicate that storm events have greater pathogen concentration, loading, and weighted loading rate compared to base flow data at all sites for the eight sub-watersheds studied.

The project also provided valuable data relating to appropriate sampling intervals for monitoring storms East of Hudson. For the larger streams in the Kensico watershed, 30 minute sample intervals using two autosamplers (24 samples for each autosampler) seem to capture most small to moderate storms adequately. Larger storms (2 inches or greater) at these sites require additional autosampler runs, or longer sampling intervals. In general, smaller streams require a 10-30 minute sample interval depending on the size of the storm, the rainfall intensity, and consistency. DEP missed several peak flows at small streams because the interval was too long.

Differences between the timing of protozoan transport in unmodified streams and BMP-modified streams became quite apparent during DEP's analysis. Unmodified streams exhibited the "first flush phenomenon" characteristic of basins with residential development and impervious surfaces. The highest concentrations of pathogens at unmodified streams were found in the rising limb, followed by the peak of flow. Estimates of pathogen loading were greatest in the peak of flow at unmodified streams, which can be attributed to the extremely elevated flow during this portion of the storm and its ability to mobilize particles and microbes from the landscape into the streams. BMP data suggest an attenuation of protozoa in the BMPs, with a delayed discharge of the elevated protozoa later in the storm.

In sum, the project achieved most of its goals, providing informative results and generating new questions regarding the mobilization of pathogens during storm events. A complete report discussing details of the project will be forthcoming under separate cover.

Hillview Reservoir

Hillview Reservoir, part of New York City's water supply located in Yonkers, New York, fits the description of an uncovered finished water storage facility according to the Long Term Enhanced Surface Water Treatment Rule 2 (LT2). Under this rule, NYC was required to cover the reservoir or treat its discharge in a manner the rule prescribes. In September 2006, DEP initiated a study to see if a significant difference in protozoa existed at the reservoir's effluent compared to its influent, to determine if remedial actions of this kind were warranted. The sampling scheme included sites along both the Catskill and Delaware Aqueducts, which flow through and bypass Hillview Reservoir, respectively. Sample collection was carried out in two sampling periods: September 12, 2006–September 29, 2007, and March 4–August 28, 2008. No significant difference ($p=0.5$) was detected between protozoa at the inflows and outflows of Hillview, indicating the open reservoir does not contain significant sources of these pathogens. This suggests that covering Hillview Reservoir will not significantly improve the quality of drinking water with respect to levels of protozoa (DEP 2008c).

Modeling

Two major planned advancements in DEP's modeling capability—the linkage of watershed and reservoir models to a system-wide model (OASIS) and the development of more spatially-distributed and process-based watershed models—have been undertaken to support long-term planning for climate change and watershed management that maximizes water quality in the NYC Water Supply.

A system-wide modeling approach investigates how each reservoir fits into the larger water supply system. This type of analysis would investigate the probability of exceeding (or staying below) regulatory and guidance pollutant limits at key system locations (e.g., Kensico effluents, Shandaken Tunnel portal, Rondout effluent) under various realistic scenarios of flow and loading conditions. By simulating the entire system, the effects on system operations due to improved water quality in one reservoir can be analyzed.

Spatially-distributed watershed models explicitly simulate loadings from sub-basins and route water and pollutants from their sources to each reservoir. The effects of BMP-induced pollutant load reductions on reservoir water quality may differ depending on where in the watershed the pollutant sources are being treated. These analyses would support prioritization of sub-basins (and possibly stream reaches) for watershed management.

These advances in modeling are being developed as a result of several projects to upgrade DEP's modeling capability and evaluate the effects of climate change on the water supply. Current FAD funding over the next four years will provide the resources to develop the data, models, and tools that could subsequently be used as the basis for future model applications.

7.2 What work is supported through contracts?

DEP accomplishes several goals through contracts, as listed in Table 7.1. The primary types of contracts are: (1) Operation and Maintenance, (2) Monitoring, and (3) Research and Development. The Operations and Maintenance contracts are typically renewed each year because they are devoted to supporting the ongoing activities of the laboratory and field operations. The Monitoring contracts are devoted to handling some of the laboratory analyses that must be done to keep up-to-date on the status of the water supply. Research and Development contracts typically answer questions that allow DEP to implement effective watershed management and plan for the future.

Table 7.1: DEP contracts related to water quality monitoring and research.

Contract Description	Contract Term
Operation and Maintenance	
Operation and Maintenance of DEP's Hydrological Monitoring Network (Stream Flow)	10/1/06–9/30/09
Operation and Maintenance of DEP's Hydrological Monitoring Network (Water Quality)	10/1/06–9/30/10
Waterfowl Management at Kensico Reservoir	8/1/07–3/31/10
SAS Software Contract	6/24/03–6/30/09
Monitoring	
Monitoring of NYC Reservoirs for Viruses	7/29/08–7/28/11
Monitoring of NYC Reservoirs for Zebra Mussels	8/1/08–6/30/10
Monitoring of NYC Residences for Lead and Copper	1/1/07–12/31/09
Organic Analysis Laboratory Contract	7/1/08–6/30/11
Bulk Chemical Analysis	8/1/05–7/31/08
Analysis of Stormwater at Beerston, Cannonsville Watershed	11/1/07–10/30109
Research and Development	
Design of Controls for Zebra Mussels in NYC's Water Supply System	1/5/94–6/30/10
Development of Turbidity Models for Schoharie Reservoir and Esopus Creek	8/26/03–12/31/10
Croton System Model Development and Protech	11/15/05–6/30/10
Robotic Water Quality Monitoring Network	1/1/09–12/31/11

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Appendix A Reservoir-wide summary statistics for a variety of physical, biological, and chemical analytes

Appendix Table A.1. Reservoir-wide summary statistics for a variety of physical, biological, and chemical analytes, 2008.

		Kensico			New Croton			East Ashokan Basin			Rondout		
Analyte	WQS	N	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median
PHYSICAL													
Temperature (°C)		427	2.6 - 21.9	11.4	309	3.8 - 24.8	10.9	92	3.8 - 23.7	10.5	179	2.9 - 22.3	10.4
pH (units)	6.5-8.5 [1]	362	6.3 - 7.5	7.0	256	6.9 - 8.9	7.5	92	5.9 - 8.2	7.1	149	6.0 - 8.5	7.0
Alkalinity (mg/L)		20	8.7 - 13.3	10.6	29	51.7 - 70.6	59.9	9	9.2 - 12.1	9.9	9	5.3 - 9.9	6.5
Conductivity		401	50 - 88	67	309	328 - 377	353	86	50 - 64	56	179	44 - 61	53
Hardness (mg/L) [2]		20	16.12 - 20.5	19.0	18	82.5 - 93.8	87.9	8	15.9 - 18.2	16.3	9	12.1 - 16.9	14.3
Color (Pt-Co units)	(15)	371	5 - 15	10	316	8 - 45	20	89	5 - 15	9	180	7 - 16	12
Turbidity (NTU)	(5) [3]	427	0.2 - 2.5	1.1	316	0.7 - 4.7	2.0	91	0.8 - 6.6	1.6	180	0.4 - 1.7	0.9
Secchi Disk Depth (m)		117	2.3 - 6.1	4.8	102	1.6 - 3.7	2.6	25	2.1 - 5.8	4.2	51	3.7 - 6.9	5.3
BIOLOGICAL													
Chlorophyll *a* (µg/L)	7 [4]	61	<0.40 - 9.30	4.30	48	4.70 - 16.60	11.75	20	0.96 - 3.78	1.88	24	0.22 - 5.13	2.28
Total Phytoplankton (SAU)	2000 [4]	159	30 - 1300	260	161	2 - 2600	540	59	5 - 870	170	106	<5 - 650	155
CHEMICAL													
Dissolved Organic Carbon (mg/L)		193	1.1 - 1.9	1.5	160	2.1 - 4.0	2.9	57	1.3 - 1.8	1.5	80	1.3 - 1.9	1.5
Total Phosphorus (µg/L)	15 [4]	195	3 - 10	6	161	1.5 - 33	14	65	<5 - 13	8	100	<5 - 9	7
Total Nitrogen (mg/L)		177	0.15 - 0.44	0.29	162	0.22 - 0.80	0.48	48	0.11 - 0.40	0.29	80	0.25 - 0.47	0.34
Nitrate+Nitrite-N (mg/L)	10 [1]	170	0.042 - 0.336	0.190	162	<0.010 - 0.520	0.213	42	<0.050 - 0.276	0.181	29	0.120 - 0.411	0.257
Total Ammonia-N (mg/L)	2 [1]	136	<0.010 - 0.035	<0.010	138	<0.010 - 0.447	0.038	57	<0.02 - 0.05	0.02	70	<0.02 - 0.03	<0.02
Iron (mg/L)	0.3 [1]	6	0.02 - 0.04	0.02	62	0.02 - 0.14	0.07	8	0.02 - 0.06	0.03	8	0.02 - 0.04	0.02
Manganese (mg/L)	(0.05)	6	na	na	69	na	na	8	na	na	8	na	na
Lead (µg/L)	50 [1]	6	<1 - <1	<1	4	<1 - <1	<1	8	<1 - <1	<1	8	<1 - <1	<1
Copper (µg/l)	200 [1]	6	<3 - <3	<3	4	<3 - 18	<3	8	<3 - 27	<3	8	<3 - <3	<3
Calcium (mg/L)		20	4.7 - 5.8	5.4	18	20.8 - 24.6	22.8	8	4.8 - 5.2	5.0	9	3.5 - 4.9	4.1
Sodium (mg/L)		20	4.06 - 5.95	5.41	25	28.9 - 35.3	32.90	8	3.59 - 4.09	3.75	9	3.42 - 4.17	3.64
Chloride (mg/L)	250 [1]	20	7.3 - 10.9	9.0	27	60.5 - 69	66.9	27	6.3 - 7.1	6.7	25	6.4 - 8.1	6.9

Appendix Table A.1. Reservoir-wide summary statistics for a variety of physical, biological, and chemical analytes, 2008.

			Amawalk			Bog Brook			Boyd Corners			Croton Falls	
Analyte	WQS	N	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median
PHYSICAL													
Temperature (°C)		49	5.6 - 25.0	12.1	50	6.5 - 25.1	13.0	44	6.9 - 26.0	17.5	34	7.3 - 24.2	14.8
pH (units)	6.5-8.5 [1]	49	7.0 - 9.1	7.7	47	7.0 - 8.7	7.5	44	6.8 - 8.1	7.4	28	7.0 - 8.5	7.4
Alkalinity (mg/L)		9	63.2 - 79.8	69.3	9	64.3 - 78	70.6	5	23.9 - 37.1	34.5	3	44.7 - 53.6	45.8
Conductivity		49	451 - 488	470	50	308 - 329	316	44	193 - 224	209	34	251 - 409	300
Hardness (mg/L) [2]		9	98.9 - 110.0	106.2	7	92.3 - 95.7	94.1	5	40.4 - 51.2	48.3	3	65.3 - 77.6	66.0
Color (Pt-Co units)	(15)	49	12 - 35	20	48	10 - 35	18	39	15 - 30	25	24	15 - 50	21
Turbidity (NTU)	(5) [3]	49	1.0 - 4.2	2.2	48	0.9 - 5.3	2.0	40	0.7 - 3.1	1.7	24	1.5 - 18.0	2.5
Secchi Disk Depth (m)		18	2.0 - 3.9	2.9	15	2.1 - 4.4	3.3	17	2.6 - 4.3	3.6	8	2.7 - 3.6	2.9
BIOLOGICAL													
Chlorophyll *a* (µg/L)	7 [4]	18	3.10 - 22.10	9.10	14	1.40 - 34.90	5.35	18	<0.40 - 14.10	6.90	3	9.20 - 13.60	10.70
Total Phytoplankton (SAU)	2000 [4]	12	63 - 2200	310	10	250 - 3000	710	13	30 - 3300	400	8	490 - 1500	1100
CHEMICAL													
Dissolved Organic Carbon (mg/L)		47	2.7 - 4.1	3.3	45	2.8 - 4.2	3.3	40	2.2 - 4.4	3.9	13	2.1 - 2.9	2.6
Total Phosphorus (µg/L)	15 [4]	49	9 - 44	17	48	6 - 100	19	40	6 - 15	12	18	5 - 38	15
Total Nitrogen (mg/L)		49	0.24 - 0.87	0.47	41	0.18 - 0.57	0.27	37	0.15 - 0.67	0.24	13	0.26 - 1.04	0.29
Nitrate+Nitrite-N (mg/L)	10 [1]	49	<0.010 - 0.395	0.112	42	<0.010 - 0.105	0.005	38	<0.010 - 0.133	0.005	13	<0.010 - 0.210	0.095
Total Ammonia-N (mg/L)	2 [1]	42	<0.010 - 0.417	0.022	45	<0.010 - 0.292	<0.010	38	<0.010 - 0.033	<0.010	13	<0.010 - 0.843	0.027
Iron (mg/L)	0.3 [1]	3	0.05 - 0.10	0.09	3	0.06 - 0.96	0.06	4	0.07 - 0.49	0.10	0	na	
Manganese (mg/L)	(0.05)	3	na	na	3	na	na	4	na	na	0	na	na
Lead (µg/L)	50 [1]	3	<1 - 1	<1	3	<1 - <1	<1	4	<1 - <1	<1	0	na	
Copper (µg/l)	200 [1]	3	<3 - <3	<3	3	<3 - 10	<3	4	<3 - <3	<3	0	na	
Calcium (mg/L)		9	24.3 - 27.9	26.4	7	23.2 - 23.9	23.4	5	10.1 - 12.6	12.0	3	16.5 - 19.8	16.8
Sodium (mg/L)		9	44.8 - 49.8	49.00	7	23.6 - 25.5	24.50	5	20.6 - 22.5	22.10	3	28.7 - 36.3	29.00
Chloride (mg/L)	250 [1]	6	93.9 - 98.8	96.3	8	49 - 52.5	51.7	5	38 - 41.3	40.4	3	54.8 - 66.9	54.9

Appendix Table A.1. Reservoir-wide summary statistics for a variety of physical, biological, and chemical analytes, 2008.

			Cross River			Diverting			East Branch			Lake Gilead	
Analyte	WQS	N	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median
PHYSICAL													
Temperature (°C)		54	4.5 - 25.7	8.9	31	7.9 - 21.4	15.8	55	7.0 - 24.9	15.8	35	5.0 - 24.5	5.4
pH (units)	6.5-8.5 [1]	54	6.7 - 9.0	7.4	29	7.3 - 8.4	7.6	52	7.1 - 8.7	7.4	20	6.8 - 8.9	7.1
Alkalinity (mg/L)		9	38.7 - 46	42.3	4	69.4 - 102.9	78.0	9	67.8 - 92.4	85.8	3	40.2 - 45.8	41.5
Conductivity		54	219 - 247	225	31	313 - 391	358	55	292 - 345	322	20	196 - 221	209
Hardness (mg/L) [2]		9	57.7 - 65.5	61.0	3	99.4 - 124.0	102.3	6	89.6 - 110.0	102.6	3	55.5 - 58.9	56.9
Color (Pt-Co units)	(15)	51	10 - 30	20	21	20 - 40	25	55	15 - 50	25	6	10 - 25	10
Turbidity (NTU)	(5) [3]	51	0.8 - 7.4	1.8	21	1.7 - 5.8	3.0	55	0.8 - 4.1	1.9	6	1.0 - 1.9	1.4
Secchi Disk Depth (m)		16	2.6 - 5.1	3.6	15	1.4 - 3.2	2.6	16	1.9 - 4.1	2.3	7	2.6 - 5.3	4.4
BIOLOGICAL													
Chlorophyll *a* (µg/L)	7 [4]	14	2.10 - 16.40	7.10	11	4.20 - 35.30	10.58	17	1.50 - 21.20	10.70	2	3.00 - 5.80	4.40
Total Phytoplankton (SAU)	2000 [4]	9	33 - 1700	780	6	100 - 3300	1700	10	25 - 2700	675	2	9 - 30	20
CHEMICAL													
Dissolved Organic Carbon (mg/L)		51	2.5 - 3.5	2.9	17	2.7 - 4.7	3.3	52	3.0 - 6.1	3.9	6	2.6 - 3.7	3.0
Total Phosphorus (µg/L)	15 [4]	48	9 - 27	13	26	11 - 35	21	55	7 - 35	19	6	11 - 171	20
Total Nitrogen (mg/L)		51	0.11 - 0.57	0.31	14	0.28 - 0.90	0.42	49	0.18 - 0.64	0.32	6	0.23 - 0.74	0.33
Nitrate+Nitrite-N (mg/L)	10 [1]	45	<0.010 - 0.327	0.025	18	<0.010 - 0.251	0.184	49	<0.010 - 0.181	0.024	6	<0.010 - 0.042	0.012
Total Ammonia-N (mg/L)	2 [1]	45	<0.010 - 0.173	0.018	16	<0.010 - 0.616	0.021	52	<0.010 - 0.159	0.014	6	<0.010 - 0.452	<0.010
Iron (mg/L)	0.3 [1]	3	0.05 - 0.25	0.06	2	0.24 - 0.27	0.25	3	0.05 - 0.17	0.05	3	0.02 - 0.22	0.04
Manganese (mg/L)	(0.05)	3	na	na	2	na	na	3	na	na	3	na	na
Lead (µg/L)	50 [1]	3	<1 - <1	<1	2	<1 - <1	<1	3	<1 - <1	<1	3	<1 - 2	<1
Copper (µg/l)	200 [1]	3	<3 - <3	<3	2	<3 - <3	<3	3	<3 - 6	<3	3	<3 - <3	<3
Calcium (mg/L)		9	15.5 - 17.8	16.6	3	25.4 - 32.2	25.9	6	22.4 - 27.4	25.5	3	13.8 - 15.1	14.2
Sodium (mg/L)		9	16.6 - 18.1	17.80	3	29.1 - 31.5	30.00	6	21.3 - 22.7	21.55	5	15.7 - 17.0	16.30
Chloride (mg/L)	250 [1]	12	36.2 - 37.6	36.8	4	54 - 64.4	59.3	9	43.2 - 47.8	47.3	3	34.1 - 34.7	34.2

Appendix Table A.1. Reservoir-wide summary statistics for a variety of physical, biological, and chemical analytes, 2008.

			Lake Gleneida			Kirk Lake			Muscoot			Middle Branch	
Analyte	WQS	N	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median
PHYSICAL													
Temperature (°C)		35	5.0 - 24.6	5.7	24	10.5 - 27.4	21.0	58	8.3 - 23.2	15.0	45	6.7 - 24.6	10.6
pH (units)	6.5-8.5 [1]	20	7.0 - 8.8	7.4	15	7.1 - 8.8	7.6	58	7.0 - 9.0	7.6	45	7.0 - 9.0	7.4
Alkalinity (mg/L)		3	64.8 - 79.2	66.5	3	46.8 - 51.2	51.1	6	63 - 93.3	68.7	9	47.2 - 65.9	55.7
Conductivity		20	378 - 431	403	15	322 - 349	342	58	311 - 476	365	45	438 - 482	452
Hardness (mg/L) [2]		3	92.4 - 95.6	92.4	0	na		5	89.3 - 109.4	95.2	8	75.6 - 87.2	79.4
Color (Pt-Co units)	(15)	6	10 - 70	15	5	20 - 30	25	56	20 - 90	25	38	15 - 50	22
Turbidity (NTU)	(5) [3]	6	0.7 - 10.0	1.6	5	2.1 - 4.7	4.5	56	1.1 - 10.0	2.8	38	1.6 - 11.0	2.6
Secchi Disk Depth (m)		7	4.5 - 5.0	4.8	18	1.8 - 3.6	2.9	32	1.5 - 3.4	2.5	15	1.8 - 6.4	3.0
BIOLOGICAL													
Chlorophyll *a* (µg/L)	7 [4]	1	2.60 - 2.60	2.60	2	10.10 - 18.80	14.45	29	1.10 - 39.10	16.40	13	<0.40 - 21.00	9.00
Total Phytoplankton (SAU)	2000 [4]	2	50 - 200	125	2	120 - 1800	960	21	25 - 4400	1200	7	23 - 2700	900
CHEMICAL													
Dissolved Organic Carbon (mg/L)		6	2.3 - 3.0	2.8	5	4.3 - 4.5	4.4	56	1.5 - 4.9	3.7	38	2.4 - 4.2	3.1
Total Phosphorus (µg/L)	15 [4]	6	8 - 268	21	5	17 - 35	26	56	13 - 60	23	38	12 - 221	20
Total Nitrogen (mg/L)		6	0.24 - 0.95	0.26	5	0.27 - 0.56	0.31	49	0.25 - 1.35	0.48	34	0.22 - 1.39	0.45
Nitrate+Nitrite-N (mg/L)	10 [1]	3	<0.010 - <0.010	0.005	5	<0.010 - 0.045	0.005	56	<0.010 - 0.552	0.203	36	<0.010 - 0.382	0.065
Total Ammonia-N (mg/L)	2 [1]	6	<0.010 - 0.769	<0.010	5	<0.010 - 0.183	<0.010	56	<0.010 - 0.99	0.019	33	<0.010 - 0.831	0.047
Iron (mg/L)	0.3 [1]	3	0.02 - 0.86	0.04	3	0.05 - 0.11	0.09	4	0.10 - 2.35	0.16	4	0.06 - 1.22	0.12
Manganese (mg/L)	(0.05)	3	na	na	3	na	na	4	na	na	4	na	na
Lead (µg/L)	50 [1]	3	<1 - 2	2	3	<1 - 2	<1	4	<1 - <1	<1	4	<1 - <1	<1
Copper (µg/l)	200 [1]	3	<3 - <3	<3	3	<3 - 8	4	4	<3 - <3	<3	4	<3 - <3	<3
Calcium (mg/L)		3	22.9 - 24.1	22.9	0	na		5	22.7 - 27.4	24.2	8	19.3 - 22	20.4
Sodium (mg/L)		6	40.2 - 42.8	40.90	1	32.3 - 32.3	32.30	5	27.4 - 38.1	32.10	8	50.3 - 54.7	52.45
Chloride (mg/L)	250 [1]	3	79.3 - 81.6	79.4	3	64.7 - 65.4	64.7	6	58.2 - 81.1	71.1	8	96 - 103.3	99.8

Appendix Table A.1. Reservoir-wide summary statistics for a variety of physical, biological, and chemical analytes, 2008.

		Titicus			West Branch			West Ashokan Basin			Pepacton		
Analyte	WQS	N	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median
PHYSICAL													
Temperature (°C)		49	4.8 - 25.5	10.9	147	3.6 - 23.6	13.8	143	4.0 - 22.8	9.5	203	2.7 - 23.3	7.3
pH (units)	6.5-8.5 [1]	49	7.0 - 8.6	7.7	133	6.4 - 8.1	7.2	143	5.9 - 7.5	6.7	157	6.6 - 9.2	7.1
Alkalinity (mg/L)		9	58.5 - 68.3	64.3	14	9.4 - 50.5	17.9	12	6.6 - 13.9	10.1	21	9.2 - 13.5	10.5
Conductivity		49	261 - 298	275	139	59 - 165	95	105	42 - 70	55	190	54 - 67	58
Hardness (mg/L) [2]		9	76.1 - 89.8	82.6	5	19.2 - 30.2	22.1	9	12.7 - 20.0	18.1	19	16.3 - 20.3	18.2
Color (Pt-Co units)	(15)	46	10 - 35	20	147	8 - 30	15	141	6 - 18	12	197	6 - 17	12
Turbidity (NTU)	(5) [3]	46	0.8 - 4.9	1.9	147	0.7 - 3.5	1.4	144	1.3 - 9.3	3.6	197	0.4 - 9.0	1.6
Secchi Disk Depth (m)		17	2.0 - 4.6	2.7	60	0.2 - 5.0	3.6	39	1.4 - 4.5	3.1	66	0.6 - 5.1	3.9
BIOLOGICAL													
Chlorophyll *a* (µg/L)	7 [4]	17	1.40 - 18.70	8.40	28	<0.40 - 16.60	4.45	28	1.04 - 4.71	2.18	43	0.03 - 8.03	4.33
Total Phytoplankton (SAU)	2000 [4]	7	75 - 1600	640	76	21 - 2500	440	75	<5 - 610	180	61	<5 - 880	230
CHEMICAL													
Dissolved Organic Carbon (mg/L)		45	2.5 - 4.6	3.1	62	1.5 - 3.3	2.0	85	1.0 - 2.1	1.3	145	1.2 - 2.0	1.4
Total Phosphorus (µg/L)	15 [4]	42	11 - 48	17	74	5 - 19	9	105	<5 - 14	8	192	<5 - 22	8
Total Nitrogen (mg/L)		45	0.20 - 0.70	0.34	75	0.15 - 0.39	0.26	75	0.15 - 0.39	0.30	130	0.14 - 0.59	0.47
Nitrate+Nitrite-N (mg/L)	10 [1]	40	<0.010 - 0.353	0.020	76	<0.010 - 0.264	0.131	59	<0.050 - 0.301	0.222	64	<0.050 - 0.480	0.381
Total Ammonia-N (mg/L)	2 [1]	36	<0.010 - 0.431	0.023	76	<0.010 - 0.101	<0.010	85	<0.02 - 0.03	<0.02	142	<0.02 - 0.04	<0.02
Iron (mg/L)	0.3 [1]	3	0.05 - 0.42	0.08	5	0.03 - 0.96	0.06	8	0.02 - 0.50	0.05	8	0.02 - 0.04	0.03
Manganese (mg/L)	(0.05)	3	na	na	5	na	na	8	na	na	8	na	na
Lead (µg/L)	50 [1]	3	<1 - <1	<1	5	<1 - <1	<1	8	<1 - 1	<1	8	<1 - <1	<1
Copper (µg/l)	200 [1]	3	<3 - <3	<3	5	<3 - <3	<3	8	<3 - 14	<3	8	<3 - 3	<3
Calcium (mg/L)		9	19.4 - 23.1	21.0	5	5.1 - 7.9	5.8	9	3.8 - 6.2	5.5	19	4.8 - 6.1	5.3
Sodium (mg/L)		9	17.9 - 19.9	18.70	5	7.85 - 10.5	8.80	9	3.32 - 4.41	3.79	19	3.62 - 3.90	3.74
Chloride (mg/L)	250 [1]	9	39 - 41	39.8	14	9.6 - 34.3	19.0	36	5.9 - 7.6	6.6	40	6.2 - 7	6.8

Appendix Table A.1. Reservoir-wide summary statistics for a variety of physical, biological, and chemical analytes, 2008.

			Neversink			Schoharie			Cannonsville	
Analyte	WQS	N	Range	Median	N	Range	Median	N	Range	Median
PHYSICAL										
Temperature (°C)		136	3.3 - 22.4	8.1	119	4.2 - 22.1	9.7	183	3.7 - 23.2	11.8
pH (units)	6.5-8.5 [1]	136	5.6 - 7.3	6.3	119	6.3 - 7.7	6.9	166	6.5 - 9.1	7.0
Alkalinity (mg/L)		9	1.7 - 6.5	3.0	9	9.7 - 18.8	12.9	18	10.9 - 20.4	15.8
Conductivity		136	25 - 31	29	108	58 - 92	73	183	73 - 103	83
Hardness (mg/L) [2]		9	7.3 - 8.2	8.0	6	16.4 - 19.8	18.6	18	20.0 - 26.6	24.7
Color (Pt-Co units)	(15)	136	7 - 18	12	91	5 - 24	16	165	8 - 23	14
Turbidity (NTU)	(5) [3]	136	0.3 - 1.6	0.8	120	1.2 - 11.0	4.3	165	0.8 - 11.0	2.4
Secchi Disk Depth (m)		39	4.4 - 9.8	5.8	41	1.1 - 4.0	2.2	59	1.7 - 5.3	2.9
BIOLOGICAL										
Chlorophyll *a* (µg/L)	7 [4]	32	0.47 - 6.00	2.65	35	0.16 - 5.67	1.63	48	1.44 - 13.27	5.07
Total Phytoplankton (SAU)	2000 [4]	62	<5 - 220	41	52	<5 - 1100	56	76	5 - 4400	295
CHEMICAL										
Dissolved Organic Carbon (mg/L)		97	1.4 - 2.1	1.6	73	1.4 - 2.8	1.7	147	1.3 - 2.2	1.6
Total Phosphorus (µg/L)	15 [4]	135	<5 - 8	5	104	6 - 19	10	163	5 - 19	14
Total Nitrogen (mg/L)		97	0.10 - 0.35	0.28	73	0.14 - 0.45	0.32	120	0.20 - 0.79	0.54
Nitrate+Nitrite-N (mg/L)	10 [1]	46	<0.050 - 0.250	0.180	37	<0.050 - 0.350	0.180	60	<0.050 - 0.721	0.402
Total Ammonia-N (mg/L)	2 [1]	96	<0.02 - 0.08	<0.02	64	<0.02 - 0.04	0.02	132	<0.02 - 0.05	0.02
Iron (mg/L)	0.3 [1]	7	0.04 - 0.10	0.06	4	0.11 - 0.33	0.15	8	0.04 - 0.11	0.07
Manganese (mg/L)	(0.05)	7	na	na	4	na	na	8	na	na
Lead (µg/L)	50 [1]	7	<1 - 1	<1	4	<1 - <1	<1	8	<1 - <1	<1
Copper (µg/l)	200 [1]	7	<3 - <3	<3	4	<3 - <3	<3	8	<3 - 5	<3
Calcium (mg/L)		9	2.1 - 2.3	2.3	6	5.1 - 6.0	5.8	18	5.6 - 7.6	7.1
Sodium (mg/L)		9	1.69 - 1.85	1.80	6	4.57 - 5.32	5.04	18	5.94 - 7.56	6.40
Chloride (mg/L)	250 [1]	21	3.1 - 3.7	3.5	28	6.8 - 11.1	9.6	32	10.3 - 12.7	11.1

Notes for Appendix A:

Footnotes:

1 = Numeric water quality standards, from 6NYCRR Part 703.
2 = Hardness calculated as follows:
Hardness=2.497[Ca^{+2}] + 4.118[Mg^{+2}]
3 = Narrative water quality standards.
4 = DEP target values are listed for chlorophyll *a*, total phosphorus, and total phytoplankton. The total phosphorus target value of 15 µg L^{-1} applies to source water reservoirs only and has been adopted by NYSDEC in the TMDL Program.

The turbidity, color, and manganese standards in parentheses are applicable only to keypoint and treated water, respectively, but are supplied to provide context for the reservoir data.

Abbreviations:

N = number of samples
na = not available
Range = minimum to 95%-ile (to avoid the occasional outlier in the dataset)
< = non detect; number to right of < is the detection limit
SAU = standard areal units

Data Analysis Considerations:

Reservoirs are sampled at least monthly from April to November, except for the controlled lakes Gleneida, Kirk, and Gilead, which are only sampled 3 times per year. Some reservoirs (e.g., Croton Falls and Diverting) were sampled less than monthly because of limited access due to dam rehabilitation work. The 2008 data were provisional at the time this report was written.

For most parameters, the data for each reservoir represent a statistical summary of all samples taken at the sites and depths listed in Section 3.3, Reservoir Status, of the Integrated Monitoring Report (DEP 2003a).

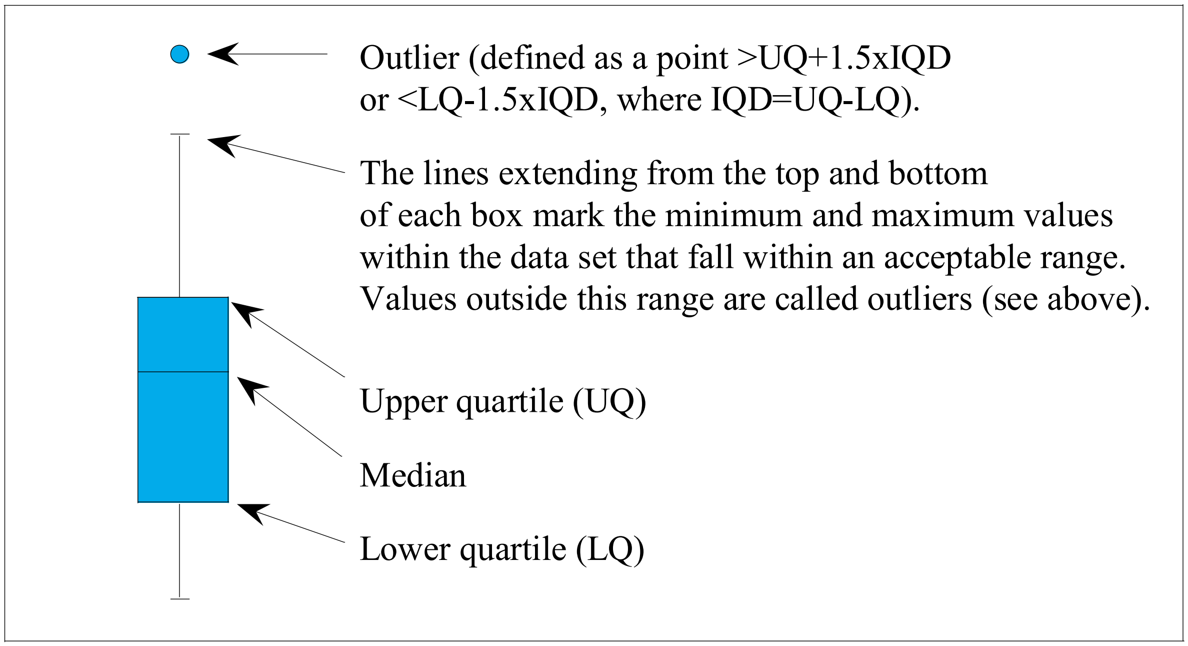
Chlorophyll *a* results are from surface samples collected at a 3-meter depth from April –November. Note that this differs from the trophic status boxplots presented in Chapter 3, which only consider photic samples collected during the growing season (May–October).

Values less than the detection limit have been converted to half the detection limit for all calculations. Analytical detection limits vary by analyte and laboratory.

Analytical Methods:

In general all analytical methods are taken from Standard Methods. Details are available on request.

Appendix B Key to Boxplots



Appendix C - Phosphorus-Restricted Basin Assessment Methodology

A phosphorus-restricted basin is defined in the New York City Watershed Regulations as "the drainage basin of a reservoir or controlled lake in which the phosphorus load to the reservoir or controlled lake results in the phosphorus water quality values established by the New York State Department of Environmental Conservation and set forth in its Technical and Operational Guidance Series (TOGS) 1.1.1, Ambient Water Quality and Guidance Values (October 22, 1993) being exceeded as determined by the Department pursuant to its annual review conducted under Section 18-48c of Subchapter D." (DEP 2002a). The designation of a reservoir basin as phosphorus restricted has two primary effects:1) new or expanded wastewater treatment plants with surface discharges are prohibited in the reservoir basin, and 2) stormwater pollution prevention plans required by the Watershed Regulations must include an analysis of phosphorus runoff, before and after the land disturbance activity, and must be designed to treat the 2-year, 24-hour storm. A summary of the methodology used in the phosphorus-restricted analysis will be given here; the complete description can be found in A Methodology for Determining Phosphorus Restricted Basins (DEP 1997).

The list of phosphorus-restricted basins is updated annually. The data utilized in the analysis is from the routine limnological monitoring of the reservoirs. All reservoir samples taken during the growing season, which is defined as May 1 through October 31, are used. Any recorded concentrations below the analytical limit of detection are set equal to half the detection limit. The detection limit for DEP measurements of total phosphorus is assessed each year by the DEP laboratories, and typically ranges between 2–5 $\mu g\ L^{-1}$. Phosphorus concentration data for the reservoirs approaches a lognormal distribution; therefore, the geometric mean is used to characterize the annual phosphorus concentrations. Appendix Table C.1 provides the annual geometric mean for the past six years.

The five most recent annual geometric means are averaged arithmetically, and this average constitutes one assessment. The "running average" method weights each year equally, thus reducing the effects of unusual hydrology or phosphorus loading for any given year, while maintaining an accurate assessment of the current conditions in the reservoir. If any reservoir has less than three surveys during a growing season, then that annual average may or may not be representative of the reservoir, and the data for the under-sampled year is removed from the analysis. In addition, each five-year assessment must incorporate at least three years of data.

To provide some statistical assurance that the five-year arithmetic mean is representative of a basin's phosphorus status, given the interannual variability, the five-year mean plus the standard error of the five-year mean is compared to the NYS guidance value of 20 $\mu g\ L^{-1}$. A basin is **unrestricted** if the five-year mean plus standard error is below the guidance value of 20 $\mu g\ L^{-1}$, and phosphorus **restricted** if it is equal to or greater than 20 µg L^{-1}, unless DEP, using its best professional judgment, determines that the phosphorus-restricted designation is due to an unusual and unpredictable event unlikely to occur in the future. A reservoir basin designation, as phosphorus restricted or unrestricted, may change through time based on the outcome of this annual assessment. However, a basin must have two consecutive assessments (i.e., two years in a row) that result in the new designation in order to officially change the designation.

Appendix Table C.1: Geometric mean total phosphorus data utilized in the phosphorus-restricted assessments. All reservoir samples taken during the growing season (May 1 through October 31) are used. Any recorded concentrations below the analytical limit of detection are set equal to half the detection limit.

Reservoir Basin	2003 µg L^{-1}	2004 µg L^{-1}	2005 µg L^{-1}	2006 µg L^{-1}	2007 µg L^{-1}	2008 µg L^{-1}
Delaware District						
Cannonsville Reservoir	15.4	15.1	19.6	20.5	14.0	13.4
Pepacton Reservoir	9.1	9.2	8.7	10.8	9.7	8.2
Neversink Reservoir	5.2	5.0	7.3	7.3	4.7	4.7
Rondout Reservoir	6.8	8.6	7.8	8.6	7.1	6.1
Catskill District						
Schoharie Reservoir	7.5	13.3	20.6	17.4	9.7	9.5
Ashokan-West Reservoir	6.1	9.3	26.0	11.2	8.1	7.2
Ashokan-East Reservoir	7.0	10	11.0	9.9	7.3	7.5
Croton District						
Amawalk Reservoir	19.6	26.5	24.0	24.5	20.2	17.9
Bog Brook Reservoir	16.9	26.8	18.6	18.7	24.0	21.5
Boyd Corners Reservoir	12.4	13.8	*	17.4	15.6	11.6
Cross River Reservoir	17.9	20.2	18.7	18.6	17.8	13.8
Croton Falls Reservoir	20.4	18.1	*	19.2	*	14.4**
Diverting Reservoir	28.8	28.3	*	*	*	22.8
East Branch Reservoir	26.5	44.2	28.3	28.4	23.0	21.6
Middle Branch Reservoir	23.7	*	31.5	24.2	25.0	27.9
Muscoot Reservoir	29.5	26.0	26.8	27.9	25.7	27.6
Titicus Reservoir	27.3	25.4	24.6	29.6	21.6	17.5
West Branch Reservoir	10.2	11.5	14.8	10.3	9.6	9.4
Lake Gleneida	22.8	*	*	24.2	*	*

Appendix Table C.1: (Continued) Geometric mean total phosphorus data utilized in the phosphorus- restricted assessments. All reservoir samples taken during the growing season (May 1 through October 31) are used. Any recorded concentrations below the analytical limit of detection are set equal to half the detection limit.

Reservoir Basin	2003 $\mu g\ L^{-1}$	2004 $\mu g\ L^{-1}$	2005 $\mu g\ L^{-1}$	2006 $\mu g\ L^{-1}$	2007 $\mu g\ L^{-1}$	2008 $\mu g\ L^{-1}$
Lake Gilead	28.5	21.8	*	30.5	33.6	*
Kirk Lake	30.8	*	*	29.7	28.6	*
Source Water						
Kensico Reservoir	7.6	8.8	9.7	7.6	7.0	6.4
New Croton Reservoir	19.5	22.4	18.2	18.1	17.7	15.5

* Indicates less than three successful surveys during the growing season (May–October).

**The Croton Falls mean was biased due to sampling the main basin only (for details, see Section 3.7).

Appendix D. Monthly coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008)

Appendix Table D.1: Monthly coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008). 6NYCRR Part 703 requires a minimum of five samples per month. Both the median value and >20 % of the total coliform counts for a given month need to exceed the stated value for a reservoir to exceed the standard.

Reservoir	Class	Standard (Median/ Value not > 20% of samples)	Collection Date	n	Median Total Coliform (CFU100mL^{-1})	Percentage > Standard
CA	A	2400/5000	Apr-08	5	20	0
CA			May-08	5	45	0
CA			Jun-08	5	20	0
CA			Jul-08	5	>1600	0
CA			Aug-08	5	100	0
CA			Sep-08	5	<100	0
CA			Oct-08	5	40	0
CA			Nov-08	5	60	0
CBB	AA	50/240	Apr-08	5	<5	0
CBB			May-08	5	10	0
CBB			Jun-08	6	25	0
CBB			Jul-08	5	10	0
CBB			Aug-08	5	120	0
CBB			Sep-08	6	100	0
CBB			Oct-08	5	20	0
CBB			Nov-08	6	40	0
CBC	AA		Apr-08	6	15	0
CBC			May-08	5	20	0
CBC			Jun-08	5	440	80
CBC			Jul-08	7	<20	0
CBC			Aug-08	7	1000	100
CBC			Sep-08	7	<500	100
CBC			Oct-08	7	200	14
CCF	A/AA	50/240	Jul-08	5	900	100
CCF			Aug-08	5	<100	0

Appendix Table D.1: (Continued) Monthly coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008). 6NYCRR Part 703 requires a minimum of five samples per month. Both the median value and >20 % of the total coliform counts for a given month need to exceed the stated value for a reservoir to exceed the standard.

Reservoir	Class	Standard (Median/ Value not > 20% of samples)	Collection Date	n	Median Total Coliform (CFU100mL^{-1})	Percentage > Standard
CCF			Sep-08	6	50	0
CCF			Oct-08	18	50	0
CCF			Nov-08	3	Insufficient Data	-
CCR	A/AA	50/240	Apr-08	6	10	0
CCR			May-08	5	<5	0
CCR			Jun-08	6	20	0
CCR			Jul-08	6	85	17
CCR			Aug-08	5	20	0
CCR			Sep-08	6	410	67
CCR			Oct-08	6	90	17
CCR			Nov-08	6	60	0
CD	AA	50/240	Apr-08	5	20	0
CD			May-08	3	Insufficient Data	-
CD			Jun-08	5	TNTC	?
CD			Jul-08	5	250	60
CD			Aug-08	5	400	60
CD			Sep-08	4	Insufficient Data	-
CEB	AA	50/240	Apr-08	5	20	0
CEB			May-08	6	50	0
CEB			Jun-08	6	120	0
CEB			Jul-08	6	20	0
CEB			Aug-08	5	60	0
CEB			Sep-08	6	215	50
CEB			Oct-08	6	30	0
CEB			Nov-08	6	65	0

Appendix Table D.1: (Continued) Monthly coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008). 6NYCRR Part 703 requires a minimum of five samples per month. Both the median value and >20 % of the total coliform counts for a given month need to exceed the stated value for a reservoir to exceed the standard.

Reservoir	Class	Standard (Median/ Value not > 20% of samples)	Collection Date	n	Median Total Coliform (CFU100mL^{-1})	Percentage > Standard
CGD	A	2400/5000	Apr-08	5	<5	0
CGD			May-08	5	5	0
CGD			Jun-08	5	35	0
CGD			Jul-08	5	200	0
CGD			Aug-08	5	<50	0
CGD			Sep-08	5	10	0
CGD			Oct-08	5	90	0
CGD			Nov-08	5	10	0
CGL	AA	50/240	Apr-08	5	<5	0
CGL			May-08	5	5	0
CGL			Jun-08	5	5	0
CGL			Jul-08	5	<100	0
CGL			Aug-08	5	<20	0
CGL			Sep-08	5	20	0
CGL			Oct-08	5	20	0
CGL			Nov-08	5	5	0
CKL	B	2400/5000	Apr-08	5	5	0
CKL			May-08	5	10	0
CKL			Jun-08	5	30	0
CKL			Jul-08	5	100	0
CKL			Aug-08	5	100	0
CKL			Sep-08	5	60	0
CKL			Oct-08	5	200	0
CM	A	2400/5000	Apr-08	7	45	0
CM			May-08	7	160	0

Appendix Table D.1: (Continued) Monthly coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008). 6NYCRR Part 703 requires a minimum of five samples per month. Both the median value and >20 % of the total coliform counts for a given month need to exceed the stated value for a reservoir to exceed the standard.

Reservoir	Class	Standard (Median/ Value not > 20% of samples)	Collection Date	n	Median Total Coliform ($CFU100mL^{-1}$)	Percentage > Standard
CM			Jun-08	7	300	0
CM			Jul-08	7	200	0
CM			Aug-08	7	2300	29
CM			Sep-08	7	580	0
CM			Oct-08	7	620	0
CM			Nov-08	7	200	0
CMB	A	2400/5000	Apr-08	5	5	0
CMB			May-08	5	20	0
CMB			Jun-08	5	30	0
CMB			Jul-08	5	20	0
CMB			Aug-08	7	70	0
CMB			Sep-08	5	40	0
CMB			Oct-08	5	40	0
CMB			Nov-08	5	40	0
CT	AA	50/240	Apr-08	5	5	0
CT			May-08	5	5	0
CT			Jun-08	5	50	0
CT			Jul-08	5	200	40
CT			Aug-08	5	200	40
CT			Sep-08	5	50	0
CT			Oct-08	5	20	0
CT			Nov-08	5	40	0
EDP	A/AA	50/240	Apr-08	34	2	0
EDP			May-08	34	3	3
EDP			Jun-08	28	4	0

Appendix Table D.1: (Continued) Monthly coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008). 6NYCRR Part 703 requires a minimum of five samples per month. Both the median value and >20 % of the total coliform counts for a given month need to exceed the stated value for a reservoir to exceed the standard.

Reservoir	Class	Standard (Median/ Value not > 20% of samples)	Collection Date	n	Median Total Coliform ($CFU100mL^{-1}$)	Percentage > Standard
EDP			Jul-08	32	12	13
EDP			Aug-08	16	40	0
EDP			Sep-08	16	15	0
EDP			Oct-08	15	12	0
EDP			Nov-08	16	6	0
NN	AA	50/240	Apr-08	26	2.5	4
NN			May-08	25	7	0
NN			Jun-08	24	2	0
NN			Jul-08	12	4	0
NN			Aug-08	12	<10	0
NN			Sep-08	11	16	0
NN			Oct-08	11	12	0
NN			Nov-08	12	15	0
SS	AA	50/240	Apr-08	20	170	25
SS			May-08	18	90	17
SS			Jun-08	18	950	78
SS			Jul-08	9	>8000	92
SS			Aug-08	9	>16000	100
SS			Sep-08	9	>29000	100
SS			Oct-08	9	2000	100
SS			Nov-08	9	1900	100
WDC	A/AA	50/240	Apr-08	30	2	0
WDC			May-08	30	11	3
WDC			Jun-08	30	100	17
WDC			Jul-08	15	200	41

Appendix Table D.1: (Continued) Monthly coliform-restricted calculations for total coliform counts on non-terminal reservoirs (2008). 6NYCRR Part 703 requires a minimum of five samples per month. Both the median value and >20 % of the total coliform counts for a given month need to exceed the stated value for a reservoir to exceed the standard.

Reservoir	Class	Standard (Median/ Value not > 20% of samples)	Collection Date	n	Median Total Coliform ($CFU100mL^{-1}$)	Percentage > Standard
WDC			Aug-08	15	80	10
WDC			Sep-08	15	100	6
WDC			Oct-08	15	<10	0
WDC			Nov-08	15	35	0

Note: (1) The reservoir class is defined by 6NYCRR Parts 815, 862, 864, and 879. For those reservoirs that have dual designations, the higher standard was applied. (2) Diverting Reservoir had five samples in June that were Too Numerous To Count (TNTC). The median could not be estimated for these samples.

Exhibit 10: Proposed Treatment Methods

All surface water and groundwater entering New York City's distribution system is treated with chlorine, fluoride, food grade phosphoric acid and, in some cases, sodium hydroxide; additionally, the City has the capability to treat with alum and chlorine at selected watershed locations, when needed.

Due to their high quality, waters from the Croton and Catskill/Delaware systems have historically only been treated with chlorine disinfection, beginning in 1910 for the Croton System and at the startup of the Catskill and Delaware systems. New York City continues to use chlorine to meet the New York State Sanitary Code and federal Safe Drinking Water Act disinfection requirements.

Chlorination currently takes place at multiple locations in the Croton and Catskill/Delaware systems. Croton water is chlorinated at the Croton Lake Gate House to achieve a level of disinfection sufficient to satisfy the Surface Water Treatment Rule (SWTR) in the New Croton aqueduct. Additional chlorine is added at the Jerome Park Reservoir to help maintain a residual within the distribution system. Similarly, the Catskill/Delaware system water is chlorinated twice prior to the distribution of water into the City. Chlorine is initially added to both the Catskill and Delaware aqueducts as the water leaves Kensico Reservoir. Chlorine levels from this initial application are used to achieve compliance with the SWTR. Additional chlorine is added to the City's three water tunnels at Hillview Reservoir and at several points in the City to help maintain residual levels in the distribution system. NYC also has the ability to treat water quality issues in the Catskill and Delaware system at watershed reservoirs above Kensico Reservoir. Chlorine in the form of sodium hypochlorite can be added to water leaving Rondout and West Branch Reservoirs. Two water treatment facilities located in the influent chambers of West Branch (Delaware Shaft 9) and Kensico Reservoirs (Delaware Shaft 17) can provide dechlorination with sodium bisulfite, thus avoiding the release of chlorinated water into either the West Branch or Kensico Reservoirs.

DEP is one of the many drinking water systems in New York State that provides drinking water with a controlled, low level of fluoride for consumer dental health protection. In 1966, the City began adding fluoride at the Kensico (Catskill and Delaware) and Dunwoodie (Croton) Facilities. The New York City Health Code requires a fluoride concentration of 1.0 mg/L, with an acceptable range of 0.9 to 1.1 mg/L. To ensure that the fluoride supplement in the water provides optimal dental protection, NYSDOH requires that NYCDEP monitor fluoride levels on a daily basis.

Two water treatment facilities can also apply aluminum sulfate (alum) to increase settling of particulates in Catskill and Delaware water entering Kensico Reservoir during periods of high turbidity. Alum has been used occasionally on the Catskill system, where it is added to the Catskill Aqueduct at the Pleasantville Alum Plant prior to the water entering the Kensico Reservoir. Alum can also be added to the Delaware system between West Branch and Kensico Reservoirs at Delaware Shaft 17 in an emergency. However, this facility has not been used since the 1970s. Sodium hydroxide addition may also take place when alum is being used at these locations to help improve the effectiveness of alum treatment.

Sodium hydroxide may also be added to Croton, Catskill, and Delaware water to raise the pH and reduce corrosivity. Sodium hydroxide additions take place at Hillview (and occasionally at Dunwoodie) to assist in corrosion control and to neutralize acidity arising from fluoride addition.

Food grade phosphoric acid is added for corrosion control to create a protective film on pipes that reduces the release of metals such as lead from household plumbing. Phosphoric acid is applied at the Hillview downtake chambers (Catskill and Delaware) and the Jerome Park Reservoir Gate House No. 5 (Croton).

Comprised of 69 wells, the NYCDEP's Groundwater System provides drinking water to fewer than 100,000 people in New York City. Residents within the system receive groundwater or a mix of ground and surface waters depending on demand and supply availability. All groundwater entering New York City's distribution system is treated with chlorine, fluoride, food grade phosphoric acid, and, in some cases, sodium hydroxide. Additionally, a sequestering phosphate is applied at several wells to prevent the precipitation of naturally occurring minerals, mostly iron and manganese, in the distribution mains and customers' household piping. Air stripper facilities and granular activated carbon units can be operated at several wells if needed, to remove volatile and semivolatile organic compounds.

Figure 1 indicates the current principal chemical feed locations, with the new Cat/Del UV Facility and Croton Water Filtration Plant (red) for the Croton, Catskill and Delaware systems.

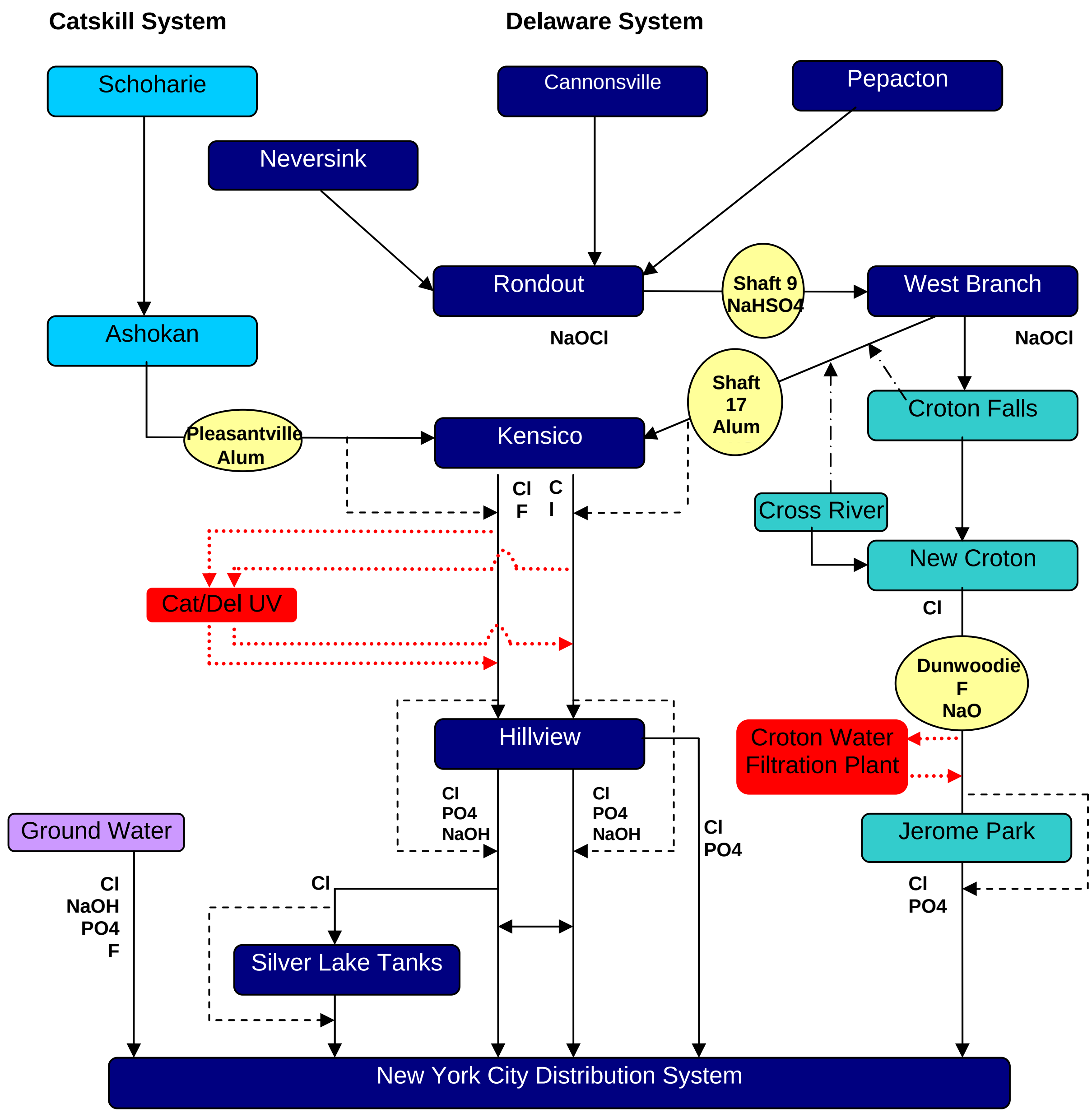


Figure 1. This diagram of the New York Water Supply System indicates the locations and current treatment capabilities of system treatment facilities. Also indicated are the locations of the Croton Water Filtration Plant and the Catskill-Delaware UV plant (in red), which are currently under construction.

Catskill/Delaware UV Facility

EPA published new regulations in the Federal Register on January 5, 2006, including the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), to improve control of microbial pathogens. In preparation for the new rule, which was first proposed in August 2003, New York City designed an ultraviolet (UV) light disinfection plant for the Catskill/Delaware System. Construction of the facility began in 2008 and operation is expected to begin in 2012.

Capable of supplying 90 to 100 percent of New York City's drinking water, the Catskill-Delaware Water System operates under a Filtration Avoidance Determination (FAD) granted by the USEPA, allowing operation of the system without filtration, but with implementation of several actions that further protect water quality. One of the FAD requirements entails design and construction of an Ultraviolet Light (UV) Disinfection Facility for the Catskill/Delaware Water System, to provide 3-log inactivation of *Cryptosporidium*. The NYCDEP is now constructing the 2,020-million gallon per day UV Facility at the New York City-owned Eastview site, a 153-acre property situated in the Westchester County Towns of Mount Pleasant and Greenburgh. The UV Facility construction effort consists of several components, including a main UV building with 56 UV disinfection chambers (each of which will treat 40 mgd); water conveyance systems (e.g., valve and metering chambers); rehabilitation of and modifications to existing Shaft 19; and a new Catskill Connection Chamber. The Facility will also include emergency power and an uninterrupted power supply (UPS). The plant will provide an additional barrier of microbiological protection by inactivating potentially harmful organisms, such as Cryptosporidium and Giardia. This treatment will supplement DEP's existing microbial disinfection programs.

Croton Water Filtration Plant

The City's goals are to ensure that water from all three of its water supply systems is at all times protected against microbiological contamination, is aesthetically pleasing, and meets all drinking water quality standards. With respect to the Croton System, the City is proceeding with the construction of a filtration plant for Croton System water, pursuant to the terms of a November 1998 federal court Consent Decree (United States vs. State of New York). The filtration plant is expected to reduce color levels, the risk of microbiological contamination, and disinfection byproduct (DBP) levels in the Croton System water. The filtration plant will also ensure compliance with stricter water quality standards. In September 2004 the City issued a notice to proceed with the first phase of construction of the Croton Water Filtration Plant at the Mosholu Golf Course site in the Bronx. In August 2006 and August 2007 the second and third phases went forward. Construction work at the site continues to make progress: excavation of the two Treated Water Tunnels has been completed; placement of concrete for lining the Raw Water Tunnel is underway; and, concrete placement, installation of mechanical piping and electrical work at the site continue to advance. In addition, work off-site at the Treated Water Shafts at Jerome Park Reservoir continues. The Croton Water Filtration Plant is expected to be operational by 2012.

The Croton Water Filtration Plant will treat up to 290 MGD using 48 dissolved air flotation stacked over filter media tanks and 20 20-MGD low pressure/high output UV units. New Croton and Jerome Park Reservoirs will be raw water sources for the plant. The finished water's chemical treatment levels will match the levels in the Catskill/Delaware water. Treated water from the plant will be capable of being feed into both the low pressure and high pressure service areas of the distribution system.

Exhibit 11

Project Justification:

A. The City's Land Acquisition Program (LAP) is justified by public necessity.

New York City currently operates its Catskill/Delaware Water Supply System pursuant to a filtration avoidance determination (FAD) issued by the U.S. Environmental Protection Agency (EPA), in consultation with the New York State Department of Health, in July 2007. As stated in the 2007 FAD, "Land acquisition is one of the most effective, and therefore, important mechanisms to permanently protect the City's Catskill/Delaware watershed." 2007 FAD at page 42. As described in the FAD, the LAP "seeks to prevent future degradation of water quality by acquiring sensitive lands and by managing the uses on those lands. The overarching goal of the LAP is to ensure that undeveloped, environmentally-sensitive watershed lands remain protected and that the watershed continues to be a source of high-quality drinking water to the City and upstate counties." Id. As a program fundamental to the continued high quality of the City's drinking water, and as a critical component of the City's continued filtration avoidance, the Land Acquisition Program is justified by public necessity.

The City is currently operating the LAP pursuant to a water supply permit issued by NYSDEC in 1997. In accordance with the MOA and the terms of the 1997 Water Supply Permit, the initial 10-year 1997 Water Supply Permit was extended to cover an additional period, through January 20, 2012. Under the 2007 FAD, the City is committed to continue the LAP through 2017, and to plan for further implementation through 2022. Accordingly, the FAD requires the City to apply for a new water supply permit, anticipated to take effect on January 21, 2012, no later than January 21, 2010. This application satisfies this condition of the FAD.

As noted in the FAD, the LAP is described in detail in the 1997 New York City Watershed Memorandum of Agreement (MOA), a comprehensive agreement among the City, the State, EPA, the watershed communities, and a number of environmental and land preservation organizations. The MOA established a framework for both ensuring long-term protection of the City's water supply and its sources, as well as supporting the economic vitality of the watershed communities. The City seeks in the 2012 Water Supply Permit to maintain elements of the LAP established under the MOA, which have proven effective in maintaining the balance struck in the MOA. These include:

- *Real property interests acquired under the LAP will be maintained in a natural state for watershed protection purposes (1997 WSP ¶ 21);*[1]
- *The LAP operates on a willing buyer/willing seller basis (1997 WSP ¶ 5);*
- *The City pays fair market value for real property interests, as described in the MOA and Special Condition 13 of the 1997 Water Supply Permit;*
- *The City does not acquire property containing habitable dwellings in the West of Hudson Watershed (1997 WSP ¶¶ 7- 8);*

1 *This and subsequent references are to the special conditions set forth in the 1997 Water Supply Permit.*

- *Specified Towns and Villages have the option to establish certain areas as off limits to the City's acquisition program (1997 WSP ¶ 10);*[2]

- *The City will acquire real property interests in Priority Areas 2, 3 and 4 of the Catskill / Delaware System (1997 WSP ¶ 6) only if they contain established natural features criteria as listed in paragraph 63 of the MOA and Special Condition 9 of the 1997 Water Supply Permit;*[3]

- *The LAP provides an opportunity to local governments to be consulted concerning each acquisition (1997 WSP ¶¶ 11-12);*[4]

- *The City allows certain recreational uses on lands held for watershed protection (WSP ¶¶ 15-16);*

- *The City pays real property taxes as assessed on land acquired in fee and on watershed conservation easements (WSP ¶ 18-20); and*

- *The Permit shall be valid through its term so long as the City continues to maintain valid and enforceable contracts for the Watershed Protection and Partnership programs which the City is required to fund pursuant to the 2007 FAD and successor Filtration Avoidance Determinations.*[5]

Exhibit 7 describes modifications to the LAP that the City proposes in connection with ongoing discussions involving NYSDEC along with other State and federal agencies, as well as representatives of the watershed communities and environmental advocacy and land protection organizations. Exhibit 7 also includes the City's Long-Term Land Acquisition Plan, which addresses the schedule issues described in Special Condition 14 of the 1997 WSP.

Except as specified in Exhibit 7 or as specifically noted above, the City expects that the 2012 Water Supply Permit will include the terms and conditions of the 1997 Water Supply Permit.

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2 *Exhibit 7 proposes modifications to the areas that towns may determine to be off limits for acquisition.*

3 *Exhibit 7 proposes a clarification to the applicability of the natural features criteria as set forth in the MOA. In addition, in [YEAR], the City sought and obtained authorization to acquire certain properties not meeting the natural features criteria pursuant to a program administered under the Hazard Mitigation Grant Program of the Federal Disaster Assistance Act. The City would expect this authorization to continue under the 2012 Water Supply Permit.*

4 *As the LAP is already in operation, the City does not expect to provide the notifications to local officials described in ¶ 11(a) or to make the presentations described in ¶ 11(b) and (c).*

5 *The City expects that the programs subject to this requirement, memorialized in Special Conditions 25 and 27 of the 1997 Water Supply Permit, will be:*

  - *Septic Remediation and Replacement Program*
  - *Septic Maintenance Program*
  - *Community Wastewater Management Program*
  - *Stormwater Retrofit Program*
  - *Watershed Agricultural Program*
  - *Stream Management Program*

The City does not envision the need for permit terms relating to the possibility of the Watershed Regulations becoming unenforceable, as currently memorialized in Special Condition 26 of the 1997 Water Supply Permit.

B. The proposed project takes proper consideration of other sources of supply that are or may become available.

NYSDEC has agreed that this component of the standard elements of the project justification for a water supply permit is not relevant to, and therefore not required to be included in, this application.

C. All work and construction connected with the proposed project will be proper and safe.

For the most part, the LAP does not involve "work or construction." In rare instances, the City removes structures from property that it acquires in fee under the LAP. All demolition and site restoration work done by DEP is proper and safe, and performed in full conformance with applicable environmental, health and safety laws (as discussed further in "Other Components: SHPA Compliance").

D. The supply will be adequate.

As the City does not seek new water source development in this application, NYSDEC has agreed that this element of the standard elements of a project justification for a water supply permit is not relevant to, and therefore not required to be included in, this application.

E. There will be proper protection of the supply and watershed or proper treatment of any additional supply.

As discussed above, the purpose of the LAP is to protect the City's water supply and watershed. In addition, DEP maintains an active land management program to ensure that lands it holds in fee and easement for watershed protection are in fact preserved for that purpose:

- *Since its first acquisitions in 1997, the City has continued to expand the number and percent of properties that are opened for various forms of public recreation, and has also expanded the types of uses. Decisions as to what types of recreational uses will be allowed on a given property are made with water quality and public safety considerations as paramount criteria. Uses that may involve body contact with water have not been allowed. Hunting has been encouraged in order to (1) reduce levels of deer browse that have decimated sapling growth and thus forest health, (2) reduce diseases that can be transmitted by certain game animals, and (3) provide for regional recreational and economic benefits.*

- *All conservation easements are monitored regularly by DEP staff.*

- *A comprehensive watershed-wide forest management plan is being developed and will be implemented in order to maximize long-term health of forest ecosystems and provide guidance for future forestry projects.*

In addition to the watershed protection purposes of the LAP and stewardship programs themselves, DEP has developed and continues to implement a robust, multi-faceted

Watershed Protection Program, which is memorialized in the FAD. The elements include, among many others and in addition to land acquisition and stewardship:

- *Administration and enforcement of the Rules and Regulations for the Protection from Contamination, Degradation and Pollution of the New York City Water Supply and its Sources, 15 RCNY Chapter 18; 10 NYCRR Part 128 ("Watershed Regulations");*
- *The Wastewater Treatment Plant Upgrade Program, to fund and oversee upgrades to all existing wastewater treatment plants in the watershed to meet the stringent requirements of the Watershed Regulations, including tertiary treatment;*
- *A suite of programs to repair existing septic systems or to build or extend sewage treatment infrastructure to cover areas with concentrations of substandard septic systems;*
- *A set of programs to address pollution from stormwater, including funding for best management practices for agriculture in the watershed; and*
- *Extensive water quality monitoring and other research programs.*

F. The proposed project is just and equitable to all affected municipalities and their inhabitants and in particular with regard to their present and future needs for sources of water supply.

The LAP focuses on acquiring and maintaining lands for watershed protection rather than on creating new (or expanding existing) sources of water supply. It will not result in additional consumption, impoundment, or use of upstate water resources. Accordingly, the LAP does not affect any community's access to surface or groundwater, in fact provides added protection for such local sources and uses, and therefore is just and equitable to all affected municipalities and their inhabitants with regard to their present and future needs for sources of water supply.

In addition, pursuant to the Water Supply Act of 1905, municipalities in Ulster, Greene, Delaware, Schoharie, Sullivan, Orange, Westchester, and Putnam Counties may take and receive water from the City's system (L. 1905, ch. 724, § 40; see also *Ad. Code § 24-360). New York City presently supplies water from its system to approximately one million residents of these upstate counties. The LAP will not affect the supply of New York City water provided to these communities, and can only serve to protect its quality.*

Finally, to the extent that a community may identify property held by the City as essential for infrastructure for its own water supply system, the community has the opportunity to raise that concern during the local consultation process before the City closes on any parcel under the LAP,[6] or at the public hearing held by the City for each acquisition (see Ad. Code § 358).

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6 *1997 Water Supply Permit, Special Condition 12.*

G. There is provision for fair and equitable determinations of and payments of any direct and indirect legal damages to persons or property that will result from the acquisition of any lands in connection with the proposed project or from the execution of the proposed project.

Fundamentally, because the LAP operates as a willing buyer/willing seller process, LAP cannot cause legal damages since no person is required to sell land to the City. Moreover, DEP pays fair market value (FMV) for all property acquired under the LAP. The process for determining FMV for the LAP is established in MOA paragraph 61 and Special Condition 13 of the 1997 Water Supply Permit, and explicitly includes an opportunity for the seller to obtain an independent appraisal in the event that he or she disagrees with the City's appraisal. The City's appraiser will review the seller's appraisal and the City may revise its offer based on information provided by the City's appraiser after review of the seller's submission. In any event, however, no seller is obliged to accept the City's offer; because the LAP does not involve condemnation, the LAP does not have the potential to cause unfair or inequitable determinations of payments.

Moreover, consistent with the MOA and with the New York State Real Property Tax Law, DEP-owned land and easements are fully taxable. Therefore, the LAP does not result in any loss to local governments of real property tax revenues.

H. The applicant has developed and implemented a water conservation program in accordance with local water resource needs and conditions (see "Other Components", Item 3).

Other Components: SHPA Compliance

The LAP would not generally result in any construction activity that would disturb historic or archeological resources in the watershed. The LAP has the potential to result in a benefit to historic and archaeological resources on acquired sites by ensuring that these sites would not be disturbed. In some cases, lands under consideration for acquisition may contain historic structures. As part of the Community Review Process mandated by the MOA, local Town or Village governments would advise the City whether they wish any structures on property to be removed. Should acquired property be determined to require demolition or alteration of any structure, it would be determined if the structure is subject to State and local regulations regarding historic resources. If the structure is of historical significance, the City would adhere to all applicable historic preservation laws and rules and regulations.

Therefore, the LAP is not expected to result in the potential for significant adverse impacts on historic or archaeological resources.

Water Conservation Program

New York City Department of Environmental Protection
59-17 Junction Blvd.
Flushing, NY 11373

December 2006

Table of Contents

Appendix Volume

Introduction and Summary

This report is a detailed description of past and current water conservation efforts by the New York City Department of Environmental Protection ("DEP"). The report will update program progress during the past year, including both accomplishments and shortfalls, and describe activities that are being planned or considered for the future. The report will be updated annually and issued to the New York State Department of Environmental Conservation ("DEC") and the public on June 1 of each year.

DEP's policy and experience is that saving water is usually the most cost-effective and environmentally benign method of insuring an ample supply of water for the region and that conservation methods are to be used whenever they are cost effective and do not conflict with other important goals.

The city's water conservation programs address the many sources of water use and waste and have been developed in cooperation and collaboration with regulators, NGO's and the citizens and businesses of the city over a period of more than 20 years.

With the city's population expected to rise to 9.1 million by 2030, from 8.3 million in 2005, water efficiency will continue to have an important role to play, not just to help assure supply but also to assist in meeting goals to reduce combined sewer overflows, maintain wastewater quality and meet nitrogen removal goals.

DEP's program has addressed improved water efficiency in the distribution system and at the end use:

- Each year DEP surveys approximately 4,000 miles (or 59% in FY06) of the distribution piping for leaks, repairing leaks which prevented the continued loss of 5.5 MGD in FY06. The entire city is on a three-year survey schedule while the drainage areas for the Wards Island, Newtown Creek and North River Wastewater Treatment Plants are on a nine-month schedule. This area of concentrated attention covers all of Manhattan, half of the Bronx and about one-quarter of Brooklyn. This leak detection survey program is in addition to repairs of leaks from customer complaints. Leaks discovered through complaint repairs totaled 39.36 MGD for FY06. The leak detection program has brought the distribution system leak rate to about 10-15% of what it was in the 1980's.

- Each year DEP replaces an average of 55-60 miles of old water mains, equal to 2-3% of the old cast iron mains in the system.

- DEP has substantially completed the largest water meter installation program in North America and is moving during the 2007-2010 period toward radio-based Automatic Meter Reading ("AMR") providing at least daily readings and eventually, monthly billing.

- The water/sewer system was financially internalized in the mid-1980's virtually ending cross subsidies with the city's general revenue budget and placing the cost of operating and maintaining the system on users.

- DEP completed the world's largest toilet replacement program during 1994-1997 resulting in 70-90 MGD of savings through the replacement of 1.3 million toilets. The New York City Housing Authority further contributed approximately 100,000 replacements through their own effort. DEP intends to implement upgraded fixture replacement incentives during the period of 2008-2010 including toilets, urinals and some clothes washers. Other end-use programs are under consideration.

- DEP has upgraded its demand analysis and study capabilities with a new demand study in 2004-2005, addition of full-time staff dedicated to this function and beginning the integration of water use data into city-wide GIS functions.

- Since 1990 the group of water conservation programs implemented by DEP has resulted in a decrease in in-city water consumption and wastewater flow of approximately 23%, at a time when the city's population increased by approximately 7.9%. The three wastewater treatment plants that were exceeding dry weather flow limits in the 1980's are all operating well under their allowed flow rates. Per capita use has declined from more than 200 gcpd around 1990 to 138 gcpd today.

<u>Abbreviations and Acronyms Found in This Report</u>

AMR	Automatic Meter Reading (sometimes referred to as "AMI" for "Advanced Metering Infrastructure")
CIP	Capital Improvement Plan
CSO	Combined Sewer Overflow
CY	Calendar Year
DEC	New York State Department of Environmental Conservation
DEP	New York City Department of Environmental Protection
DRBC	Delaware River Basin Commission
FY	Fiscal Year (July 1 – June 30)
GCPD	Gallons per Capita Per Day
HCF	Hundred Cubic Feet
HPD	New York City Department of Housing Preservation and Development
LF	Linear feet
MGD	Millions of Gallons Per Day
NYCHA	New York City Housing Authority
RWS	Residential Water Survey

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The Water and Wastewater Systems

Water System Overview and Current Issues

DEP supplies water and sewer service to the Boroughs of the Bronx, Brooklyn, Manhattan, Queens, Staten Island, an area of over 300 square miles, and serves over eight million people. The City is also required by State law to sell water in counties where its water supply facilities are located and where it currently provides water to an additional approximately one million people. The Water System provides an average of approximately 1107 MGD of water (2005). Water consumption has decreased since 1990 when an average of approximately 1,500 MGD was provided by the Water System. The amount of water that can be safely drawn from a watershed during the worst period in the drought of record is the "Dependable Yield." DEP has determined that the System could have furnished an average of 1,290 MGD during the drought of record in the mid-1960s. Including groundwater wells in Queens, dependable yield now might total 1,323 MGD although the groundwater wells only currently produce about 15 MGD. During periods of normal rainfall, watersheds supply more than the Dependable Yield. The Sewer System collects and treats an average of approximately 1227 MGD of wastewater (2005). Sewer service is provided to virtually the entire City, except for significant parts of the Borough of Staten Island, the Borough of Queens communities of Breezy Point and Douglaston, and the Borough of Brooklyn community of Seagate. Sewer service is also provided to certain upstate communities in System watershed areas.

History

Early Manhattan settlers obtained water for domestic purposes from shallow privately owned wells. In 1677 the first public well was dug in front of the old fort at Bowling Green. In 1776, when the population reached approximately 22,000, a reservoir was constructed on the east side of Broadway between Pearl and White Streets. Water pumped from wells sunk near the Collect Pond, east of the reservoir, and from the pond itself, was distributed through hollow logs laid in the principal streets. In 1800 the Manhattan Company (now JPMorgan Chase) sank a well at Reade and Centre Streets, pumped water into a reservoir on Chambers Street and distributed it through wooden mains to a portion of the community. In 1830 a tank for fire protection was constructed by the City at 13th Street and Broadway and was filled from a well. The water was distributed through two 12-inch cast iron pipes. As the population of the City increased, the well water became polluted and supply was insufficient. The supply was supplemented by cisterns and water drawn from a few springs in upper Manhattan.

After exploring alternatives for increasing supply, the City decided to impound water from the Croton River, in what is now Westchester County, and to build an aqueduct to carry water from the Old Croton Reservoir to the City. This aqueduct, known today as the Old Croton Aqueduct, had a capacity of about 90 MGD and was placed in service in 1842. The distribution reservoirs were located in Manhattan at 42nd Street (discontinued in 1890) and in Central Park south of 86th Street (discontinued in 1925). New reservoirs were constructed to increase supply: Boyds Corner in 1873 and Middle Branch in 1878. In 1883 a commission was formed to build a second aqueduct from the Croton watershed as well as additional storage reservoirs. This aqueduct, known as the New Croton Aqueduct, was under construction from 1885 to 1893 and was placed in service in 1890, while still under construction.

Since 1842, there have been no significant interruptions of service.

In 1905 the Board of Water Supply was created by the State Legislature. Pursuant to the 1905 Act, the City was empowered to develop areas of the Catskill Mountains, located in the Hudson River Basin, and portions of the Delaware River Basin located to the west of the Catskill Mountains for water supply purposes. In return for these development rights, the 1905 Act requires the City to furnish, upon request, supplies of fresh water to municipalities and water districts in eight northern counties in which City water supply facilities and watersheds are located. The City's obligations under the 1905 Act in this respect have now passed to the Board. The 1905 Act also governs the rates that may be levied for such water. An eligible municipality or district may draw water based on a formula computed by multiplying the local population with the daily per capita consumption in the City. The City is currently engaged in a long-term project to update and modernize various water supply agreements governing the furnishing of water to such municipalities and water districts.

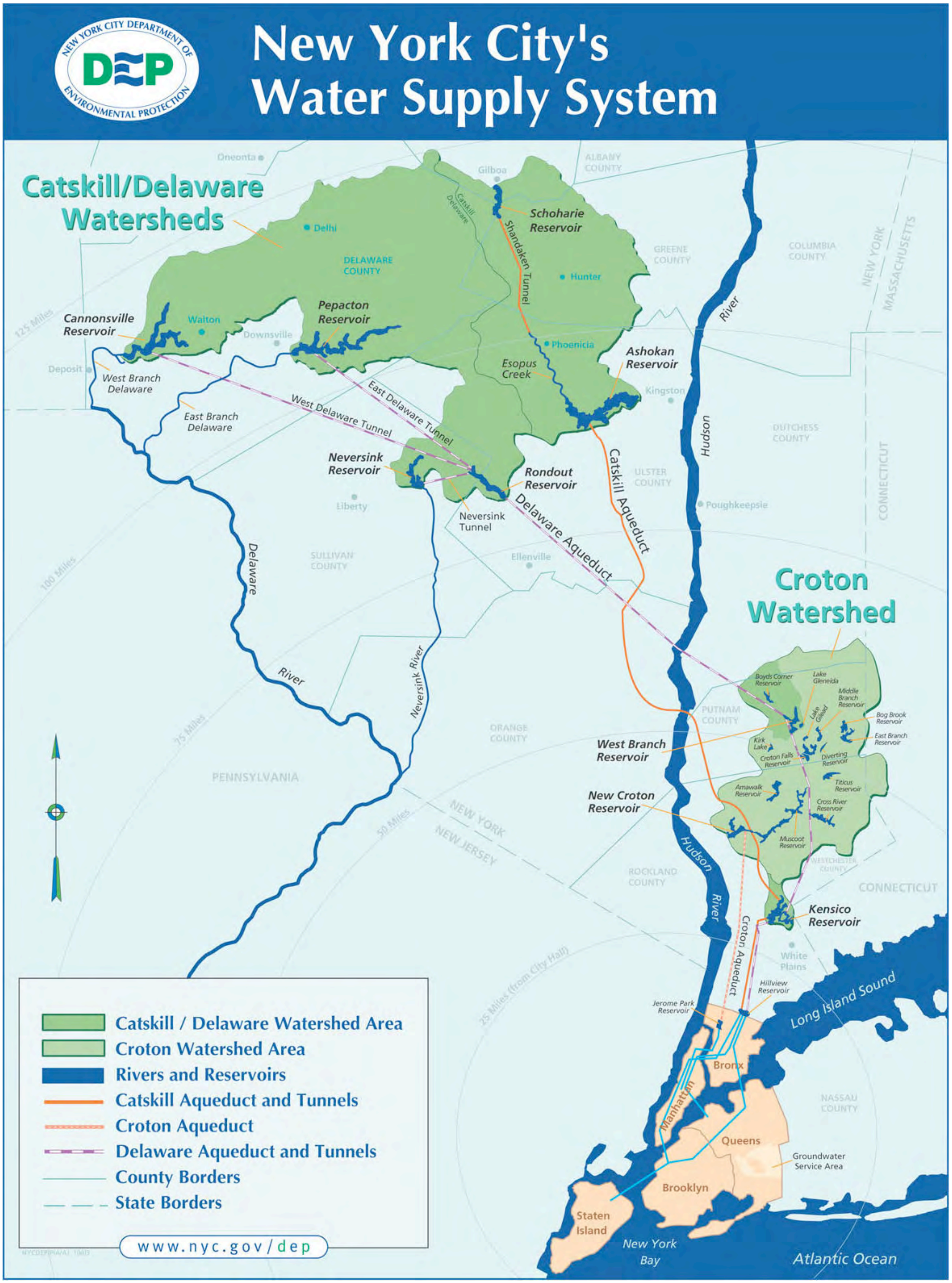
After careful study, the City decided to develop the Catskill region as an additional water source. The Board of Water Supply proceeded to plan and construct facilities to impound the waters of the Esopus Creek, one of the four watersheds in the Catskills, and to deliver the water throughout the City. This project, to develop what is known as the Catskill System, included the Ashokan Reservoir and the Catskill Aqueduct and was completed in 1915. It was subsequently turned over to the City's Department of Water Supply, Gas and Electricity for operation and maintenance. The remaining development of the Catskill System, involving the construction of the Schoharie Reservoir and Shandaken Tunnel, was completed in 1928.

In 1927 the Board of Water Supply submitted a plan to the Board of Estimate and Apportionment for the development of the upper portion of the Roundout watershed and tributaries of the Delaware River within the State of New York. This project was approved in 1928. Work was subsequently delayed by an action brought by the State of New Jersey in the Supreme Court of the United States to enjoin the City and State of New York from using the waters of any Delaware River tributary. In May 1931 the Supreme Court of the United States upheld the right of the City to augment its water supply from the headwaters of the Delaware River. Construction of the Delaware System was begun in March 1937. The Delaware System was placed in service in stages: The Delaware Aqueduct was completed in 1944, Neversink Reservoir in 1950, Rondout Reservoir in 1951, Pepacton Reservoir in 1954 and Cannonsville Reservoir in 1967.

Water for the System is derived from three upstate reservoir systems (the Croton, Catskill and Delaware Systems) and a system of wells in Queens that were acquired as part of the City's acquisition of the Jamaica Water Supply Company ("Jamaica Water"). The three upstate water collection systems include 18 reservoirs and three controlled lakes with a total storage capacity of approximately 550 billion gallons. They were designed and built with various interconnections to increase flexibility by permitting exchange of water from one system to another. This feature mitigates localized droughts and takes advantage of excess water in any of the three watersheds.

The Water System is currently furnishing water to users in portions of four of the eight eligible northern counties. The Water System provides approximately 85% of the water used in Westchester County and approximately 7.5% of the water used in Putnam, Orange and Ulster Counties.

Approximately 95% of the total water supply is delivered to buildings by gravity. Only about 5% of the water is regularly pumped by DEP to maintain the desired pressure. As a result, operating costs are relatively insensitive to fluctuations in the cost of power. When drought conditions exist, additional pumping is required.


NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DEP
New York City's Water Supply System
Catskill/Delaware Watersheds
Schoharie Reservoir
Cannonsville Reservoir
Pepacton Reservoir
Ashokan Reservoir
Neversink Reservoir
Rondout Reservoir
West Delaware Tunnel
East Delaware Tunnel
Shandaken Tunnel
Neversink Tunnel
Delaware Aqueduct
Catskill Aqueduct
Esopus Creek
West Branch Delaware
East Branch Delaware
Delaware River
Neversink River
Hudson River
Croton Watershed
West Branch Reservoir
New Croton Reservoir
Kensico Reservoir
Croton Aqueduct
Jerome Park Reservoir
Hillview Reservoir
Bronx
Manhattan
Queens
Brooklyn
Staten Island
Groundwater Service Area
Long Island Sound
New York Bay
Atlantic Ocean
PENNSYLVANIA
NEW YORK
NEW JERSEY
CONNECTICUT
Catskill / Delaware Watershed Area
Croton Watershed Area
Rivers and Reservoirs
Catskill Aqueduct and Tunnels
Croton Aqueduct
Delaware Aqueduct and Tunnels
County Borders
State Borders
www.nyc.gov/dep

Water Collection and Distribution

The three main reservoir systems are the Croton, Catskill and Delaware Systems.

The following tables set forth the capacities and original in-service dates of the System's collecting and balancing reservoirs and distribution facilities based on the City records.

COLLECTING RESERVOIRS

NAME	AVAILABLE CAPACITY(1) (BILLION GALLONS)	ORIGINAL IN-SERVICE DATE
CROTON		
New Croton	19.0	1905
Croton Falls Main	14.2	1911
Cross River	10.3	1908
West Branch	10.1	1895
Titicus	7.2	1893
Amawalk	6.7	1897
East Branch	5.2	1891
Muscoot	4.9	1905
Bog Brook	4.4	1892
Middle Branch	4.0	1878
Boyds Corner	1.7	1873
Croton Falls Diverting	0.9	1911
Total	88.6	
CATSKILL		
Ashokan	122.9	1915
Schoharie	17.6	1926
Total	140.5	
DELAWARE		
Pepacton	140.2	1955
Cannonsville	95.7	1964
Rondout	49.6	1950
Neversink	34.9	1954
Total	320.4	
Total Available Capacity	547.5	

(1) Capacity above minimum operating level.

BALANCING RESERVOIRS AND DISTRIBUTION FACILITIES

NAME	STORAGE ORIGINAL CAPACITY (BILLION GALLONS)	IN-SERVICE DATE
BALANCING RESERVOIRS		
Kensico	30.6	1915
Hillview	0.9	1915
Total Balancing Reservoirs	31.5	
DISTRIBUTION FACILITIES		
Central Park	1.0	1862
Jerome Park	0.8	1905
Silver Lake (tanks)	0.1	1970
Total Distribution Facilities	1.9	
Total Storage Capacity	33.4	

The following table sets forth the Dependable Yield and storage capacity for each of the water supply systems.

WATER SYSTEM DEPENDABLE YIELD AND CAPACITY

SYSTEM	DEPENDABLE YIELD (MGD)	STORAGE CAPACITY(1) (BILLION GALLONS)
Croton	240	86.6
Catskill	470	140.5
Delaware	580	320.4
Queens wells	33	2.6
Total	1,323	550.1

(1) Capacity above minimum operating level.
Delaware system is limited to 520 MGD during drought
Queens wells could be expanded to 61.8 MGD five-year average under WSA 9424, but have been operating at only 15 MGD.

The Croton System normally provides approximately 10% of the City's daily water supply and can provide substantially more of the daily water supply during drought conditions. The Croton System consists of 12 reservoirs and three controlled lakes on the Croton River, its three branches and three other tributaries. The water in the Croton System flows from upstream reservoirs through natural streams to downstream reservoirs, terminating at the New Croton Reservoir. The watershed which supplies the Croton System has an area of 375 square miles. It lies almost entirely within the State, approximately 45 miles north of lower Manhattan, with a small portion in the State of Connecticut.

The Catskill System watersheds occupy sparsely populated areas in the central and eastern portions of the Catskill Mountains and normally provide approximately 40% of the City's daily water supply. Water in the Catskill System comes from the Esopus and Schoharie Creek watersheds, located approximately 100 miles north of lower Manhattan and 35 miles west of the Hudson River. The Catskill System is comprised of the Schoharie Reservoir (formed by the Gilboa Dam across Schoharie Creek) and Ashokan Reservoir (formed by the Olivebridge Dam across Esopus Creek) and the Catskill Aqueduct.

The Delaware System, located approximately 125 miles north of lower Manhattan, normally provides approximately 50% of the City's daily water supply. Three Delaware System reservoirs collect water from a sparsely populated region on the branches of the Delaware River: Cannonsville Reservoir (formed by the Cannonsville dam on the West Branch of the Delaware River); Pepacton Reservoir (formed by the Downsville Dam across the East Branch of the Delaware River); and Neversink Reservoir (formed by the Neversink Dam across the Neversink River, a tributary to the Delaware River).

In addition, wells in Queens can supplement the City's daily water supply. The wells could be used to provide more of the daily supply during drought conditions. Unlike the rest of the City's water supply, which is a surface and gravity-supplied system originating in a network of upstate reservoirs, well water is pumped from extensive underground aquifers. The acquisition of wells in Queens from Jamaica Water in 1996 represented the first new water supply source for the City since the 1960s when the Delaware surface water system initially came on line. DEP is currently planning improvements to the ground water system which will augment the supply of water from underground aquifers.

Current demand/flow projections show that if conservation programs, including metering, toilet replacement, hydrant locking, leak detection, and public information, remain effective there will be no predicted need for the City to find additional long-term water supply sources to meet normal demand.

The System's water supply is transported through an extensive system of tunnels and aqueducts. Croton System water is delivered from the New Croton Reservoir by the New Croton Aqueduct to the Jerome Park Reservoir in the Bronx. From Jerome Park Reservoir and from direct connections to the New Croton Aqueduct, trunk mains carry water to the service area. The Catskill and Delaware Aqueducts convey water from Ashokan Reservoir and Rondout Reservoir to Kensico Reservoir and then to Hillview Reservoir in Yonkers. Both Kensico and Hillview Reservoirs serve as balancing reservoirs. Water from the Catskill and Delaware Systems is mixed in the Kensico Reservoir, and is conveyed to Hillview Reservoir where water enters Tunnels 1, 2 and 3. Trunk mains carry water from tunnel shafts and from the distribution facilities (Jerome Park and Hillview Reservoirs and Silver Lake Tanks) to the service area.

Rondout-West Branch Tunnel. DEP regularly assesses the condition and integrity of the System's tunnels and aqueducts to determine the extent and effect of water loss. In particular, since the early 1990s, DEP has monitored the condition of the Rondout-West Branch Tunnel, which comprises a portion of the Delaware Aqueduct. The Rondout-West Branch Tunnel carries water 45 miles from the Delaware System under the Hudson River and into West Branch Reservoir. It has a capacity of 900 MGD and normally contributes 50% of the City's water supply. It has the highest pressures and the highest velocities in the Water System. In addition, a portion of the tunnel crosses a fractured rock formation, which is potentially subject to greater stress than the deep rock tunnels located in the City. As a result of DEP's flow tests, visual observations and other analyses, it has been determined that approximately 15 MGD to 36 MGD of water is being lost from the tunnel and is surfacing in the form of springs or seeps in the area. DEP has initiated the engineering work to determine the nature and extent of repairs which may be necessary to remedy the water loss. DEP has also determined that the situation in the tunnel and amount of water loss is stable. In the opinion of the professional engineering firm retained by DEP in conjunction with that investigation, there is very little immediate risk of failure of the tunnel. DEP intends to make the necessary repairs. The costs to perform such repairs could be substantial depending on the nature of the required repair. To perform the repair work, the tunnel will probably have to be shut down and de-watered. During any such period, it will be necessary for the City to increase reliance on its other water supplies, and to implement more stringent measures to encourage conservation and decrease demand. In general, the Delaware System continues to demonstrate a high degree of reliability after 55 years of continuous service. Nevertheless, DEP considers it prudent to conduct regular tunnel and aqueduct inspections and surveys to detect any problems that might arise so that corrective actions can be taken if needed.

DEP has begun to evaluate additional strategies and projects for improving dependability of water supplies, which could entail the development of additional or interim supplies and demand reduction measures to meet demands during periods of extended facility outages due to planned or unplanned inspection, repair or rehabilitation. DEP has retained a consultant to develop a long term dependability plan. DEP intends to evaluate various alternative projects which, when combined, could allow for any portion of the Water System to be taken out of service for a period of up to one year. Elements of that plan may include: interconnections with other neighboring jurisdictions; increased use of groundwater supplies; increased storage at existing reservoirs; withdrawals and treatment from other surface waters; hydraulic improvements to existing aqueducts; and additional tunnels.

Tunnel 1. From Hillview Reservoir, water from the Catskill and Delaware Systems is delivered into the City by a circular, cement-lined, pressurized, bedrock tunnel that narrows in diameter from 15 to 11 feet. Tunnel 1 is 18 miles in length and extends south from Hillview Reservoir through the West Bronx to Manhattan and Brooklyn. Tunnel 1 is 200 to 750 feet underground and thus avoids interference with streets, buildings, subways, sewers, pipes and other underground infrastructure. These depths are necessary to ensure substantial rock covering necessary to withstand the bursting pressure of the water inside and to ensure water tightness. Tunnel 1 has a capacity of approximately 1,000 MGD. Shafts placed along the tunnel connect with surface mains which deliver water to the distribution system.

Tunnel 2. The second tunnel also delivers Catskill and Delaware System water from Hillview Reservoir. It is a circular, cement-lined, pressurized, bedrock tunnel, 200 to 800 feet below the street surface and 15 to 17 feet in diameter. Tunnel 2 extends south from Hillview Reservoir, east of Tunnel 1, through the Bronx, under the East River at Rikers Island, through Queens and Brooklyn, and connects with Tunnel 1 in Brooklyn. Tunnel 2 has a capacity of more than 1,000 MGD and is 20 miles in length. Shafts placed along the tunnel connect with surface mains which deliver water to the distribution system.

Richmond Tunnel. Connecting to Tunnel 2 in Brooklyn is the ten-foot diameter, five-mile long Richmond Tunnel, which was completed in 1970 and carries water 900 feet beneath Upper New York Bay to Staten Island. The Richmond Tunnel, the Richmond Distribution Chamber, the Richmond Aqueduct and the underground Silver Lake Tanks were designed to improve the water supply facilities of Staten Island. The underground storage tanks (among the world's largest) have a combined capacity of 100 million gallons and replaced the Silver Lake Reservoir (now Silver Lake).

Tunnel 3. A new water tunnel, Tunnel 3, connecting the reservoir system to the City is presently under construction to increase pressure/flow to meet a growing demand in the eastern and southern areas of the City, permit inspection and rehabilitation of Tunnels 1 and 2, and provide water delivery alternatives to the City in the event of disruption in Tunnel 1 or 2. Tunnel 3 is being built in four stages. Stage I commenced operation in July 1998. It follows a 13-mile route which extends south from Hillview Reservoir in Yonkers under Central Park Reservoir in Manhattan, and east under the East River and Roosevelt Island to Long Island City in Queens. Stage II has two distinct legs. They are currently under construction and expected to be completed in 2012. They will extend from the end of Stage I to supply Queens, Brooklyn and the Richmond Tunnel and from the valve chamber at Central Park into lower Manhattan. Upon completion, and with the installation of additional surface mains, Stage II will enable the system to maintain full service even if Tunnel 1 is shut down. The Stage III project is now referred to as the Kensico-City Tunnel (the "Kensico Tunnel"). Stage IV is intended to deliver additional water to the eastern parts of the Bronx and Queens. It would extend southeast from the northern terminus of Stage I in the Bronx to Queens and then southwest to interconnect with the Queens portion of Stage II. Stage IV is currently being re-evaluated.

Kensico-City Tunnel. The Kensico-City Tunnel will extend from the Kensico Reservoir to the Van Cortlandt Valve Chamber , south of Hillview Reservoir. $1.7 billion is included for the project in the CIP.

The water distribution system consists of a grid network of over 6,200 miles of pipe, as well as valves, fire hydrants, distribution facilities, gatehouses, pump stations, and maintenance and repair yards. Approximately 32% of the pipe in the System was laid before 1930, 37% between 1930 and 1969, and the remainder thereafter. The CIP provides for the programmatic replacement of water mains in accordance with certain established criteria. These criteria were reviewed and confirmed by the U.S. Army Corps of Engineers in its independent study of the City's distribution system completed in November 1988.

Various facilities provide storage to meet the hourly fluctuations in demand for water throughout the City, as well as any sudden increase in draft that might arise from fire or other emergencies. With the exception of some communities in the outlying areas of the City which may experience low pressure service during peak hours in summer months, the water distribution system provides generally excellent service.

DEP has received several approvals for Water Supply Applications in the past, including:

WSA No. 1, City of New York (Original Catskill project: Ashokan Reservoir)
Decision of May 14, 1906
Modifying Decision of September 26, 1927

WSA No. 166, City of New York--10th Application (Schoharie Reservoir approved)
Memorandum of October 13, 1914
Decision of October 21, 1914 *[NOTE: Superseded by WSA No. 214]*

WSA No. 214, City of New York--11th Application (Schoharie Reservoir modified)
Memorandum of June 6, 1916
Decision of June 6, 1916

WSA No. 466, City of New York--14th Application (Rondout & Pepacton Reservoirs)
Memorandum of May 25, 1929
Decision of May 25, 1929
Modifying Decision of January 26, 1943 (Emergency use of Rondout Reservoir)
Extension of Time for Construction, March 4, 1947
Modification to end obligation to maintain Dunraven Causeway Bridge, October 4, 2002

WSA No. 611, City of New York--16th Application (Lower Rondout Creek)
Memorandum of September 18, 1931
Decision of September 18, 1931 *[NOTE: Approval rescinded on June 5, 1951]*

WSA No. 1342, City of New York--23rd Application (Neversink Reservoir)
Memorandum and Decision of February 20, 1939

WSA No. 2005, City of New York--30th Application (Cannonsville Reservoir)
Decision of November 14, 1950

The Wastewater (Sewer) System

The Sewer System is comprised of the sewage collection system and the water pollution control facilities.

History

Systematic collection of sewage and building of sewers began in the City as early as 1696. Major portions of the Sewer System in lower and central Manhattan were begun in the early 1830s and completed by 1870. The oldest sewer now in service was built in 1851. The oldest components of the Sewer System, located in Manhattan and Brooklyn, are constructed mostly of brick, clay and cement. The other Boroughs have newer sewers made primarily of vitreous clay and concrete. Historically, waste collection and disposal was a matter of local jurisdiction. Upon consolidation of the City in 1898, Presidents of the five Boroughs were given responsibility for sewage collection and disposal in their respective Boroughs. A Commissioner of Borough Works was established in each Borough for planning, constructing and administering its sewer system. This local responsibility for sewage collection existed until the mid-1960s.

Although water pollution control did not become a major issue until recent years, it has been a concern of local conservationists and public officials for over a century. The first water pollution control facility in the City was opened in 1886, when a small plant was constructed on Coney Island to protect the bathing beaches. In 1904, a Sanitary Commission was established and charged with developing a master plan for water pollution control in the City. Although the Sanitary Commission completed its task in 1910, water pollution control plant construction did not receive serious attention until 1929, when the City established a department to construct water pollution control facilities under the jurisdiction of the Department of Sanitation. In the 1930s this function was transferred to the Department of Public Works. In 1931, a plant construction program was begun to construct a system of water pollution control plants and associated facilities to control and treat all sewage produced within the City. The first of these plants, Coney Island, opened in 1935. Three larger plants, Wards Island, Tallmans Island and Bowery Bay, were placed in operation before the end of the 1930s. During the 1940s two additional plants, Jamaica and 26th Ward, were opened. The post-war years witnessed an intensified construction effort and, by 1967, 12 major treatment plants were in operation treating about 1,000 MGD at an average removal efficiency of about 65%. At that time most other urban areas were providing only about 35% removal efficiency.

The City Charter of 1963 consolidated the Borough sewer organizations into a City-wide department under the Department of Public Works. In 1968, various municipal services were consolidated into a single agency known as the Environmental Protection Administration, which included responsibility for sanitation and water and air quality resources. Within the Environmental Protection Administration, the Department of Water Resources had jurisdiction over the Bureaus of Water Supply and Water Pollution Control. These Bureaus were responsible for water supply and sewage collection and treatment. In 1977, water supply, sewage collection and treatment, and air quality monitoring responsibilities were combined into DEP.

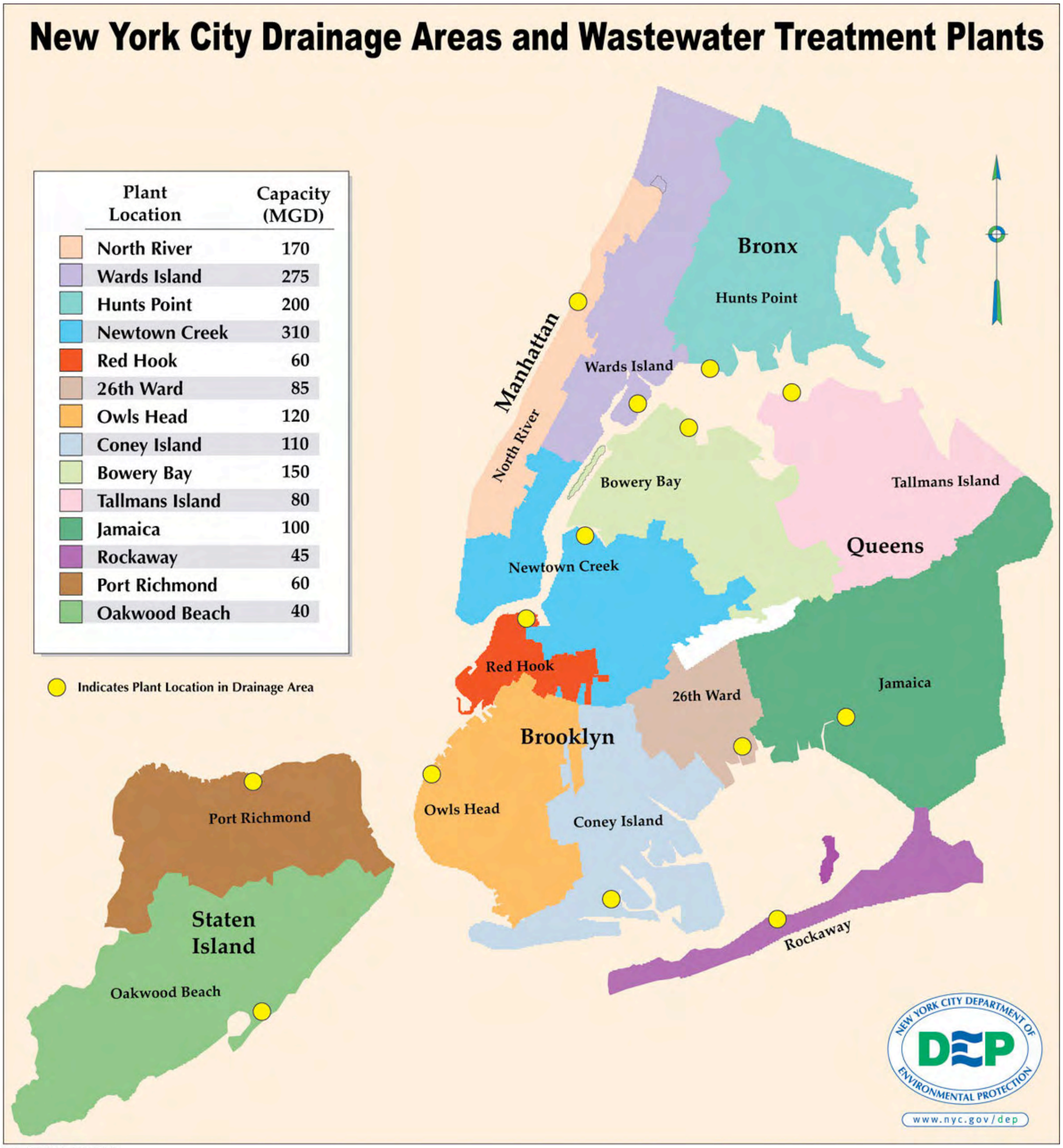
Sewage Collection and Treatment

The Sewer System's plants currently treat approximately 1,225 MGD of wastewater. The Sewer System is divided into 14 drainage areas corresponding to the 14 water pollution control plants and includes over 6,600 miles of sewer pipes of varying size which are classified as one of three types: sanitary, storm or combined. Sanitary sewers accommodate household and industrial waste. Storm sewers carry rainwater and surface water runoff. Combined sewers carry both types of waste. Approximately 70% of the City's sewers are of the combined type. In addition to the sewage pipes, the Sewer System includes catch basins and seepage basins to prevent flooding and sewer backups.

The Sewer System is comprised of a number of sewer facilities built to varying standards. Different materials and methods of construction were used resulting in different life cycles. Approximately 4,000 miles or two-thirds of the City's sewer pipe is made of vitreous clay. Significant mileage of sewer pipe is composed of other building materials including cement, reinforced concrete, iron and brick. Some pipe in the collection system was installed before 1870, and approximately 15% of all sewer pipe in the collection system is over 100 years old.

The facilities related to the treatment of sewage include water pollution control plants, a combined sewer overflow treatment plant, wastewater pump stations, laboratories, sludge dewatering facilities and inner-harbor vessels which transport sludge between facilities. Sludge is a by-product of the sewage treatment process. Sludge that is treated through the sewage treatment process (or "biosolids") is acceptable for land-based beneficial use either directly or after additional provisions such as composting, lime stabilization or thermal pelletization.

Issues of both water supply volume and consequent sewage treatment volume are raised from time to time in connection with the System. Measures to increase the supply of water available to the System and to increase the CSO sewage treatment capacity of the various water pollution control plants in the System are either being constructed under the CIP or are under continuing review for feasibility and cost effectiveness. However, the immediate approach to both the issues of supply and treatment capacity is conservation, through voluntary changes in user behavior, through education and the effect of actual use charges based on metered water usage, leak detection and repair and increased use of newly designed low-flow water use fixtures such as toilets.



NYCDEP/PA/AJ 5/05

System Demand

In 2005, the City consumed an average of 1,108 million gallons of water per day (MGD). As recently as 1990, the City consumed an average of 1,500 MGD. Past City efforts to encourage conservation have been extremely successful in saving water even as the population increased. Between 1990 and 2003, water use decreased by 23.2 percent while population increased by 7.9 percent.

DEP's historical and current water demand for in-city consumers through the year 2045 are shown in Figure 1 and Table 1. These projections are used in DEP's infrastructure and other planning efforts.

DEP also supplies water to several upstate communities in Orange, Putnam, Ulster, and Westchester Counties. A summary of historic upstate water consumption from 1994 to 2005 is provided in Table 2. Projections for upstate water consumption are not available at this time, but it is anticipated that Westchester County will continue it's current population and water demand growth trend whereas growth in other supplied counties will remain minimal.

Per capita water consumption in 2005 was approximately 138 gallons per capita per day (gcpd), a decrease from 208 gcpd in 1988.

Table 1 2006 DEP Interim In-City Water Demand

Year	Historic Population	Interim Population Projection	Historic Water Demand (MGD)	Interim Water Demand Projections (MGD)	Historic Wastewater Flow (MGD)	Interim Wastewater DWF Projections (MGD)
1979	7,070,525		1,512.4			
1980	7,000,717		1,505.9			
1981	7,033,086		1,309.3			
1982	7,065,455		1,382.4			
1983	7,097,824		1,423.8			
1984	7,130,194		1,465.0			
1985	7,162,563		1,325.8			
1986	7,194,932		1,350.7			
1987	7,227,301		1,446.5			
1988	7,259,670		1,483.9			
1989	7,292,039		1,401.7		1676	
1990	7,324,408		1,423.8		1575	
1991	7,392,803		1,469.3		1582	
1992	7,461,198		1,368.6		1537	
1993	7,529,593		1,368.5		1515	
1994	7,597,988		1,357.7		1530	
1995	7,666,383		1,325.7		1439	
1996	7,734,778		1,297.9		1431	
1997	7,803,173		1,205.5		1374	
1998	7,871,568		1,219.5		1332	
1999	7,939,963		1,237.2		1269	
2000	8,008,278	8,008,278	1,240.4		1259	

Table 1 2006 DEP Interim In-City Water Demand

2001		8,058,000	1,184.0		1250	
2002		8,107,000	1,135.6		1175	
2003		8,156,000	1,093.7		1206	
2004		8,205,000	1,099.5		1178	
2005		8,254,000	1,107.6		1227	
2006		8,304,000		1121		1238
2007		8,354,000		1123		1240
2008		8,405,000		1122		1239
2009		8,455,000		1121		1238
2010		8,507,000		1120		1238
2011		8,536,000		1128		1245
2012		8,565,000		1135		1251
2013		8,594,000		1141		1256
2014		8,624,000		1148		1261
2015		8,654,000		1154		1267
2016		8,684,000		1160		1272
2017		8,713,000		1166		1278
2018		8,743,000		1173		1283
2019		8,774,000		1179		1288
2020		8,804,000		1185		1294
2021		8,834,000		1191		1299
2022		8,865,000		1196		1303
2023		8,895,000		1201		1307
2024		8,926,000		1206		1311
2025		8,956,000		1210		1315
2026		8,987,000		1215		1320
2027		9,018,000		1221		1324
2028		9,049,000		1226		1329
2029		9,080,000		1232		1334
2030		9,112,000		1237		1339
2031		9,131,000		1242		1343
2032		9,152,000		1247		1347
2033		9,174,000		1250		1350
2034		9,196,000		1254		1353
2035		9,218,000		1258		1356
2036		9,240,000		1261		1359
2037		9,263,000		1265		1362
2038		9,285,000		1268		1365
2039		9,307,000		1272		1368
2040		9,329,000		1275		1371
2041		9,352,000		1278		1374
2042		9,374,000		1281		1377
2043		9,397,000		1284		1379
2044		9,419,000		1288		1382
2045		9,446,000		1291		1385

Figure 1 2006 DEP Interim In-City Water Demand

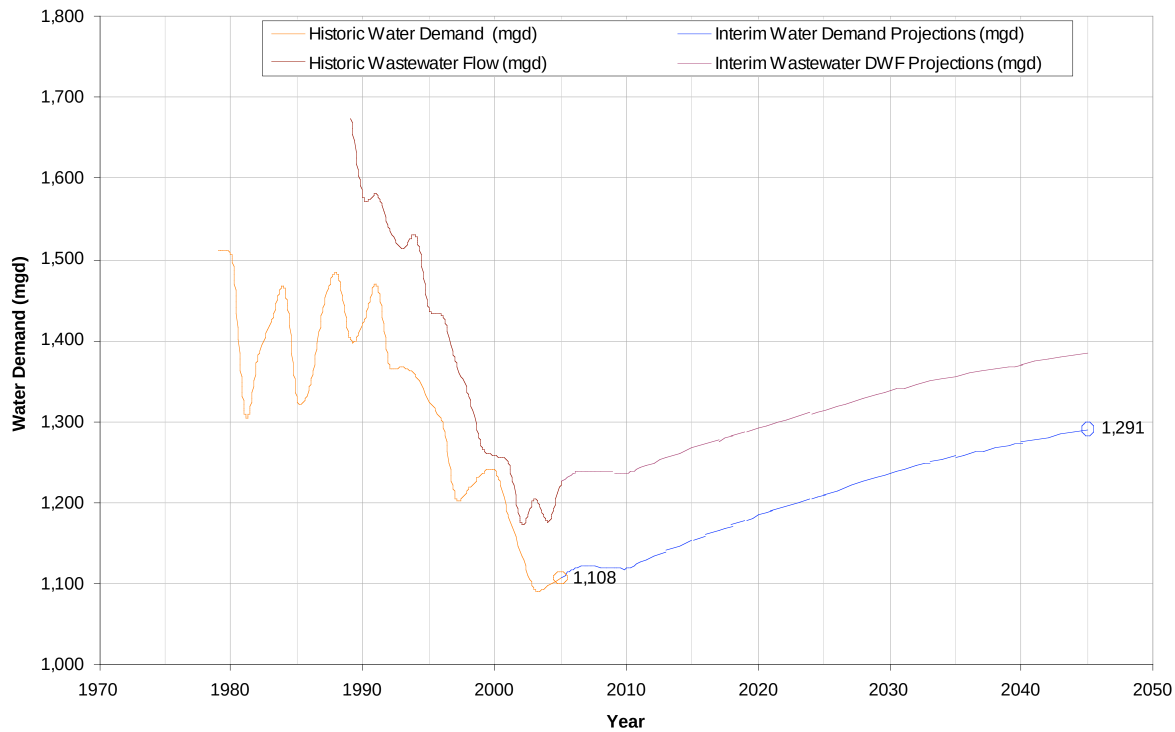


Table 2 Upstate Water Demand on DEP System

Year	Historic Water Demand (MGD)
1994	119.1
1995	123.0
1996	120.2
1997	123.1
1998	124.6
1999	128.4
2000	124.9
2001	128.3
2002	121.0
2003	115.8
2004	117.5
2005	123.7

Table 3: Largest Upstate Customers (Over 2 MGD)	
Customer	**2003 MGD**
Yonkers	28.46
United Water New Rochelle	18.79
Mt. Vernon	8.95
Westchester Joint Water Works #1	8.08
White Plains	7.83
Greenburgh	6.81
Yorktown	3.17
Ossining	2.85
Scarsdale	2.82
New Windsor/Stewart Airport	2.58
Portchester/Rye	2.53
Tarrytown	2.30
Cortland	2.21
Remaining 36 Customers	17.81

Water Use by Category and System Audit

Based on 2002 metering data, water usage by category is presented by borough and city as a whole in Table 4.

Table 4 2003 Percent Daily Water Consumption by Borough		
	Residential	**Non-Residential**
Manhattan	68%	32%
Bronx	92%	8%
Brooklyn	81%	19%
Queens	82%	18%
Staten Island	89%	11%
NYC Total	80%	20%
Does not include UAW and other non-metered usage.		

Statistically significant data for some non-residential customer classes is still not available due to unacceptably large numbers of estimated meter readings from these customers. Inadequate data for these non-residential customer classes prevents DEP from completing and further refining its water demand model and any system auditing analysis. The effort to resolve this problem will continue through the next year. DEP has also recently completed an updated analysis of distribution system losses. That analysis and a system water balance table, will appear in the June 2007 edition of this report. The table will list consumption between residential and non-residential, metered and unmetered, losses and UAW with a format similar to Table 4a:

Table 4a : General Water Balance 2003	
Category	**Daily Average Consumption (MGD) and (Notes)**
Known Water Use in Buildings and Other End Uses	
Residential Metered	461 (1)
Residential Unmetered	355 (1)
Non-Residential Metered	184
Non-Residential Unmetered	20 (2)
Subtotal Residential	817
Subtotal Non-Residential	204
Total Known Water Use in Buildings and Other End Uses	1021
Distribution System Leakage	xx (3)
Unaccounted-For Water Exclusive of Distribution Leakage	xx (4)
Total Daily Average Water Entering City: 2003	1094 (5)

Notes:

1. "Residential Metered" includes properties metered and billed on a metered basis. "Residential Unmetered" includes properties metered but billed on flat-rate, and extrapolated consumption of unmetered residential properties. From meter data used in interim draft demand study.
2. "Non-residential Unmetered" is extrapolated from the unit consumption of metered properties in the respective building class. From interim draft demand study.
3. "Distribution System Leakage" is calculated from measured leak rates from distribution leak detection surveys and repairs and leak rates and numbers from report leaks (main breaks, service line breaks). The June 2007 Report will include a detailed analysis.
4. Total Average Daily Water Entering City – Total Known End Uses – Distribution System Leakage
5. Average Daily Flow Into the City as Measured by Hillview and Shaft Meters.

Water Rate Structure

Water/wastewater rates are set annually by the New York City Water Board after a series of public hearings. The public rate setting process begins in April with the publication of "Public Information Regarding Water and Sewer Rates" available at http://nyc.gov/html/dep/html/wboard.html#bluebook .

93%+ of customers are billed on metered rates. One rate applies to almost all customers and that rate is currently (July 1, 2006 – June 30, 2007) $4.69/HCF of which $1.81 is the water charge and $2.88 is the wastewater charge. The water and wastewater charges are allocated based on the difference in system costs between water and wastewater.

Approximately 7% of customers are billed on unmetered rates, often referred to as "frontage." This is a system of charges associated with building size and the number of water-using fixtures. This system of unmetered rates will end on July 1, 2009 when customers will either move to metered billing or a conservation-conditioned flat rate for high-density, generally low-income apartment buildings, the Multifamily Conservation Program (http://nyc.gov/html/dep/html/meter.html#mcp).

The Water Board has commissioned analyses on alternative rate structures over the years, including rates theoretically designed to encourage greater efficiency of use. The Board has yet to be convinced that under current operating conditions there are any alternative rates which will provide a cost-effective rate-based tool. However, future movement to automatic meter reading and to monthly billing, as well as eventually replacing the current billing system with a more modern system, may result in a reassessment of this view.

Master Meters

DEP uses three venturi tubes to obtain flows entering City Tunnel No.'s 1, 2, and 3 from Hillview Reservoir. These venturi tubes are connected to meters using differential pressure (DP) cells to provide master flow readings for the three City Tunnels. All three meters have monthly charts to record the flow as well as digital counters to provide cumulative flow readings.

Currently there are 40 shafts in service on the three City Tunnels which bring water to the surface and distribute it to consumers. Except for two shafts, they have venturi tubes and DP cells to measure the flow. Where meters are missing or temporarily out of service, the flows are estimated by DEP engineers. In addition, Radcom datalogging connections allow DEP engineers to monitor the flows remotely. The individual shaft flows for each tunnel are also compared to the master meters at Hillview Reservoir. If abnormalities are found, field investigations are quickly started so that repairs or adjustments can be made. By carefully monitoring the tunnel flows, DEP is able to expeditiously correct many conditions which could contribute to water main breaks or flow reversals resulting in discolored water and water quality complaints.

When the Croton System is in service, most of the flow leaving the Jerome Park Reservoir is measured by venturi meters at various locations in the Bronx and Manhattan. The largest flow component from the Jerome Park Reservoir is measured at a location in northern Manhattan. The flow to the East Bronx is measured at an East Bronx location. Pumped water from the Jerome

Park Reservoir is measured at the Jerome Avenue Pumping Station in the Bronx and the 40th Street Pumping Station in Manhattan. In addition, flow to the South Bronx is measured at the south end of the Jerome Park Reservoir. Currently, the flow meters at the Mosholu Pumping Station and Inwood area of Manhattan are out of service. In the future, when the Croton Water Treatment Plant is completed and placed in service (2011), all Croton water will be measured by new magnetic flowmeters.

Customer Meters

Metering of Remaining Unmetered Properties

Approximately 97% of accounts are physically metered. The unmetered properties fall into a few categories:

1.3%	Refused to meter, being billed 100% surcharge over flat-rate charges
0.7%	Pending meter installation, often with technical problems
1%	Properties with deteriorated water service pipes, exempt properties (houses of worship), vacant properties

The number of properties surcharged for failing to meter has dropped from 35,000 in 2000 to approximately 11,000 in 2006.

DEP will bid a new meter installation contract set in early 2007.

Properties with deteriorated service pipes, usually either lead or galvanized metal, pose a unique problem. If the service line is sufficiently deteriorated that it is leaking, DEP can order it repair under “leak and waste” rules and the meter installation can then be performed. If the service line is not leaking, but both the meter installation contractor and DEP agree that the pipe is likely to fail if an installation is performed, DEP’s options are limited. To hurry the eventual replacement of these service lines, which would also serve the interest of reducing customer exposure to lead from some of those service lines, DEP is proposing changes to the city’s water use rules (Rules of the City of New York, Title 15, Chapter 20) to prohibit repair, as opposed to replacement, of lead or galvanized meter service lines and to require the installation of a water meter by any licensed plumber who applies for a permit to repair or replace a service line for an unmetered property.

Vacant properties will be metered when the property is redeveloped.

Houses of worship were made exempt from water/sewer charges in the 1980’s due to a law passed by the State Legislature. The (approximately) 1,400 unmetered exempt properties were not originally included in the Universal Metering Program but DEP will conduct a campaign to meter them in 2007-2008.

Meter Reading

Meters installed during DEP’s Universal Metering Program, since 1987, have had “absolute encoder” registers and remote meter reading receptacles, usually installed on the front or side wall of the building. These allowed the great majority of meters to be read without having to gain physical access to the buildings. They have proven to be somewhat imperfect since they can be broken intentionally or accidentally and actual read rates have not exceeded 85-87% citywide. Meters are read quarterly and billing occurs on a quarterly schedule, except for several thousand accounts either connected into a telephone-based (“inbound”) AMR system or read by the building owners/managers with reads faxed to DEP. These “Read Your Own Meter” customers are read and billed monthly. The telephone AMR system shows actual read rates of 93-94%, with estimated reads coming from meters that have malfunctioned or had their telephone connections interrupted.

DEP has been testing radio-based AMR alternatives over the last two years and at this writing plans to issue an RFP for a city-wide fixed network AMR system to be installed over a three-year period. Such a system will not only allow an eventual move to monthly billing, but will provide a rich source of water use data since a fixed network system can read meters daily or even more often. This data will improve DEP’s ability to understand customer water use, calculate unaccounted-for water in a more detailed manner and track savings from conservation programs. It will also provide early leak detection warnings that can be transmitted to customers.

DEP cooperated with a Con Edison pilot of Itron’s mobile AMR system in 2005-2006 involving approximately 300 properties in Brooklyn. DEP has been placing “hard to read” and “Read Your Own Meter” accounts throughout Brooklyn, Queens and Manhattan onto a mobile system manufactured by Transparent Technologies which currently totals about 200 accounts but is expected to grow to several hundred or more during 2006-2007.

Current plans are to develop a citywide “fixed network” system leveraging a citywide wireless system being installed by the New York City Department of Information and Telecommunication Technology (DOITT) during 2007-2008. DOITT’s project will identify and develop rooftop locations for AMR receivers along with its own equipment, and the DOITT system will be used to transmit the meter readings back to DEP. Pilot installations of several manufacturers equipment and an RFP are scheduled for early 2007.

Meter Repair/Replacement Program

Water meters register at a slower rate as they age. The exact age when replacement makes sense may depend on the physical age of the meter, the amount of water that has flowed through the meter over the years (the “mileage”), water quality, the type of meter and perhaps the manufacturer. An additional consideration is the cost to access a building to perform the work. For ” – 1” meters in DEP’s system, it appears that replacement is clearly cost effective by 18-22 years of age.

Since the earliest meters installed during the Universal Metering Program will be reaching 20 years old beginning in 2007-2008, the replacement of at least 100,000 meters will be included in the citywide AMR project currently scheduled to begin before the end of 2007. In addition to this, DEP inspectors routinely replace 30,000+ small meters each year and will be scaling up to approximately 50,000 by 2008. DEP Information Systems staff are preparing a report listing meters installed in 1995 or before with their total registration to help prioritize small meter systematic replacement over the next several years.

DEP began a program of consciously replacing larger (2” or larger) old meters in the system in 2004. That program continues today. During the original Universal Metering Program, 48,000 smaller old meters were replaced as part of that effort.

Inaccuracy and under registration among larger water meters is an even more important issue than for smaller meters since far more water flows through them and under registration has a greater impact.

DEP has been performing field meter accuracy tests for many years and in 1999 we compiled data on larger turbine and compound meters to determine typical accuracy levels of older meters. The results are presented in Table 5.

Table 5: Older Turbine and Compound Meter Accuracy

Meter Size/Type/Age	Mean Accuracy	Sample Size
3" Turbine 1-5 years old	65%	5
3 x e" Comp., 1-5 years old	84%	11
3 x e" Comp., 6-10 years old	77%	16
3 x :" Comp., 6-10 years old	87%	2
3 x :" Comp.,11-15 years old	78%	3
3 x :" Comp., 16+ years old	70%	2
4 x e" Comp. 1-5 years old	83%	11
4 x e" Comp., 6-10 years old	98%	4
4 x e" Comp., 11-15 years old	97%	2
4 x e" Comp., 16+ years old	84%	2
4 x :" Comp. 1-5 years old	90%	21
4 x :" Comp. 6-10 years old	89%	41
4 x :" Comp. 11-15 years old	49%	7
4 x :" Comp. 16+ years old	74%	12
4 x 1" Comp. 1-5 years old	95%	6
4 x 1" Comp. 6-10 years old	84%	21
4 x 1" Comp. 11-15 years old	86%	18

Table 5: Older Turbine and Compound Meter Accuracy		
4 x 1" Comp. 16+ years old	75%	12
4" Turbine, 1-5 years old	91%	14
4" Turbine, 6-10 years old	96%	14
4" Turbine, 11-15 years old	77%	18
4" Turbine, 16+ years old	90%	23
6 x 1" Comp. 1-5 years old	92%	11
6 x 1" Comp. 6-10 years old	94%	21
6 x 1" Comp. 11-15 years old	81%	5
6 x 1" Comp. 16+ years old	96%	2
6" Turbine, 1-5 years old	97%	11
6" Turbine, 6-10 years old	87%	15
6" Turbine, 11-14 years old	51%	14
6" Turbine, 16+ years old	78%	15
8" Turbine, 1-5 years old	100%	2
8" Turbine, 6-10 years old	83%	3
8" Turbine, 16+ years old	58%	2

In 2004 DEP began two contracts aimed specifically at replacing the largest and oldest meters in the system. Those two contracts replaced 1,100 meters out of the 5,000 over 2” turbine and compound meters. Several hundred more have been replaced under other replacement contracts.

This work is continuing through current and future meter replacement contracts.   DEP is also conducting an analysis of the billable consumption “before” and “after” the large meters were replaced, to estimate revenue gains.

In addition to these directed meter replacements, DEP also repairs and replaces 30,000 – 50,000 meters each year with smaller meter replacements (2” and smaller) and repairs being performed by DEP Inspectors and larger meter replacements being performed by licensed plumber Contractors.

Distribution Leak Detection, Pipe Repair and Replacement

The appendix includes tables which list the quantities of distribution pipe by size and material. The following table summarizes that information. Cast iron piping is generally the oldest and ductile iron and polyethylene-lined cast iron the newest.

Table 6: Water Main Quantities by Material Type (Linear Feet)		
Material Type	**Quantity**	**Percentage**
Cast iron	12,701,124	35.45%
Ductile iron	9.765,553	27.26%
Concrete lined cast iron	12,102,978	33.78%
Concrete	178,781	0.50%
Steel	1,056,729	2.95%
Polyethylene Lined	5,154	<0.1%
Unknown	15,043	<0.1%
TOTAL	35,825,362 (6,785 miles)	

Table 7: Water Main Quantities by Age		
Vintage	**Quantity**	**Percentage**
Pre-1900	3,524,871	10%
1901-1920	3,734,078	11%
1921-1940	9,085,758	26%
1941-1960	5,831,591	16%
1961-1980	5,145,377	14%
1981-2000	6,783,039	19%
2001-2005	1,546,109	4%

DEP replaced slightly under 59 miles of distribution pipe annually, on average, between 1996 and 2005 and plans to replace slightly more than and average of 56 miles annually from 1996 through 2015.

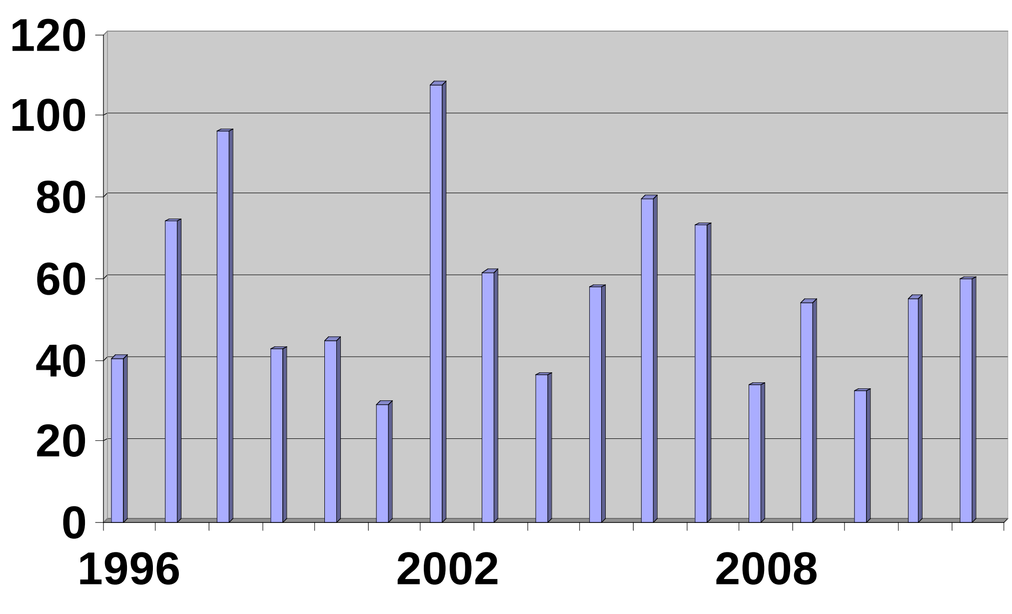
Distribution system leaks are detected and repaired both in response to customer complaints, and through a systematic survey of the distribution system. All parts of the distribution system are surveyed at least once every three years and the system located in the drainage areas for the Newtown Creek, North River and Wards Island wastewater plants is surveyed at least once every nine months.

Table 8: Distribution Leak Repair Statistics: FY06	
Survey Work	
Length of Piping Surveyed	21,524,265 LF (4,076 miles)
Number of Leaks Repaired	115
Water Savings	5.46 MGD
Source of Leak	39% Service Line, 34% Valve, 11% Hydrant, 10% Joint Leak, Main 6%

Table 8: Distribution Leak Repair Statistics: FY06	
Complaint Work	
Number of Leaks Repaired	249
Water Savings	39.36 MGD
Source of Leak	43% Service Line, 33% Main Break, 12% Valve, 12% Joint Leak, <1% Hydrant Leak

Table 9: Expansion and Results of Distribution Leak Detection		
Time Period	**Linear Feet Surveyed (000,000 LF)**	**Leaks Found/Repaired (GPD per 1,000 LF)**
Initial Citywide Cycle (1984-1990)	40.13 (Over six years)	2,334
FY1988	5.5	4,600
FY1996	23	550
FY2006	21.5	253.6

Miles of Pipe Replaced or Planned



Fixture Replacement and Customer Centered Programs

75% of residential water use occurs in the bathroom for toilet flushing, showers and use of the bathroom lavatory. Improving the efficiency of use in the bathroom was a clear goal for DEP and any water utility with water conservation goals.

<u>Residential Water Survey Program (RWS): Understanding the Housing Stock</u>

DEP began offering free water saving kits to homeowners in 1991 as well as free walk-through surveys of private homes to identify leaks and install low-flow showerheads, faucet aerators, and toilet displacement bags. By 1993 this program expanded to include multiple dwellings. Currently, small commercial occupancies are also included.

The RWS effort was directed at actual installation of water-saving items, as tens of thousands of water-saving showerheads and faucet aerators were installed, but also at collecting data on water use (and leaks) in New York residences. This information served both to educate property owners and to inform DEP about where leak problems lie.

Table 10: Leaks Measured During NYC Residential Water Surveys (2001-2003)

Leak Location	Number of Leaks	Leak Rate (gpd)
Shower	1949	70
Toilet Overflow	1837	574
Toilet Flapper	1414	533
Bathroom Faucet	1411	46
Kitchen Faucet	1225	44
Flushometer Valve	651	389
Toilet Ballcock	320	523
Toilet Shutoff Valve	32	440
Percentage of Dwelling Units with Leaks: 24.6%		

<u>Toilet Rebate Program (1994-1997)</u>

DEP conducted the largest toilet replacement program in history between 1994 and 1997 during which time more than 1.3 million toilets were replaced. A 20-year net present value comparison of the toilet rebate program and equivalent expansions of the supply and wastewater systems found that the conservation program would provide a net savings of $196 million from deferring construction of new supply and wastewater treatment capacity by ten years. The cost of conserved water was estimated at $4.54 million per MGD, as compared to approximately $10 million per MGD for new supply and wastewater treatment sources.

Total savings from the program have been estimated at about 80 MGD and an impact evaluation of the program (FN) found a 29% reduction in use among participating apartment buildings.

<u>Plans for Future Programs</u>

The eventual need to temporarily close the Delaware Aqueduct to allow repair of the leak has led DEP to study a wide variety of possible demand reduction and supply diversification projects to prevent supply shortfalls during the period of the Delaware Aqueduct outage. New incentive programs to replace additional existing toilets, existing urinals and to provide an incentive to install higher-efficiency toilets and urinals in new construction are amongst the most cost-effective options studied. DEP plans to begin offering a voucher-based toilet replacement program to high-density apartment buildings by the end of 2007 or beginning of 2008 and expand the program citywide by 2009. Incentives aimed at clothes washers in apartment building laundry rooms and laundromats are also being planned.

Table 11: Currently Planned Fixture/Appliance Incentive Programs (Estimated) 2008-2011

Project Description	Estimated Savings (MGD)	Estimated Cost ($000,000)	$M/MGD
Toilet Replacements (Phase I, 2008)	10	26	2.60
Toilet Replacements (Phase II 2009-2010)	30	99	3.30
Clothes Washers	10	35	3.50
Cost-Sharing ICI Program	4.5	16	3.60
School-Public Building Replacements	5.5	16	2.88
Subtotal	60 MGD	157	2.62

Phase I of the toilet replacement program is fully funded and DEP is developing the specifications for an Administrative Project Management Contractor in Fall 2006. Funds for Phase II and the Clothes Washer effort should be added to the capital budget in January 2007. A program to replace old fixture in public schools and other public buildings is currently under discussion, as is a performance-based program to co-fund water-saving projects in non-residential properties. By comparison to the under-$3 million per MGD cost of the efficiency programs, the lowest capital cost for supply projects is approximately $10 million per MGD.

<u>Public Buildings (NYCHA)</u>

As part of the wastewater consent decrees, the New York City Housing Authority replaced 103,432 toilets in buildings located in the Newtown Creek, North River and Wards Island drainage areas during the 1990's through 2004. This is almost 99% of the fixtures in NYCHA buildings within the drainage area. NYCHA's periodic bathroom renovation projects throughout their system continue to add to their savings through the present day.

Public Buildings (Non-NYCHA)

DEP is in the early planning stages of a project for fixture replacements in city schools and other public buildings. DEP contracted with a water/energy engineering firm to perform detailed non-residential water audits of both private and public commercial-industrial buildings. Several New York City schools and hospitals were surveyed and data collected on the potential cost and savings of fixture replacements in these buildings. With cooperation from the Department of Education and School Construction Authority, DEP hopes to identify buildings which do not have water-saving fixtures and are not scheduled for capital upgrade projects in the next several years. These buildings would then be the subject of a fixture replacement program.

Building Manager Education

Since 1991 DEP and HPD have co-sponsored water conservation seminars design primarily for apartment building managers and maintenance staff, but open to the public. Over 5,000 people associated with more than 800,000 dwelling units have attended these seminars over time. The seminars compose part of a Building Education curriculum organized by HPD as well as stand-alone seminars offered biweekly.

Outdoor Water Use Reduction

Although DEP maintains restrictions and limits on outdoor water use, even outside of a drought emergency, outdoor water use has not been a high priority for program development since outdoor use is relatively minor. In 2005 and 2006 use during the warmest months was only 10-16% higher than average daily use during mid-winter and some of that additional use was due to the operation of evaporative cooling towers for central air conditioning systems. Average daily use in April and May, before the air conditioning season, was no higher than average daily use in January and February.

Watering Restrictions and Enforcement

DEP maintains and occasionally updates Chapter 20 and Chapter 21 of the Rules of the City of New York (“RCNY”). Chapter 20 includes general water use rules including connections to the system, meters, backflow protection and rules governing outdoor water use. Chapter 21 contains rules in effect during a drought emergency.

Chapter 21 was updated and revised in 2006 and Chapter 20 is current being updated with a new version of the Rules expected late in early 2007. The new version of Chapter 21, as well as the existing and proposed versions of Chapter 20 are included in the Appendix.

The water use rules included in Chapter 20 are generally similar to those maintained by many water utilities. They include:

a) Prohibition against most outdoor water use between the hours of 11 a.m. and 7 p.m. and between November 1 and March 31.

b) Requirement that hoses have nozzles. The proposed updated rule limits the flow rate of such nozzles to 5 gpm are required automatic shutoff handles.

c) Car washes using city water (as opposed to those using ground water) are required to recycle 80% of their water.

d) Public fountains and similar uses must use recirculated water.

e) Hydrant use requires a permit. The proposed changes place the onus on the applicant to demonstrate they could not use metered water in lieu of a hydrant.

The drought emergency rules describe a drought emergency as having three possible stages of increasing seriousness: Stages 1-3. Major issues of the drought rules include:

a) Lawn watering is prohibited beyond Stage 1 and watering of golf course fairways is prohibited even in Stage 1. Home lawn watering is limited to every other day.

b) Sidewalk and vehicle washing is prohibited except for health and safety reasons or Code compliance

c) Request by the DEP Commissioner to the New York City Water Board to enact a “drought emergency rate increase”

d) Esthetic and recreational uses are banned.

e) Requirements for extensive “save water” signage

Hydrant Use Controls

DEP has installed locking devices on more than 30,000 hydrants citywide and also joins with the Fire Department in distributing spray caps each season. This policy has reduced peak use on all but the most severe heat waves.

Water Reuse

On July 1, 2004 the New York City Water Board created the Comprehensive Water Reuse Program (“CWRP”) rate which provides for a discounted water/sewer rate for mixed use or residential buildings that recycle water using a “blackwater” recycling system. One year later the qualifications for the rate were expanded to buildings which recycle blackwater or combinations of greywater and stormwater or greywater and district steam condensate. Only one building has applied for this rate, to date.

DEP is also examining the feasibility of reusing stormwater released by MTA sump pumps and reclaimed water near selected wastewater treatments plants.

Educational Campaign Program to Encourage Water Conservation Behavior

In order to help educate the public and raise awareness about water conservation, the DEP has developed, through its Bureau of Communications and Intergovernmental Affairs, a public education and outreach program. This program has been running for many years and has several integrated components that address a wide range of topics through a multiple media approach, as outlined below.

- Publications
- Promotional Items
- School Programs
- Public Event-based Programs
- Web Site

The following sections provide descriptive information regarding DEP programs conducted during 2005, programs planned for 2006, and new initiatives that will be investigated for implementation in 2006 and 2007.

Publications

A list of flyers, brochures, posters, and publications is provided in Table 12. These items were displayed or distributed throughout the public education program, and most are readily available on the DEP web site. Examples of the publications are shown in the following pages.

Table 12. Literature / Publications

New York City's Wastewater Treatment System (Report)
2004 New York Harbor Water Quality Report (Report on CD)
New York City's Water Supply System (Postcard for Conference)
Grease Disposal Tips (Leaflet)
Biosolids Beneficial Use Program (Leaflet)
Floatables Reduction Program (Leaflet)
Staten Island Bluebelt (Leaflet)
Clean Streets = Clean Beaches (Poster/Leaflet)
The DEP in The News (Newsletter)
Bureau of Wastewater Treatment: Bureau Summary (Report)
New York City 2004 Drinking Water Supply and Quality Report (Report)
Fire Hydrants (Poster)
Dos & Don'ts of Water Conservation (Leaflet)

PLANT A "NATIVE NEW YORKER"

What is a native plant?

A native plant lives or grows naturally in a particular region without direct or indirect human intervention. There are a large variety of native plants that grow throughout New York City. New York City native plants include the following: ferns, grasses, sedges, trees, vines, shrubs, and wildflowers. Plants evolve over time in response to climate, soils, rainfall, drought, and frost; as well as interactions with the other species inhabiting the local community. Thus, native plants possess certain traits that make them uniquely adapted to local conditions, providing a practical and ecologically valuable alternative for landscaping, conservation and restoration projects.

In North America, plant species are generally described as native if they occurred here prior to European settlement. This distinction is made because of the large-scale changes that have occurred since the arrival of the European settlers. The Europeans imported a variety of plants to this country and today, many are still a major component of traditional lawns and gardens.

Benefits of native plants

The benefit of growing and landscaping with native plants is that they are more likely to thrive under the local conditions while being less likely to invade new habitats. Native plants are well adapted to local environmental conditions, maintain or improve soil fertility, reduce erosion, and often require less fertilizer and pesticides than many alien plants. These characteristics save time and money and reduce the amount of harmful run-off threatening the aquatic resources of our streams, rivers, and estuaries. In addition, functionally healthy and established natural communities are better able to resist invasions by alien plant species. So, the use of native plants can help prevent the spread of alien species already present in a region and help avert future introductions.

On a broader ecological scale, planting native species contributes to the overall health of natural communities. Disturbances of intact ecosystems that open and fragment habitat, such as land clearing activities, increase the potential of invasion by alien species. Native plants provide important alternatives to alien species for conservation and restoration projects in these disturbed areas. They can fill many land management needs currently occupied by non-native species, and often with lower costs and maintenance requirements. Once established in an appropriate area, most native plant species are hardy and do not require watering, fertilizers, or pesticides.

Black-eyed Susan *(Rudbeckia hirta)* is an easy-to-grow biennial that thrives in poor soil. In colder climates, sow in mid-summer for blooms the following summer. In warmer climates, sow in early spring for late summer blooms.

Butterfly weed *(Asclepias tuberosa)* is part of the milkweed family and grows up to 2 feet. The flowers tend to be bright orange, and showy. Butterfly weed flourishes during the months of July and August and attracts many butterflies. The foliage is a favorite food of monarch caterpillars.

Heart-leaved aster *(Aster cordifolius)* is part of the Aster family and grows up to 4 feet. The flowers are powder blue, showy, and bloom through the months of August-October.

Wild bergamot *(Monarda fistulosa)* grows to 4 feet. Flowers bloom lilac or pink and grow between the months of July-September. Other native *Monarda* species include: Horse mint (*Monarda punctata*) which grows up to 3 feet and has yellow flowers with purple spots; and Bee balm (*Monarda didyma*) which grows up to 4 feet and has red flowers. All three species attract humming birds.

Other native plants to consider for your garden:

Birdfoot violet *(Viola pedata)*
Jack-in-the-pulpit *(Arisaema triphyllum)*
Perfoliate bellwort *(Uvularia perfoliatea)*
Smooth blue aster *(Aster laevis)*
Wake robin *(Trillium erectum)*
Wild blue lupine *(Lupinus perennis)*
Wild columbine *(Aquilegia canadensis)*
Wild geranium *(Geranium maculatum)*
Yellow forest violet *(Viola pubescens)*

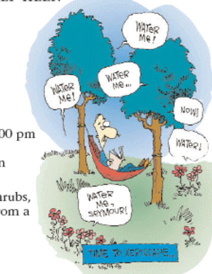
www.nyc.gov/dep
Michael R. Bloomberg, Mayor
Emily Lloyd, Commissioner

Information was gathered from: City of New York Department of Parks and Recreation, www.nyc.gov/parks; US EPA, www.epa.gov; Brooklyn Botanic Garden, www.bbg.org; NYSDEC Natural Heritage Program, www.dec.state.ny.us

HOW TO SAVE WATER AND KEEP PLANTS GREEN DURING A DROUGHT EMERGENCY

Mayor Bloomberg declared a drought emergency beginning April 1, 2002.
Here are some facts about the drought and a list of ways you can help.

An open hydrant wastes one million gallons of water per day.
Report **open hydrants** and **water waste** by calling (718) DEP-HELP.



PROHIBITED ACTIVITIES:

- No washing of vehicles, sidewalks, driveways, or streets.
- No ornamental fountains.

WHEN AND HOW TO WATER:

- Lawn watering is currently restricted to 7:00 am to 9:00 am and 7:00 pm to 9:00 pm with even numbered addresses on even dates, and odd numbered addresses on odd dates. In a Stage II emergency all lawn watering is prohibited.
- All other plants (flowers, perennials, annuals, and ground cover, shrubs, and trees) may only be watered with hand-held containers filled from a hose, hoses restricted to less than five gallons per minute, or low-pressure/low-flow irrigation devices.

OTHER WAYS TO KEEP PLANTS GREEN:

- Spread mulch or wood chips in planting beds to help plants maintain moisture.
- Weed planting beds often to relieve competition for water.
- Cultivate/aerate soil to help dry soil absorb and retain rainwater.
- Water plants with gray water (such as bath and dish water) using hand held containers, and collect rainwater in closed containers whenever possible.
- Water in the early morning or evening to prevent evaporation.
- Use hose with automatic shut-off nozzles. They control the flow of water and allow you to walk away from the hose without wasting water.
- Use soil moisture retention additives. When added to soil, they help it retain nutrients and moisture.
- Use tree gators to water your street trees, backyard trees and large shrubs.
- Avoid planting annuals, but if planting is absolutely necessary, use drought tolerant annuals such as portulaca, marigold, wax begonia, verbena, and be prepared to maintain them.

To learn more about the drought visit the DEP or Parks web site at:
www.nyc.gov/parks or www.nyc.gov/dep

City of New York Parks & Recreation

Save Water
Don't Drip New York Dry!

The DOs & DON'Ts of Water Conservation

In or out of a drought, every New Yorker can save hundreds of gallons of water each week by following these simple water-saving tips.

BATHROOM

- ✔ Do take short showers and save 5 to 7 gallons a minute.
- ✔ Do fill the tub halfway and save 10 to 15 gallons.
- ✔ Do install water-saving toilets, showerheads and faucet aerators. Place a plastic bottle filled with water in your toilet tank if you can't switch to a low flow toilet.
- ✖ Don't run the water while shaving, washing your hands or brushing your teeth. Faucets use 2 to 3 gallons a minute.
- ✖ Don't use the toilet as a wastebasket, and don't flush it unnecessarily.

KITCHEN & LAUNDRY

- ✔ Do run the dishwasher and washing machine only when full. Save even more by using the short cycle.
- ✔ Do install faucet aerators.
- ✖ Don't let the water run while washing dishes. Kitchen faucets use 2 to 3 gallons a minute. Filling a basin only takes 10 gallons to wash and rinse.
- ✖ Don't run water to make it cold. Have it chilled in the refrigerator, ready to drink.

EVERYWHERE

- ✔ Do repair leaky faucets and turn taps off tightly. A slow drip wastes 15 to 20 gallons each day.
- ✖ Don't open fire hydrants.

OUTDOORS

- ✔ Do use a self-closing nozzle on your hose.
- ✖ Don't water your sidewalk or driveway - sweep them clean.
- ✖ Don't overwater your lawn or plants. Water before 9 a.m. or after 7 p.m.

Do share this information with family and friends.

REPORT LEAKS & WATER WASTE.
Call 311

Visit DEP's Web site at: www.nyc.gov/dep

Michael R. Bloomberg, Mayor
Emily Lloyd, Commissioner

Printed on Recycled paper 4/05

PLAY WITH A HYDRANT AND YOU'RE PLAYING WITH FIRE.

Hydrants are for fighting fires, not for having fun.

Each time a hydrant is opened illegally, a thousand gallons of water are wasted each minute, and children risk serious injury from the powerful flow.

There's also a severe loss of water pressure. Which means if there's a fire, someone could die.

So if you need to cool off, try the beach or the nearest pool, or get an approved spray cap for a neighborhood hydrant from your local fire house.

Save Water. It Could Save a Life.

TO REPORT OPEN HYDRANTS, CALL 311

www.nyc.gov/dep
Michael R. Bloomberg, Mayor
Emily Lloyd, Commissioner

Promotional Items

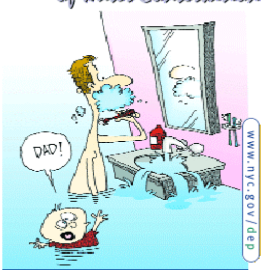
The DEP distributed approximately 267,450 promotional items at various tabling events. Table 13 summarizes the advertising efforts of this program for 2005 and provides a list of additional promotional items as well. Examples of the promotional items are depicted in the following pages and include Save Water Sponges, magnets, book marks, buttons, and bumper stickers.

Table 13. Public Outreach Program

Promotional Item Distribution, 2005

Category	Total Number
Beach Bags	10,250
Frisbees	8,500
Litter Bags	10,000
Metro Card Holders	35,000
Save Water Sponges	25,000
Twixit Clips	19,700
Save Water – Don't Drip New York Dry (Bumper Sticker)	25,000
Dos & Don'ts of Water Conservation (Bookmark)	130,000
Dos & Don'ts of Water Conservation (Magnet)	4,000
	267,450

The DOs & DON'Ts of Water Conservation



BATHROOM

✔ Do take shorter showers and fill the tub halfway.

✖ Don't run water while washing your hands & brushing your teeth.

KITCHEN & LAUNDRY

✔ Do run the dishwasher & washing machine only when full.

✖ Don't run water to make it cold. Chill it in the refrigerator, ready to drink.

EVERYWHERE

✔ Do install water-saving fixtures.

✖ Don't ignore leaky toilets & faucets. Turn taps off tightly.

OUTDOORS

✔ Do use a self-closing nozzle on your hose.

✖ Don't open fire hydrants.

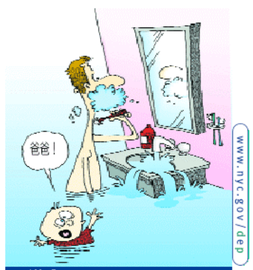
REPORT LEAKS & WATER WASTE. Call 311

In or out of a drought, every New Yorker can save hundreds of gallons of water each week by following these simple water-saving tips.

DEP

Michael R. Bloomberg, Mayor
Emily Lloyd, Commissioner

節省用水注意事項



浴室

✔ 應該縮短淋浴時間，只將浴缸的水加到一半。

✖ 不應在洗手、刷牙時讓水繼續流。

廚房和洗衣

✔ 應該只在洗碗機和洗衣機裝滿之後才使用。

✖ 不應將水龍頭打開等水變冷。應該將水放在冰箱中降溫以供飲用。

所有地方

✔ 應該安裝節水裝置。

✖ 不應忽視漏水。應將水龍頭擰緊。

戶外

✔ 應該在水管上使用自動開關噴咀。

✖ 不應打開消火栓。

**請報告漏水及浪費水的現像。
電話：(718) 337-4357**

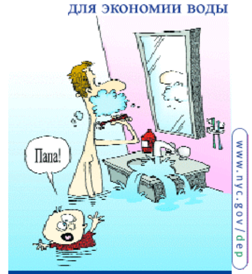
不論是否乾旱缺水，只要按照以上常識去做，每一位紐約人每週都能節省幾百加侖水。

DEP

紐約市市長Michael R. Bloomberg
環保署署長Christopher O. Ward

ЧТО НУЖНО И ЧЕГО НЕЛЬЗЯ ДЕЛАТЬ

для экономии воды



ВАННАЯ КОМНАТА

✔ Стойте меньше времени под душем и заполняйте ванну наполовину.

✖ Не оставляйте кран открытым на то время, пока вы моете руки и чистите зубы.

КУХНЯ И СТИРКА

✔ Используйте посудомоечную или стиральную машину, только если она заполнена.

✖ Не сливайте воду, чтобы охладить ее. Охлаждайте воду в холодильнике до температуры, приятной для питья.

ВЕЗДЕ И ПОВСЮДУ

✔ Обязательно установите арматуру, которая экономит воду.

✖ Не проходите мимо утечек воды. Полностью закрывайте краны.

ВО ДВОРЕ

✔ Используйте шланг с самозакрывающимся распылителем воды.

✖ Не открывайте пожарные гидранты.

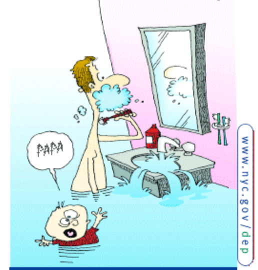
**СООБЩАЙТЕ ОБ УТЕЧКАХ И ПОТЕРЯХ ВОДЫ.
Звоните по телефону (718) 337-4357**

Как в засуху, так и при обилии атмосферных осадков каждый житель Нью-Йорка может еженедельно экономить сотни галлонов воды, следуя приведенным выше простым советам.

DEP

Майкл Р. Блумберг, мэр
Кристофер О. Уорн, глава департамента

LOS "SI" Y LOS "NO" para conservar agua



CUARTO DE BANO

✔ Tome duchas más cortas y llene la bañera por la mitad.

✖ No deje correr el agua mientras se lava las manos o se cepilla los dientes.

COCINA Y LAVADERO

✔ Use el lavaplatos y la máquina de lavar la ropa sólo cuando estén llenos.

✖ No deje correr el agua para que se enfríe. Refrigere agua en la nevera y téngala lista para beber.

EN CUALQUIER LUGAR

✔ Instale artefactos que ahorran agua.

✖ No pase por alto las goteras. Al cerrar las llaves del agua, asegúrese que estén bien ajustadas.

AL AIRE LIBRE

✔ Use una boca de cierre automático en su manguera.

✖ No abra hidrantes de incendio.

Para informar sobre goteras y desperdicio de agua, llame al 311.

Haya o no una sequía, todo neoyorquino puede ahorrar cientos de galones de agua cada semana siguiendo estos simples consejos

DEP

Michael R. Bloomberg, Alcalde
Christopher O. Ward, Comisionado

Save Water

NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION — DEP

Don't Drip New York Dry!

REPORT LEAKS AND WATER WASTE • CALL 311

School Programs

DEP's Bureau of Communications and Intergovernmental Affairs will continue to develop and implement school-based education programs to help make young people and adults aware of the importance of conserving water. DEP will provide classroom lessons, staff development workshops for teachers and administrators, printed material describing harbor water issues, and assistance for curriculum development and student research projects.

DEP’s ongoing partnerships with education and environmental organizations, such as the New York City Soil and Water Conservation District, the Bronx River Alliance, Council on the Environment of New York City, the American Littoral Society, the New York-New Jersey Harbor Estuary Program and the South Street Seaport Museum enable DEP to reach a diverse audience.

DEP's environmental education resources for New York City's public and private schools emphasize critical and creative thinking, decision-making skills, communication and collaborative learning across disciplines. All programs are inquiry-based and are aligned with New York City Performance Standards in Science, Math, Social Studies and Applied Learning and with the New York City Department of Education's new Science Scope and Sequence.

NEW YORK CITY WATER SUPPLY
Activity 1: CREATE A RAINSTORM

This is an excellent ice-breaking activity to use with students of all ages and any group size, as well as for beginning a teacher training workshop.

Objectives:
- To creatively help teachers and students understand the water cycle.
- To actively engage students and teachers in learning about the source of their drinking water.

Method:
- Pose the question: "Where do you think your drinking water comes from?" Some responses may be "rain", "snow", "reservoirs."
- Introduce the activity: "As a group, right in this room, we are going to create a rainstorm. You will need to concentrate and use your imagination. We will make the rainstorm using our hands and feet, so make sure that you have enough room to do so. Lets review the different things we will do. (Go through each movement). Now, watch my hands and as I change what they are doing, you follow and do the same thing."
- Start to **rub your palms together.** You can narrate the storm if you chose. "We are in the Catskill Mountains, over 125 miles away from New York City. It's summer and a rainstorm is brewing. The wind is picking up and leaves start to rustle and a cloud covers the sun."
- **Snap your fingers.** "The raindrops are starting to fall, lightly at first and streams begin to fill and lakes form."
- **Clap with two fingers to palm.** "The rain is starting to fall a little harder." Water is flowing quickly down the mountains.
- **Clap.** "The storm is getting more intense. The raindrops are falling harder and heavier. Rivers and streams swell. Reservoirs, large bodies of water, built to hold this rain and melting snow, fill with water."
- **Slap your lap and stamp your feet.** "The summer cloudburst is reaching its peak as the wind rushes through the trees and the rain comes heavy and fast."
- **Clap.** "It has been an intense cloudburst, but like many summer storms, it doesn't last long. The rain is starting to slack off and the wind is dying down."
- **Clap with two fingers on palm.**
- **Snap fingers.** "Rain drops fall in the reservoir in smaller drops."
- **Rub palms together.** "The sun comes out from behind the clouds, the leaves are fresh and wet and green. Small streams and puddles rush over the sloping ground. Whispering: And our rainstorm is over." Stop rubbing palms together. Remain silent for a few seconds.

Discussion:
- Now that you have completed the activity, discuss in more detail where NYC's drinking water comes from. "Does anyone know where we get our drinking water?" Take responses.
- "What happens if we don't get enough rain or snow where the reservoirs are located?" Introduce the concept of water conservation and drought.
- Discuss the concept of a watershed (the land that water flows across or under on its way to a stream, river, lake or reservoir).

For more information contact:

New York City
Department of Environmental Protection
59-17 Junction Boulevard
Flushing, NY 11373
educationoffice@dep.nyc.gov

Dial 311 for all NYC government information and services

Also visit DEP's Web site at:

www.nyc.gov/dep

New York City Department of Environmental Protection • Bureau of Public Affairs
59-17 Junction Boulevard • Flushing, NY 11373-5108 • Dial 311 for all NYC government information and services

NEW YORK CITY WATER SUPPLY
Activity 2: THE VALUE OF WATER

This activity examines our perception of water and helps students understand, through acting, the importance of water in our lives.

Objectives:
- To help participants understand how much water they use each day.
- To encourage discussion about the value of water.

Materials:
1. A one gallon water jug
2. Your imagination

Method:
- Ask your students if they have used water during the day. Some may answer that they have not. How was water used? List responses on the board. Encourage your students to include all water use, including the water they gave to pets and plants. Ask your students to think about the dependence living things have on water.
- Hold up a filled gallon water container and ask: "How many gallons of water do you think you use each day?" Think about how much each activity uses. For example, a ten minute shower uses about 50 gallons, one flush of the toilet averages three to five gallons and brushing teeth with the water running uses about 15 gallons. Estimate personal water use again. If the numbers are closer to 100 gallons a day, they are correct.
- "How do we get our water at home?" [Turn the tap.] Demonstrate the simplicity of this action.
- Ask your students to imagine living in New York City 160 years ago, before people could simply turn on the tap and get clean water. Where would their water come from? [From a local well or a stream.]
- Pretend t o go outside to a local well for water. "What is a well?" Use the example of digging a hole in the sand at the beach and having it fill with water as an illustration of a well. What will you need to bring with you? [A bucket, a lantern at night and warm clothing during the winter.] Let's get ready to go...
- Participants can do this activity as a group or one or two students can act it out in front of the class. Walk to the well, set down our lantern and bucket, and lower the well bucket to get water. Hoist the full bucket and empty it into the bucket you will carry home. Carry the bucket carefully. Why? [You do not want to spill any water.] Bring the bucket inside and lift it onto a table. "How did that feel?" [Heavy, a lot of work.] Imagine having to gather water that way all the time. "How would you feel about this water?" [Valuable, important, needs protection.] "Would you be careful with the water you use at home or would you waste it?" [Careful because I would not want to have to gather more water unnecessarily. I would conserve water.]
- "How much does water weigh?" Pass around the gallon jug of water. Estimate its weight. A gallon of water actually weighs 8.34 pounds. How much would a five gallon bucket weigh?

Discussion:
- If anyone in the class has gone camping ask how they treated the water they carried?
- Ask your students to describe how water is collected and reserved in countries their families are from or those they may have visited.

For more information contact:

New York City
Department of Environmental Protection
59-17 Junction Boulevard
Flushing, NY 11373
educationoffice@dep.nyc.gov

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NEW YORK CITY WATER SUPPLY
Activity 3: WHAT IS A WATERSHED?

This hands-on activity allows students and teachers to create a working model of a watershed. It also allows the audience to see the different parts of a watershed and how rain effects this environment.

Objectives:
- To introduce students and teachers to the concept of watersheds.
- To engage students and teachers in learning about the source of New York City's drinking water and its relationship to watersheds.

Materials:

For each group of 4-6 participants:
1. A plastic or metal tray (at least 4" deep)
2. A spray bottle filled with water
3. 6 sheets of newspaper
4. One large sheet of plastic wrap
5. 2 paper towels
6. Food coloring (optional)

Method:
- Introduce the activity by explaining that students will create a landscape in their box that looks very much like the area that collects New York City's drinking water.
- Ask students to work cooperatively within their groups and to discuss their observations.

Part I
- Instruct participants to create a mountainous landscape in the basin using pieces of newspaper. Mold the newspaper into mountains and place them in the plastic tray.
- Give each group a piece of plastic wrap to cover the newspaper. Make sure that the wrap is molded to the contours and tuck ends inside.
- Using the fine mist from the spray bottle, rain on the landscape. Pay careful attention to what the water drops are doing. "How are they moving?" [*Downhill*] "Are they collecting?" [*Forming puddles and/or streams*] "What might the puddles represent?" [*lakes and reservoirs*] "Did these lakes form simply by spraying directly over them?" [They formed by streams feeding them with water]. After the landscapes have been sprayed, discuss these questions. Ask someone from each group to speak to the class about the observations their group made.
- Discuss what physical feature of the watershed the plastic wrap represents. Encourage students to explore how the water moved over the plastic. What in nature might this represent ? [The bedrock of the mountains.]

Part II
- Hand out paper towels to each group. Mold to the landscape.
- Rain and observe how water moves through the landscape.
- Pose questions: "Is the water flowing in the same manner?" (It spreads out, does not move as quickly, still it flows downhill.) "What does the paper towel represent?" [soil and vegetation]
- Discuss the role vegetation plays in the natural landscape. Trees and grasses for example help to regulate the flow of water and help to prevent flooding and erosion.

Part III (Optional)
- Add a few drops of food coloring to each landscape and rain again. Pretend the color represents a chemical that was accidentally poured into the soil. What observations can you make? How does rain affect the movement of pollutants? [*It is mixed with the water and pollutes the reservoirs. It soaks into the soil.*]
- "What does this mean to our water supply?" [*It is very important to protect our water supply and our watershed from pollution.*]

Discussion:
- You have just created a watershed. Can you describe it? Why is watershed protection important to New York City?
- Can you now describe how our drinking water is collected in the watershed? Share this important information with your family and friends.
- What happens when there is not enough precipitation in the watershed? What do you do to conserve water at home and school?

For more information contact:

NYC Department of Environmental Protection, 59-17 Junction Boulevard, Flushing, NY 11373
educationoffice@dep.nyc.gov
Visit DEP's Web site at: www.nyc.gov/dep

New York City Department of Environmental Protection • Bureau of Public Affairs
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NEW YORK CITY WATER SUPPLY
Activity 4 : TESTING THE WATERS: AN INTRODUCTION TO WATER QUALITY

This hands-on curriculum-based activity allows students and teachers to explore introductory water quality testing. The lesson focuses on two specific parameters, pH and chlorine residual.

Objectives:
- To introduce the concept of water quality testing, utilizing kits and/or scientific instruments.
- To investigate specific water quality parameters pH and chlorine residual.
- To link the importance of good water quality for humans with other living things.
- To support curriculum-based learning and new performance standards.

Materials:
- Plastic collection bottle
- pH testing kit or litmus paper
- Chlorine testing kit

Background:

Ask your students what they think it means to have a good and safe drinking water supply. Why is good water quality so important to us and other living things? Ask the class if they know what agency in New York City is responsible for the operation, maintenance and protection of our water supply.

The New York City Department of Environmental Protection (DEP) has the job of supplying water to all of you every day. DEP provides approximately 1.3 billion gallons of water to over 9 million people each day. DEP has to make sure that there is enough water for all of us to use. They also have to make sure that the water is safe to drink.

There are many types of scientists that work at DEP to test the water. A monitoring program is in place in our upstate watersheds (at the reservoirs and feeder streams) and in the city (within the distribution system) to do this. Scientists that study fresh bodies of water are called limnologists. They go out to the streams and reservoirs seven days a week to collect water samples and then bring these bottles into the laboratory. There, microbiologists examine the water for bacteria and algae. Chemists, another type of scientist, look for chemicals and compounds such as calcium, lead, copper, nitrates, phosphates and hardness to determine the chemical composition of the water. There are five laboratories that test our water daily. Four of them are located upstate and conduct various analyses on our source water. The one laboratory in Queens examines the water throughout the distribution system within the City of New York.

New York City's water supply is not filtered, but certain chemicals are added to treat the water. Query the class on what chemicals are added. All water entering New York City's distribution system is treated with chlorine, fluoride, orthophosphate, and, in some cases, sodium hydroxide. Chlorine is added to disinfect the water. Fluoride is added to prevent tooth decay and cavities. Orthophosphate is added to create a protective film on pipes which reduces the release of metals, such as lead, from household plumbing. Sodium hydroxide is added to the water to raise the pH and reduce corrosivity.

As the water is entering the distribution system, samples are collected by field personnel at sampling stations, which are located throughout the five boroughs. Sampling stations were installed throughout the five boroughs to ensure an accurate and reliable method of collecting distribution water samples. At these stations, preliminary testing is done for temperature, pH, chlorine residual and phosphates. Then the water sample is brought back to the laboratory for routine and more intensive testing. The water is analyzed for a broad spectrum of microbiological, chemical, and physical measures of quality. In 2001, DEP collected over 47,000 in-City samples and performed approximately 1,031,000 analyses.

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Table 14 presents a summary of event locations per borough.

Table 14. Number of Education Events Per Borough, 2005

Location	Number of Events
Bronx	6
Brooklyn	16
Manhattan	52
Queens	20
Staten Island	0
City-wide	45
Total	**139**
Average Events Per Month	**12**

Public Event-based Programs

In 2005, the DEP attended 227 public outreach events, averaging approximately 19 events per month. Events included table top displays and outreach at 78 fairs, festivals, and concerts, most of which were community based. Other events included displays and outreach at 67 greenmarkets and farmers markets and 5 "Clean Streets = Clean Beaches" events, with the remainder including a combination of community group outreach, such as presentations and table top displays at churches, professional associations, and the Boy Scouts, as well as events conducted at City parks and museums. Table 15 includes a summary of events per borough, respectively.

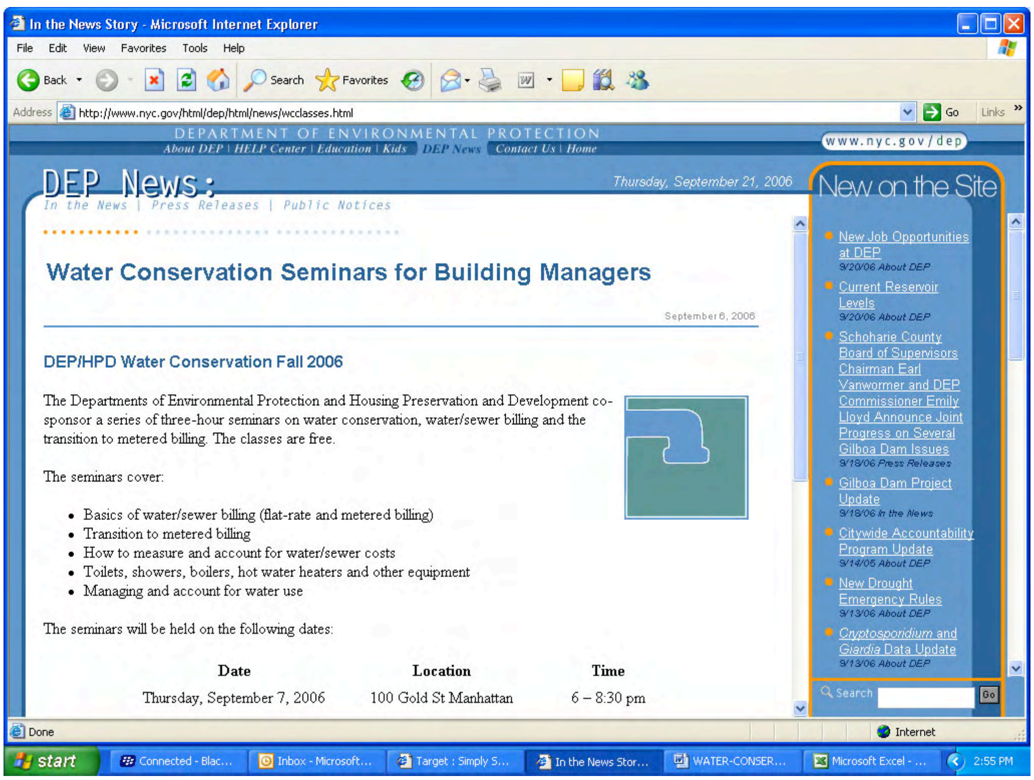
Table 15. Number of Public Outreach Events

Per Borough, 2005

Location	Number of Events
Bronx	22
Brooklyn	52
Manhattan	82
Queens	39
Staten Island	20
City-wide	12
Total	**227**
Average Events per Month	**19**

DEP Website **<u>www.nyc.gov/dep</u>**

The DEP Web Site constitutes one of the most accessible and far reaching portions of the DEP public education program. The site has numerous pages and links that connect viewers to all manner of topics with which the DEP is associated, including such far ranging issues as large construction projects (e.g., the creation of the new water supply tunnel), billing and customer service information, press releases, water quality data, departmental organizational information, and environmental education and data. With specific regard to institutional, regulatory, and public education programs addressing water conservation, the web site provides a clearinghouse for the DEP public education program including event and training schedules, contacts and links for more information, downloadable promotional materials and publications (e.g., posters, flyers, reports), and press releases.



Likewise, regulatory assistance may be found through the web site “help center” which provides links to appropriate forms, rules, and contacts to assist businesses, residents, and institutions in complying with water and sewer use regulations and to encourage the web audience to adopt environmentally sound water and sewer use habits. The major target audiences for the web site are outlined below and in Table 16, and the site’s organization by topic is provided in Table 17.

The DEP web site has been organized into four categories to target four distinct major audiences to help the department to provide conveniently accessible information to its constituency, as follows in Table 16. In addition to the four major categories, the web site also contains links on its homepage to “About DEP” and “Contact Us” pages, which span all four target audiences.

Table 16. DEP Web-Site Organization by Target Audience

Link - Category	Target Audience	General Resources Provided
Help Center (Customer Service)	Consumers and Businesses	Information, including regulatory compliance, water conservation, and pollution prevention information, to help those with a billing and/or regulatory relationship with the DEP.
DEP News	General Public	Press releases, project descriptions, and publications designed to inform the general public, as well as to assist other organizations in reporting on DEP issues.
Environmental Education	Schools, Professionals, Community Organizations, General Public	Wide ranging information, including reports, data, and class programs, designed to educate the larger New York community about environmental issues and to promote environmentally responsible behavior.
Kids	Schools, Children, Parents	Environmental education materials and activities designed for children.

The DEP website addresses water conservation in institutional, regulatory, and public education programs throughout its content and across all of the target audiences. Institutional programs are covered through several avenues. Consumers and businesses can find water conservation and pollution prevention information through the Help Center (Customer Service) pages. The news media, as well as the general public, can obtain information from DEP press releases, project reports, and event descriptions. Automatic e-mail press release updates are also available. The technical community also has access to water quality and DEP performance data, including the annual Harbor Water Quality Reports and City-wide Accountability data.

Regulatory information is also provided in multiple places accessible through the DEP website. The most direct links are provided through the Help Center pages, which allow businesses easy and organized access to regulatory requirements, pollution prevention information, and water conservation information.

Finally, the public education component of the website enhances the myriad of DEP public education programs by providing easy internet access to event schedules, educational materials for teachers and students, downloadable promotional information such as flyers and posters, reading lists, project descriptions, and the host of information associated with the DEP Public Education Programs.

The full DEP website organization has been provided in Table 7. Those categories containing information specific to institutional, regulatory, and public education programs have been highlighted and sub-categories illustrating the breadth of the relevant environmental information and the multiple pathways through which information is promoted within the website have also been included. Over fifteen links that provide cross-referenced environmental and pollution prevention information exist within the first two levels of the web site providing access to numerous resources relevant to institutional, regulatory, and public education programs to promote water conservation.

Several critical links with the DEP's partners leverage the outreach power of the DEP website, most notably, the links with NYC.gov, the official New York City web site, which exposes the DEP to a much larger, City-wide audience.

Table 17. DEP Web-Site Organization by Topic

Category	Sub-category	Institutional Components Related to Water Conservation	Regulatory Components Related to Water Conservation	Public Education Components Related to Water Conservation	Information / Materials
About DEP	Drinking Water Supply			X	
	Watersheds			X	
	Reservoir Levels			X	
	Commissioner's Statement			X	
	City-wide Accountability Program				Catch Basin maintenance data
	Wastewater Treatment				Floatables Reduction Program, Grease Discharges, Food Waste Disposers, Grease Disposal Tips, Biosolids Beneficial Use Program, Harbor Water Quality Survey
	Air, Noise, Hazmat				
	Job Opportunities				
	DEP's Bureaus			X	
Help Center	Consumer Resources			X	Grease Disposal Tips, Protect Your Water Meter and Pipes from Freezing, Annual Water Supply Statement, How Can I Save Water?
	Meter and Billing Forms			X	

Table 17. DEP Web-Site Organization by Topic

Category	Sub-category	Institutional Components Related to Water Conservation	Regulatory Components Related to Water Conservation	Public Education Components Related to Water Conservation	Information / Materials
	Water Board Rates			X	
	How Can I Save Water			X	
	Environmental Control Board			X	
	Business Resources			X	Smart Business (guide to environmental regulations and permitting requirements), Pollution Prevention, Preventing Grease Discharges, Additional Resources, Environmental Economic Development Assistance Unit
	Environmental Compliance			X	
	Drought Information			X	Numerous links to water saving tips, water conservation rules, and drought characterization and water supply status
	Doing Business with DEP			X	
Education	Education Materials			X	Large variety of educational materials and contacts
	Suggested Reading List			X	Over 10 websites and over 30 books listed for Adult Reading; Over 10 websites an over 40 books listed for Child Reading.
	The City's Water Supply			X	

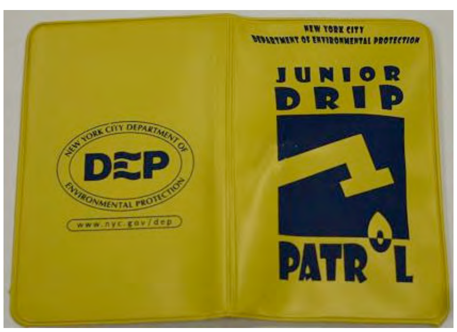
Table 17. DEP Web-Site Organization by Topic

Category	Sub-category	Institutional Components Related to Water Conservation	Regulatory Components Related to Water Conservation	Public Education Components Related to Water Conservation	Information / Materials
	Water Saver's Workbook			X	Series of activities, quizzes, and readings related to water conservation.
Kids	Fun Activities and Lessons For Children of All Ages			X	Wow, I Didn't Know That – an instructive quiz related to water conservation and pollution prevention.
DEP News	DEP News	X	X	X	DEP's online newspaper containing recent articles and reports about DEP projects and issues.
	Interactive Features			X	List based search of newsworthy topics and press releases.
	Press Releases			X	Links to recent and archived DEP press releases.
	Public Notices		X	X	Links to recent and archived public notices.
Contact Us	Where to Contact the DEP			X	Contact number for water quality condition reporting by the public.
	Sign Up for Email Updates			X	Automatic e-mail updates concerning environmental news items.
	Email the Commissioner				

Future Actions

This section, Future Actions, describes public education programs that DEP seeks to support in 2006 and 2007 to address water conservation. These future actions are based on the continuation and enhancement of the variety of successful, ongoing programs that the DEP has implemented as well a DEP endorsement of City-wide programs sponsored by other government agencies. Through these actions, DEP can further its commitment to implementing effective public education programs aimed at water conservation.

- **School Programs:** DEP will continue to provide support for City-wide environmental education resources targeting students and teachers (131 programs were supported in 2005). Support would continue to include the provision of speakers, teacher workshops, presentations, and promotional literature and items for school groups related to floatable reduction, water quality, water conservation, and other environmental topics. Similar support targeted to students and teachers would also be provided for conferences, environmental centers, museum educational programs, and community organizations, as necessary. In addition to the many programs reported last year, 2005, DEP also reached out to all the elementary and middle schools (public, private and parochial) in the New York City area, mailing 3,500 copies of the guidelines for its annual Water Conservation Art and Poetry Contest. For the last twenty years, DEP has been encouraging fifth and sixth grade students to creatively express their understanding of the New York City's water resources and the importance of wastewater treatment.

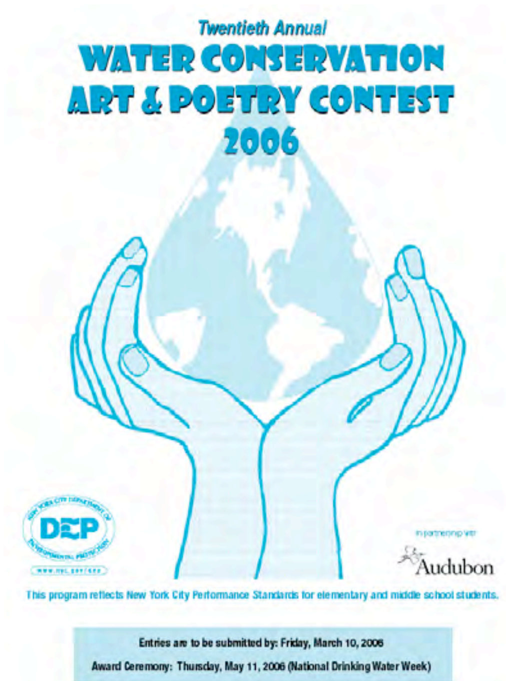


In 2006, DEP's Art and Poetry Contest included specific topics related to water conservation, such as:

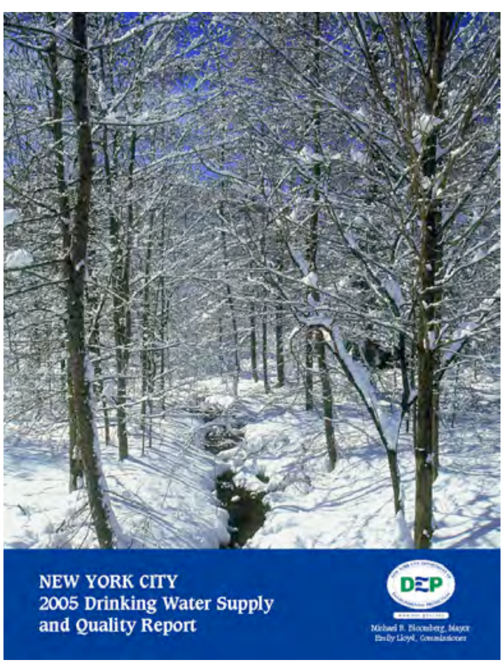
- How we use water everyday at home and in school and how it can be conserved.
- The value of water in our lives.
- The purpose of fire hydrants and their proper use.
- People share the earth's water supply with other living things.
- No matter where we live, we can help keep water clean.
- The unique properties of water make it special to all of us.
- The importance of the Croton, Catskill and Delaware watersheds.
- How our water is protected to be sure it is safe to drink.

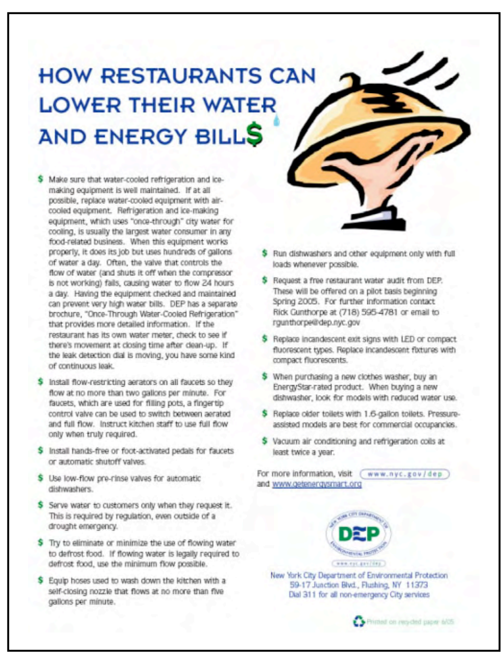
Almost 300 students were honored in the presence of their families and teachers for their outstanding expressions and understanding of the environment.

The contest has been conducted with the support of the New York City Department of Education, New York Archdiocese, The Board of Jewish Education, Greek Orthodox Archdiocese, Lutheran Schools, and Independent Schools.



- **Publications:** The wide array of DEP environmental education related literature and publications will continue to be produced and updated, as necessary, for distribution at school events, public events, and on the DEP website. Specific documents that received updates in 2006 include the New York Harbor Water Quality Report, the Drinking Water Supply and Quality Report, How to Read Your Water Meter, and High Efficiency Clothes Washers.




HOW RESTAURANTS CAN LOWER THEIR WATER AND ENERGY BILL$

$ Make sure that water-cooled refrigeration and ice-making equipment is well maintained. If at all possible, replace water-cooled equipment with air-cooled equipment. Refrigeration and ice-making equipment, which uses "once-through" city water for cooling, is usually the largest water consumer in any food-related business. When this equipment works properly, it does its job but uses hundreds of gallons of water a day. Often, the valve that controls the flow of water (and shuts it off when the compressor is not working) fails, causing water to flow 24 hours a day. Having the equipment checked and maintained can prevent very high water bills. DEP has a separate brochure, "Once-Through Water-Cooled Refrigeration" that provides more detailed information. If the restaurant has its own water meter, check to see if there's movement at closing time after clean-up. If the leak detection dial is moving, you have some kind of continuous leak.

$ Install flow-restricting aerators on all faucets so they flow at no more than two gallons per minute. For faucets, which are used for filling pots, a fingertip control valve can be used to switch between aerated and full flow. Instruct kitchen staff to use full flow only when truly required.

$ Install hands-free or foot-activated pedals for faucets or automatic shutoff valves.

$ Use low-flow pre-rinse valves for automatic dishwashers.

$ Serve water to customers only when they request it. This is required by regulation, even outside of a drought emergency.

$ Try to eliminate or minimize the use of flowing water to defrost food. If flowing water is legally required to defrost food, use the minimum flow possible.

$ Equip hoses used to wash down the kitchen with a self-closing nozzle that flows at no more than five gallons per minute.

$ Run dishwashers and other equipment only with full loads whenever possible.

$ Request a free restaurant water audit from DEP. These will be offered on a pilot basis beginning Spring 2005. For further information contact Rick Gunthorpe at (718) 595-4781 or email to rgunthorpe@dep.nyc.gov

$ Replace incandescent exit signs with LED or compact fluorescent types. Replace incandescent fixtures with compact fluorescents.

$ When purchasing a new clothes washer, buy an EnergyStar-rated product. When buying a new dishwasher, look for models with reduced water use.

$ Replace older toilets with 1.6-gallon toilets. Pressure-assisted models are best for commercial occupancies.

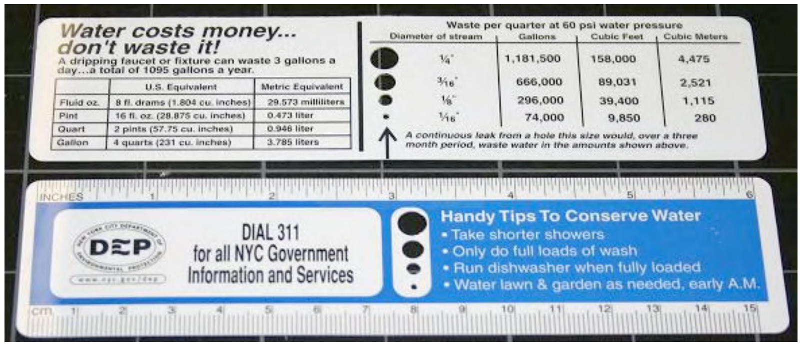
$ Vacuum air conditioning and refrigeration coils at least twice a year.

For more information, visit www.nyc.gov/dep and www.getenergysmart.org

DEP

New York City Department of Environmental Protection
59-17 Junction Blvd., Flushing, NY 11373
Dial 311 for all non-emergency City services

- **Promotional Items:** DEP will continue to provide promotional items such as magnets, bumper stickers, bookmarks, rulers, stickers, book covers, sponges, and beach toys with environmental education related messages. These items will be distributed at school and public events to reinforce water conservation messages.



- **DEP Website:** DEP will continue to improve and enhance its website. Both existing and future content will enable the public to learn more about the activities and status of the projects and initiatives aimed at conserving water. The site will provide education and outreach material, customer service updates and notices, press releases, public meeting announcements and other public information.

Drought and Emergency Procedures

From time to time the Water System experiences drought conditions caused by significantly below-normal precipitation in the watershed areas. The most recent drought was in 2002.

The Water System relies upon a surface water supply, and is sensitive to major fluctuations in precipitation. Throughout even the worst droughts, the Water System has continued to supply sufficient amounts of water to the City. To ensure adequate water supply during drought conditions, DEP, in conjunction with other City, State and interstate agencies, maintains a Drought Management Plan. The Drought Management Plan defines various drought phases that trigger specific management and operational action. Three defined phases are: "Drought Watch," "Drought Warning," and "Drought Emergency." A Drought Emergency is further subdivided in four stages based on the projected severity of the drought and provides increasingly stringent and restrictive measures.

A Drought Watch is declared when there is less than a 50% probability, based on the existing record since 1927, that either the Catskill or Delaware reservoir system will be filled by the following June 1. This phase initiates the pumping of water from the Croton System. In addition, during this phase a public awareness program begins and users, including upstate communities taking water from the System, are requested to initiate conservation measures. New York State Department of Health ("NYSDOH"), NYSDEC, and the Delaware River Basin Commission (the "DRBC") are advised of the Water System's status, and discussions are held with City agencies concerning their prospective participation in the event of a declaration of a Drought Warning.

A Drought Warning is declared when there is less than a 33% probability that either the Catskill or Delaware reservoir system will fill by June 1. All previous efforts are continued or expanded and additional programs are initiated, including the coordination of specific water saving measures by other City agencies.

A Drought Emergency is declared when it becomes necessary to reduce consumption by imposing even more stringent measures. In addition to the imposition of restrictions, DEP may enhance existing System management and public awareness programs, expand its inspection force and perform additional leak and waste surveys in public and private buildings. DEP may also require communities outside of the City that are served by the System to adopt similar conservation measures. The Drought Management Plan can be downloaded from DEP's website:
http://nyc.gov/html/dep/html/drought.html. This URL is also home to copies of general water use restrictions and Drought Emergency Rules.

DEP maintains, and regularly updates, regulations describing water use restrictions during a Drought Emergency. These rules are contained in Rules of the City of New York (RCNY) Chapter 21 and are promulgated and amended through a public rulemaking process. The rules are divided into three Drought Emergency Stages: I, II and III with restrictions increasing in number and severity with each Stage.

Appendix I

DEP Piping by Size and Type

Size and Type		Linear Feet TOTAL	percentage size by type
1" unknown		166	
1.5" unknown		836	
3" unknown		447	
2"			
Cast Iron		23,885	28.94%
Ductile Iron		896	1.09%
Concrete Lined Cast Iron		49,242	59.67%
Unknown		8,506	10.31%
	Total	82,529	100.00%
4"			
Cast Iron		103,588	75.73%
Ductile Iron		4,934	3.61%
Concrete Lined Cast Iron		27,513	20.12%
Unknown		743	0.54%
	Total	136,778	100.00%
6"			
Cast Iron		1,324,833	84.28%
Ductile Iron		43,648	2.78%
Concrete Lined Cast Iron		202,484	12.88%
Steel		742	0.05%
Unknown		47	0.00%
Polyethylene Lined		188	0.01%
	Total	1,571,942	100.00%
8"			
Cast Iron		6,085,067	36.59%

DEP Piping by Size and Type

Ductile Iron		4,258,245	25.60%
Concrete Lined Cast Iron		6,280,148	37.76%
Steel		7,877	0.05%
Unknown		278	0.00%
	Total	16,631,615	100.00%
10"			
Cast Iron		52,924	70.83%
Ductile Iron		5,883	7.87%
Concrete Lined Cast Iron		15,776	21.11%
Steel		138	0.18%
Unknown		-	0.00%
	Total	74,721	100.00%
12"			
Cast Iron		3,023,687	27.51%
Ductile Iron		3,560,994	32.40%
Concrete Lined Cast Iron		4,350,494	39.58%
Steel		56,643	0.52%
Polyethylene Lined		369	0.00%
	Total	10,992,187	100.00%
14"			
Cast Iron		14,698	74.97%
Ductile Iron		74	0.38%
Concrete Lined Cast Iron		3,656	18.65%
Steel		-	0.00%
Unknown		1,177	6.00%
	Total	19,605	100.00%
16"			
Cast Iron		431,460	63.93%
Ductile Iron		15,506	2.30%
Concrete Lined Cast Iron		223,977	33.18%
Steel			0.59%

DEP Piping by Size and Type

		3,993	
Unknown		-	0.00%
	Total	674,936	100.00%
18"			
Cast Iron		-	0.00%
Ductile Iron		612	17.71%
Concrete Lined Cast Iron		-	0.00%
Steel		-	0.00%
Unknown		2,843	82.29%
	Total	3,455	100.00%
20"			
Cast Iron		720,009	22.35%
Ductile Iron		1,683,253	52.25%
Concrete Lined Cast Iron		790,653	24.54%
Steel		27,536	0.85%
Unknown		-	0.00%
	Total	3,221,451	100.00%
24"			
Cast Iron		132,726	54.59%
Ductile Iron		46,223	19.01%
Concrete Lined Cast Iron		56,799	23.36%
Steel		3,568	1.47%
Polyethylene Lined		3,828	1.57%
	Total	243,144	100.00%
30"			
Cast Iron		144,981	70.93%
Ductile Iron		5,285	2.59%
Concrete Lined Cast Iron		29,463	14.41%
Concrete		175	0.09%
Steel		23,724	11.61%
Polyethylene Lined		769	0.38%
	Total	204,397	100.00%

DEP Piping by Size and Type

36"			
Cast Iron		215,907	52.47%
Ductile Iron		20,956	5.09%
Concrete Lined Cast Iron		16,732	4.07%
Concrete		31,252	7.60%
Steel		126,611	30.77%
	Total	411,458	100.00%
42"			
Cast Iron		345	28.47%
Ductile Iron		-	0.00%
Concrete Lined Cast Iron		29	2.39%
Concrete		88	7.26%
Steel		750	61.88%
	Total	1,212	100.00%
48"			
Cast Iron		411,598	37.58%
Ductile Iron		96,969	8.85%
Concrete Lined Cast Iron		52,946	4.83%
Concrete		133,102	12.15%
Steel		400,663	36.58%
	Total	1,095,278	100.00%
54"			
Cast Iron		-	0.00%
Ductile Iron		-	0.00%
Concrete Lined Cast Iron		-	0.00%
Concrete		1,095	42.41%
Steel		1,487	57.59%
	Total	2,582	100.00%
60"			
Cast Iron		3,419	1.68%
Ductile Iron		20,734	10.21%
Concrete Lined Cast Iron		43	0.02%

DEP Piping by Size and Type

Concrete		4,637	2.28%
Steel		174,309	85.81%
	Total	203,142	100.00%
66"			
Cast Iron		2,067	3.77%
Ductile Iron		17	0.03%
Concrete Lined Cast Iron		-	0.00%
Concrete		-	0.00%
Steel		52,753	96.20%
	Total	54,837	100.00%
72"			
Cast Iron		9,930	5.28%
Ductile Iron		1,324	0.70%
Concrete Lined Cast Iron		3,023	1.61%
Concrete		335	0.18%
Steel		173,353	92.23%
	Total	187,965	100.00%
84"			
Cast Iron		-	0.00%
Ductile Iron		-	0.00%
Concrete Lined Cast Iron		-	0.00%
Concrete		7,491	74.37%
Steel		2,582	25.63%
	Total	10,073	100.00%
96"			
Cast Iron		-	0.00%
Ductile Iron		-	0.00%
Concrete Lined Cast Iron		-	0.00%
Concrete		606	100.00%
Steel		-	0.00%
	Total	606	100.00%

TOTALS		
Cast Iron	12,701,124	
Ductile Iron		

DEP Piping by Size and Type

		9,765,553
Concrete Lined Cast Iron		12,102,978
Concrete		178,781
Steel		1,056,729
Polyethylene Lined		5,154
Unknown		15,043
	Total	35,825,362
		35,825,362

Water Conservation Program

Annual Update

New York City Department of Environmental Protection
59-17 Junction Blvd.
Flushing, NY 11373

June 2009

New York City Department of
Environmental Protection

Introduction and Summary

This report is an update of the Water Conservation Program Plan issued by the New York City Department of Environmental Protection ("DEP") in December 2006. The original document is available from DEP in paper and PDF format. That original report contains detailed information on the history and operation of the water supply and wastewater treatment systems as well as historic information on water conservation efforts. Please request a copy of that document for a more complete picture of DEP's efforts. This report provides information on recent activities.

With the city's population expected to rise to 9.1 million by 2030, from 8.3 million in 2005, water efficiency will continue to have an important role to play, not just to help assure supply but also to assist in meeting goals to reduce combined sewer overflows, maintain wastewater quality and meet nitrogen removal goals.

Water demand continued a modest downward trend in the last year, as illustrated in the graph "Historical Water Demand and Population." DEP continued efficiency-related programs and also began or completed a number of initiatives that will provide benefits in the future:

1. Automatic Meter Reading DEP began the installation of a citywide fixed-network AMR system in November 2008 with the start of installation work for Data Collection Units ("DCU") around the city as part of NYC DoITT's NYCWiN citywide wireless system. Replacement of most pre-1998 water meters and installation of the AMR "MTU's" on all water meters began the first week of March 2009 with substantial completion planned in three years.
2. Expansion of Water Demand Analysis Capability DEP's Bureau of Environmental Planning and Analysis ("BEPA") has adding staffing and software tools to analyze water consumption data. Through BEPA the New York City Water Board is conducting a study of "conservation rates," storm water rates and possible incentives for storm water BMP's.
3. Promulgation of New Water Use Rules DEP's operational bureaus and legal affairs staff completed the public revision of RCNY Chapter 20 in 2008. The new rule takes effect on June 22, 2009. The changes address several water quality and leak prevention issues in addition to a number of technical and procedural changes.
4. "Green Code Task Force" Mayor Bloomberg, Council Speaker Quinn and the U.S. Green Building Council sponsored a wide-ranging review of the city's Building Code with the goal of revising specific parts of the Code to meet environmental and "green building" goals. Technical Committees completed their work and issued recommendations in 2008. Review of the recommendations by the city and an industry advisory committee is currently underway in 2009.
5. Continuation of Ongoing Education Programs DEP's Bureau of Community and Intergovernmental Affairs ("BCIA") continues to conduct a variety of education programs on water and water efficiency directed at both students and adults.

Abbreviations and Acronyms Used in This Report

AMR	Automatic Meter Reading (sometimes referred to as "AMI" for "Advanced Metering Infrastructure")
BMP	Best Management Practices
CIP	Capital Improvement Plan
CSO	Combined Sewer Overflow
CY	Calendar Year
DCU	Data Collection Unit (AMR)
DEC	New York State Department of Environmental Conservation
DEP	New York City Department of Environmental Protection
DoITT	New York City Department of Information Technology and Telecommunications
DRBC	Delaware River Basin Commission
FY	Fiscal Year (July 1 – June 30)
GCPD	Gallons per Capita per Day
HCF	Hundred Cubic Feet
HPD	New York City Department of Housing Preservation and Development
LF	Linear feet
MGD	Millions of Gallons per Day
MTU	Meter Transmitter Unit (AMR)
NYCHA	New York City Housing Authority
RCNY	Rules of the City of New York
RFEI	Request for Expressions of Interest
RFP	Request for Proposals
RWS	Residential Water Survey
SCA	School Construction Authority
WPCP	Water Pollution Control Plant (Sewage Treatment Plant)

Contact People for Issues in this Report

New York City Water Metering
Customer-Oriented Water Conservation Programs
Requests for the original Water Conservation Plan
Warren Liebold, Bureau of Customer Services, wliebold@dep.nyc.gov (718) 595-4657

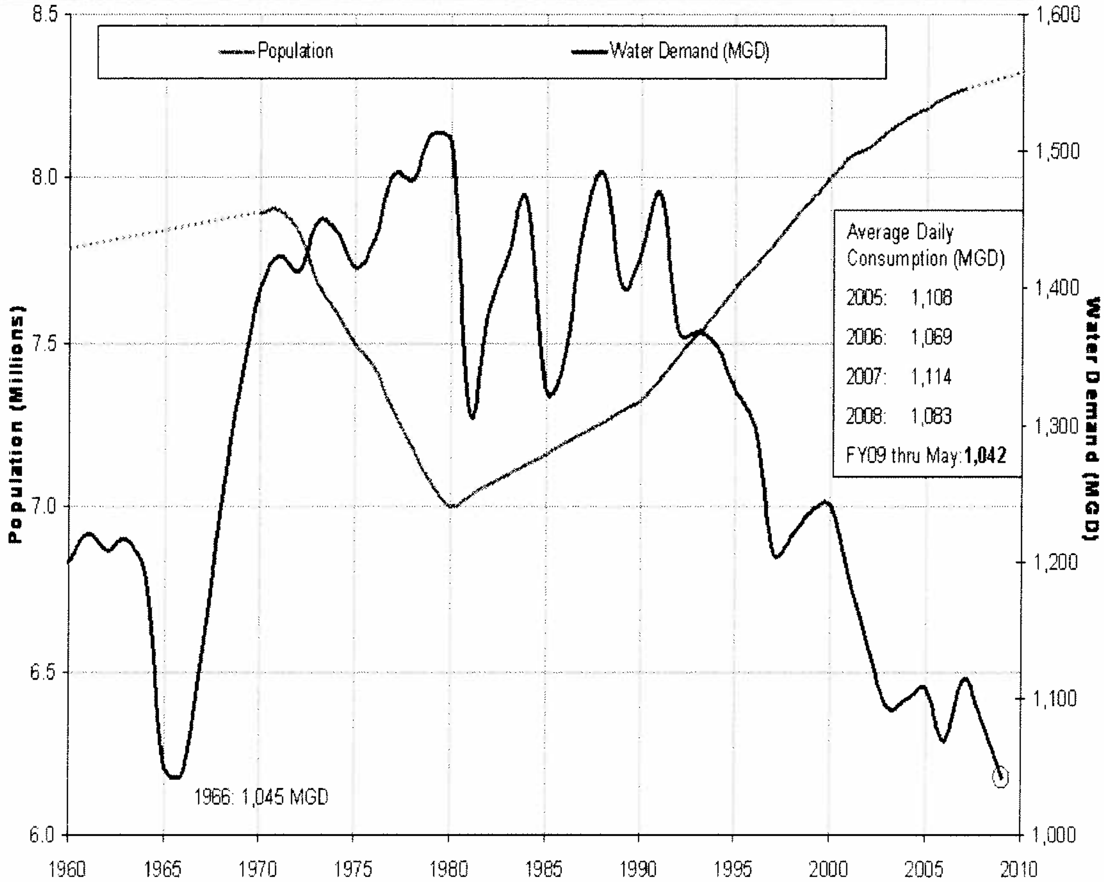
Water Demand Projections, System Auditing, Related Issues
Esther Siskind, Assistant Commissioner, Bureau of Environmental Planning and Analysis ("BEPA")
ESiskind@dep.nyc.gov (718) 595-3168

Distribution System Metering
Odd Larsen, Bureau of Water and Sewer Operations OLarsen@dep.nyc.gov (718) 595-5751

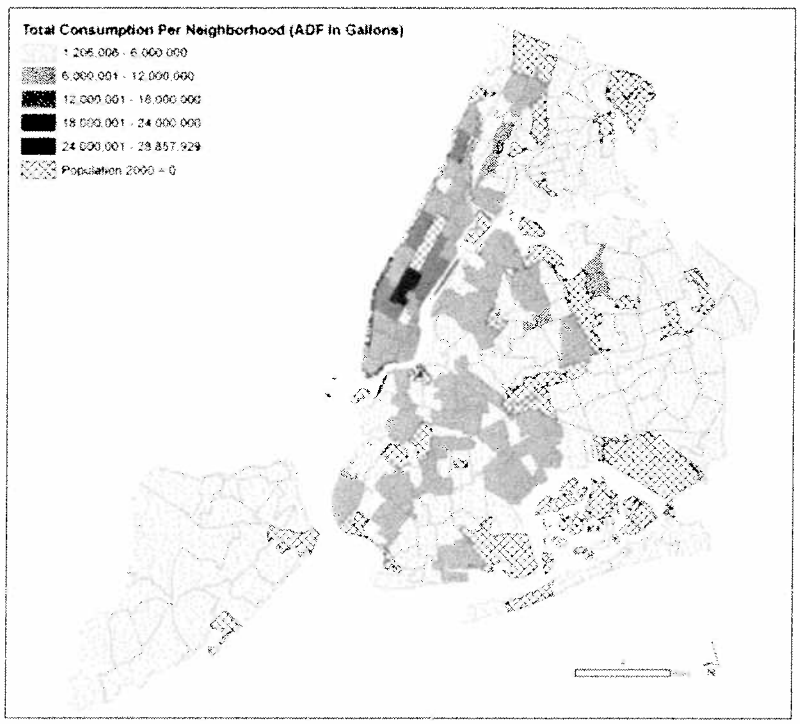
Upstate System and Customer Metering
Paul Aggarwal, Bureau of Water Supply, PAggarwal@dep.nyc.gov (914) 773-4456

Educational Programs
Kim Estes-Fradis, Bureau of Communication
KEstes-Fradis@dep.nyc.gov (718) 595-3506

Historical Water Demand and Population

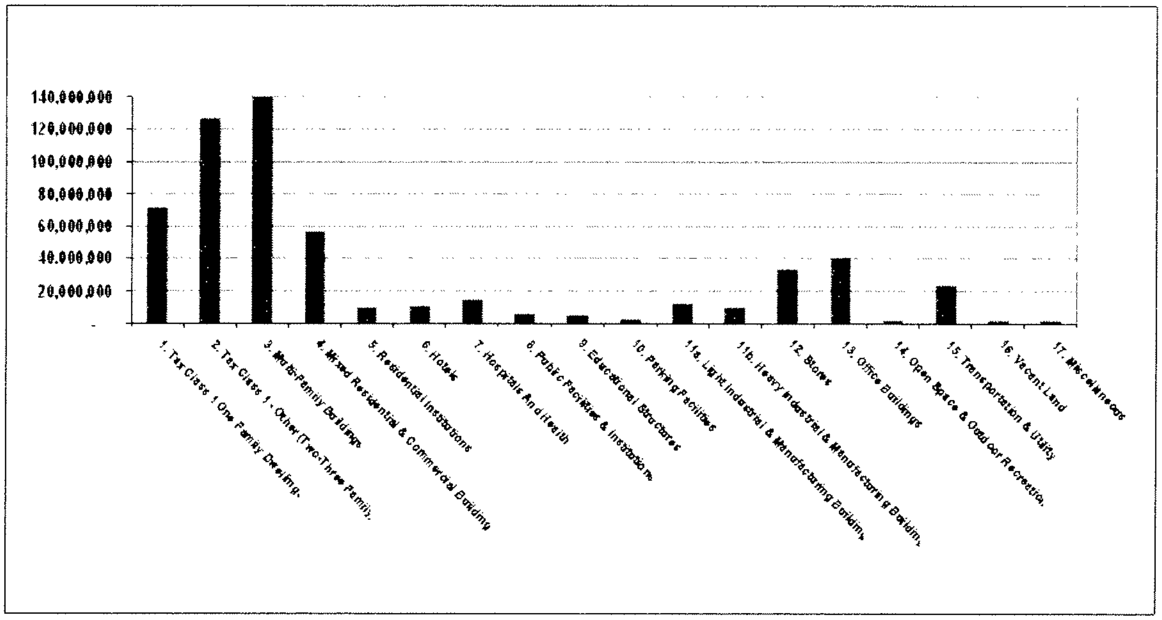


Consumption by Neighborhood FY2008



Consumption by Land Use

FY2008 Meter Billed Customers



Program and Activity Updates

Water Metering - Advanced Metering Infrastructure

Installation of the rooftop Data Collection Units ("DCU's") began in November 2008 and will be substantially complete by September 2009. The network provides close to double redundancy so by May 2009 with 200 out of 337 DCU's installed we have coverage for Brooklyn and almost all of Queens, the Bronx and Manhattan.

Large-scale installation of the transmitters ("MTU's") on water meters, and the replacement of approximately 50% of pre-1997 small meters began on March 5 in Brooklyn and Queens and in mid-March in Manhattan. Work in the Bronx began in early April 2009. Staten Island will begin on or about July 1. By mid-July 50,000 MTU's had been installed and the installation rate was moving upward from 450-500 per day with a goal or reaching 1,200 – 1,500 per day by the end of summer.

The system is generating a 97% actual read rate with the remaining 3% attributable to installation errors that will be corrected. Most MTU's are programmed to read the meter and transmit the read four times a day. Meters 2" and larger will be read once an hour. Installation of the AMR/AMI system will not only improve customer service and collections but will increase the volume of water use data by orders of magnitude. DEP will move from having meters read four times a year with an 85% actual read rate overall, to four times a day (for most customers) or hourly (for larger customers) with a 97%+ actual read rate.

Before the end of 2009 DEP plans to make consumption data available for most customers through its website.

Water Use and Demand Analysis

The Bureau of Environmental Planning and Analysis ("BEPA") within the DEP has been tasked with tracking and understanding current and past water consumption trends, which are largely based on the consumption data dating from 2001 to the present. This consumption is estimated for each available borough, block and lot and verified through various analytical methods.

Given that New York City consists of over 850,000 lots, and approximately 97% of New York City accounts are metered, the generated volume of water consumption data requires extensive clean-up and verification. To properly manage and organize the data, Microsoft SQL server software is being used. The statistical analysis portion of the study is performed using SAS® software which is designed specifically for analysis of large databases. Additionally, geographic and spatial analyses are performed using ArcGIS software.

This data is used in conjunction with various planning efforts within the agency, such as emergency preparedness, study of the DEP's rate structure, projecting water use into the future based on past trends and available population projections.

The Water Board hired a consultant in 2008 to examine advantages and disadvantages of several conservation rates, examine practical issues that must be addressed to implement a stormwater rate and research possible incentives for stormwater management BMP's. The study has benchmarked NYC's rate structure against other municipalities across the country, researched the types of stormwater, fixed/variable, and other rate structures implemented elsewhere, and has identified data needs required to more fully understand the implications of potential implementation in NYC. The study's expected release will be toward the end of 2009.

Changes in Water Use Rules

DEP has completed revisions in RCNY Title 15 Chapter 20, "Rules Governing the Supply and Use of Water." The proposed revisions were enclosed as an Appendix to last year's report. A final public hearing was held on June 16, 2008 and final approval from the city's Law Department was received in May 2009 at which time final publication of the rule occurred to announce promulgation of the new rule as of June 22, 2009 . The proposed changes related to water conservation and quality include the following:

1. A requirement that any lead or galvanized metal service pipe be completely replaced, rather than repaired, if it leaks. This is aimed at speeding the replacement of these types of services both for water quality purposes and to reduce distribution system losses.
2. A requirement that water meters, service pipes and associated vales and fittings be manufactured of a "no lead" alloy.
3. A requirement, or clarification, that public fountains and sprays must have automatic shutoffs.
4. A requirement that the water service pipe to a vacant building be disconnected after one year of vacancy and empowerment of DEP to perform the work and charge the owner if the owner does not act. This is aimed at reducing leakage from service pipes.

Green Code Task Force

In 2008 Mayor Bloomberg established a task force of architects, engineers and design professionals in partnership with the New York City Chapter of the U.S. Green Building Council to develop recommendations for changes in city codes and rules that will improve energy- and water efficiency as well as sustainable construction practices. The Task Force's technical committees submitted recommendations in late 2008 which are now being reviewed by the city and an industry advisory group prior to the introduction of legislation to the Council. http://usgbcny.org/advocacy/

The Council previously passed and Mayor Bloomberg signed Local Law 86/2005 which requires new municipal buildings to be LEED-certified or LEED Silver depending on the size and value of the project. This requirement effectively commits designers to the use of "high efficiency" toilets and urinals.

Educational Programs

School Programs

DEP's BCIA will continue to develop and implement school-based education programs to help make young people and adults aware of the consequences of littering and the importance of conserving water. DEP will provide classroom lessons, staff development workshops for teachers and administrators, printed material describing water issues, and assistance for curriculum development and student research projects. DEP continues to work in collaboration with the DSNY, New York City Department of Parks and Recreation, NYSDEC and the United States Environmental Protection Agency (EPA) to promote the "Clean Streets = Clean Beaches" campaign and other environmental education programs. Ongoing partnerships with education and environmental organizations, such as the New York City Soil and Water Conservation District, the Bronx River Alliance, Council on the Environment of New York City, the American Littoral Society, Children for Children, Going Coastal, and the South Street Seaport Museum enable DEP to reach a diverse audience.

Education and Outreach

DEP's environmental education resources for New York City's public, private, and parochial schools emphasize critical and creative thinking, decision-making skills, communication and collaborative learning across disciplines. All programs are inquiry-based and are aligned with New York City Performance Standards in Science, Math, Social Studies and Applied Learning and with the New York City Department of Education's new Science Scope and Sequence.

http://www.nyc.gov/html/dep/html/water_and_sewer_bills/propmgmt.shtml

DEP, in partnership with Trout Unlimited, runs Trout in the Classroom program, a watershed environmental education initiative for elementary through high school students. The purpose of Trout in the Classroom is to create partnerships between New York City and upstate watershed schools as they raise trout from eggs, observe and study them in the classroom, and release them into New York State approved streams. These activities help students to develop a conservation and anti-litter awareness that encourages them to develop an understanding of the shared water resources. Participants in the 2008 Trout in the Classroom teacher conference on October 14, 2008 are listed in the table below.

2008 Trout in the Classroom Participants	
Borough	**Organization**
Brooklyn	Public School 29
Manhattan	Studio School
Queens	Public School 102
Queens	Public School 192
Brooklyn	Middle School 319
Manhattan	The Neighborhood School
Brooklyn	Public School 10
Bronx	Bronx New School
Brooklyn	Green School
Manhattan	Greenhouse School
Bronx	Urban Assembly School for Wildlife Conservation
Brooklyn	Public School 230
Brooklyn	Public School 107
Bronx	Intermediate School 98

2008 Trout in the Classroom Participants	
Borough	**Organization**
Manhattan	Our Lady Queen of Martyr's School
Bronx	Mott Hall School
Manhattan	Connelly Middle School

On May, 8 approximately 850 young people and adults participated in the New York City Department of Environmental Protection's Twenty-second Annual Water Conservation Art & Poetry Program award ceremony. This program is an exciting opportunity for New York City's fourth, fifth and sixth grade students to creatively express their knowledge, through art and poetry, of our City's valuable water resources. The award ceremony, held at Cooper Union, honored the students in the presence of their teachers, friends and family members. Participants in the Art and Poetry Program were from the organizations listed in the following table:

DEP Water Conservation Art and Poetry Program Participants	
Borough	**Organization**
Bronx	Bronx River Art Center
Bronx	CS 92
Bronx	Family Life Academy Charter School
Bronx	Fieldston Middle School
Bronx	Henry Hudson IS 125
Bronx	Immaculate Conception School
Bronx	Mount Saint Michael Academy
Bronx	Our Lady of the Assumption
Bronx	PS 18
Bronx	PS 30
Bronx	PS 37
Bronx	PS 75
Bronx	PS 91
Bronx	St. Clare's of Assisi
Bronx	Visitation School
Brooklyn	A. Fantis Parochial School
Brooklyn	Fillmore Academy
Brooklyn	Hellenic Classical Charter School
Brooklyn	IS 187
Brooklyn	IS 239
Brooklyn	John Hus Moravian
Brooklyn	PS 1
Brooklyn	PS 127
Brooklyn	PS 15
Brooklyn	PS 151
Brooklyn	PS 157
Brooklyn	PS 160
Brooklyn	PS 164
Brooklyn	PS 172
Brooklyn	PS 179

DEP Water Conservation Art and Poetry Program Participants	
Borough	**Organization**
Brooklyn	PS 200
Brooklyn	PS 204
Brooklyn	PS 205
Brooklyn	PS 207
Brooklyn	PS 219
Brooklyn	PS 226
Brooklyn	PS 255
Brooklyn	PS 346
Brooklyn	PS 7
Brooklyn	PS 97
Brooklyn	St. Agatha School
Brooklyn	St. Anselm
Brooklyn	St. Cecilia School
Brooklyn	St. Michael
Brooklyn	St. Stanislaus Kostka
Manhattan	Institute for Collaborative Education
Manhattan	Our Lady Queen of Martyrs
Manhattan	PS 187
Manhattan	PS 59
Manhattan	St. David's School
Manhattan	St. George School
Manhattan	The School at Columbia University
Manhattan	United Nations International School
Queens	Christ Lutheran School
Queens	IS 25
Queens	MS 158
Queens	Our Lady of Sorrows
Queens	PS 101
Queens	PS 102
Queens	PS 118
Queens	PS 122
Queens	PS 133
Queens	PS 15
Queens	PS 165
Queens	PS 169
Queens	PS 205
Queens	PS 38
Queens	PS 74
Queens	PS 78
Queens	PS 88
Queens	PS 94
Queens	St. Andrew Avellino School
Queens	St. Benedict Joseph Labre
Queens	St. Joan of Arc
Queens	St. Robert Bellarmine
Staten Island	IS 75
Staten Island	PS 1
Staten Island	PS 53
Staten Island	PS 57

DEP Water Conservation Art and Poetry Program Participants	
Borough	**Organization**
Staten Island	PS 6
Staten Island	St. Ann School
Staten Island	St. Charles
Staten Island	St. Joseph - St. Thomas

On June 30, fifty educators took part in a day-long bus tour of the New York City watershed visiting sites such as the Ashokan Reservoir, the Frost Valley Model Forest, a working sawmill, a restored stream and an environmental education center. The purpose of the tour was for educators to learn about programs that emphasize the link between well-managed forests and water quality protection, such as water quality monitoring, stream and riparian buffer management, watershed regulations, watershed forestry and agriculture and environmental education and community outreach.

New York City Watershed Bus Tour Participants	
Borough	**Organization**
Brooklyn	Brooklyn Botanic Garden
Brooklyn	Brooklyn Children's Museum
Brooklyn	Brooklyn College, Education
Brooklyn	Groundswell
Citywide	American Littoral Society
Citywide	NY Restoration Project
Citywide	NYC Dept. of Education
Citywide	NYC Inner City Outings
Citywide	NYS Dept. Environmental Conservation
Citywide	NYU & Visiting Nurse Service of NY
Manhattan	Alianza Dominicana
Manhattan	Alliance for Progress
Manhattan	American Museum of Natural History
Manhattan	City Parks Foundation
Manhattan	Council on the Environment
Manhattan	Green Guerillas
Manhattan	Jewish Community Center
Queens	Alley Pond Environmental Center
Queens	Eastern Queens Alliance
Queens	NYC DEP
Queens	Queens Botanical Garden
Queens	Queens Museum
Queens	Trout in the Classroom
Staten Island	High Rock Park - Staten Island Greenbelt
Staten Island	Staten Island Greenbelt
Staten Island	Staten Island Zoo

On July 17 and October 30, the New York City Department of Environmental Protection hosted professional development workshops for formal and non-formal educators at the Queens

Museum of Art. Participants learned about creative ways to incorporate the study of water resources into their curriculum using the New York City watershed model and the panorama of NYC.

Participants of the DEP Professional Development Workshops

Date	Borough	Organization
7/17/2008	Brooklyn	P.S.31
7/17/2008	Citywide	American Littoral Society
7/17/2008	Citywide	City College of New York
7/17/2008	Citywide	Elementary School Science Association
7/17/2008	Citywide	Friends of the Old Croton Aqueduct
7/17/2008	Citywide	NYC Department of Education
7/17/2008	Citywide	NYS Office of Parks, Reservation, and Historic Preservation
7/17/2008	Citywide	Watershed Agricultural Council
7/17/2008	Citywide	Wildlife Conservation Society
7/17/2008	Manhattan	Alianza Dominicana
7/17/2008	Manhattan	American Museum of Natural History
7/17/2008	Manhattan	Millennium High School
7/17/2008	Queens	LaGuardia and Wagner Archives
7/17/2008	Queens	NYC DEP
7/17/2008	Queens	Queens Botanical Garden
10/30/2008	Bronx	Bronx New School
10/30/2008	Bronx	Community School 66
10/30/2008	Brooklyn	NY Aquarium
10/30/2008	Brooklyn	NYCDOE -Gateway Center for Science
10/30/2008	Citywide	MGI/GEAR UP
10/30/2008	Citywide	American Museum of Natural History
10/30/2008	Citywide	New York City Department of Education
10/30/2008	Manhattan	American Museum of Natural History
10/30/2008	Manhattan	Booker T Washington MS 54
10/30/2008	Manhattan	City College of New York
10/30/2008	Manhattan	The Neighborhood School
10/30/2008	Queens	PS 133
10/30/2008	Queens	Far Rockaway High School

The following three tables list the 2008 schedule of educational events, a listing of recipients of public education materials and a summary of event locations per borough, respectively.

Public Outreach - Education Report, 2008:
Events and Materials

Date	Borough	Organization
1/10/2008	Manhattan	Institute of Collaborative Education
1/11/2008	Brooklyn	Math and Science Exploratory School
1/12/2008	Manhattan	Adelphi University Manhattan Campus
1/12/2008	Staten Island	Public School 57
1/15/2008	Queens	Public School 36
1/17/2008	Manhattan	Public School 116

Public Outreach - Education Report, 2008:
Events and Materials

Date	Borough	Organization
1/18/2008	Manhattan	Institute for Collaborative Education
1/18/2008	Brooklyn	Math& Science Exploratory School
1/22/2008	Bronx	Public School 37
1/23/2008	Manhattan	Public School 29
1/24/2008	Manhattan	Public School 29
1/25/2008	Manhattan	Humanities Prep Academy High School
1/28/2008	Brooklyn	Middle School 88
1/31/2008	Manhattan	Institute for Collaborative Education
2/2/2008	Citywide	American Museum of Natural History
2/11/2008	Citywide	UNICEF
2/13/2008	Manhattan	Law & Public Service High School
2/15/2008	Queens	Public School 962
2/15/2008	Queens	MS 294
2/25/2008	Brooklyn	IS 220
2/27/2008	Manhattan	Public School 116
2/28/2008	Queens	Public School 88
2/29/2008	Brooklyn	MS 447
2/29/2008	Queens	MS 294
3/3/2008	Queens	Public School 124
3/5/2008	Staten Island	Public School 57
3/12/2008	Bronx	Community School 66
3/15/2008	Manhattan	NYC Tap Project
3/14/2008	Brooklyn	Public School 86
3/19/2008	Bronx	Public School 754
3/20/2008	Brooklyn	Public School 205
3/22/2008	Citywide	American Museum of Natural History
3/25/2008	Queens	Public School 133
3/26/2008	Brooklyn	PS 116
3/26/2008	Brooklyn	Public School 321
3/27/2008	Manhattan	Henry Street School for International Studies
3/31/2008	Manhattan	Middle School 319
4/2/2008	Brooklyn	Public School 10
4/3/2008	Bronx	New Explorers High School
4/3/2008	Queens	Public School 133
4/4/2008	Queens	Public School 102
4/8/2008	Brooklyn	The Green School
4/9/2008	Manhattan	Neighborhood School
4/11/2008	Brooklyn	Public School 27
4/12/2008	Citywide	Science Council of New York
4/14/2008	Manhattan	Children's Aid Society
4/15/2008	Manhattan	Institute for Collaborative Education
4/15/2008	Manhattan	Public School 163
4/16/2008	Queens	Queens College
4/17/2008	Brooklyn	Public School 107
4/17/2008	Manhattan	Middle School 319
4/17/2008	Manhattan	Children's Aid Society (Mirabal)
4/18/2008	Manhattan	Green School
4/22/2008	Manhattan	Connelly Middle School
4/23/2008	Queens	Sacred Heart School
4/26/2008	Brooklyn	Global Youth Service Day

Public Outreach - Education Report, 2008:
Events and Materials

Date	Borough	Organization
4/28/2008	Manhattan	Public School 116
4/29/2008	Queens	Public School 102
4/30/2008	Brooklyn	John Dewey High School
4/30/2008	Manhattan	Institute for Collaborative Education
5/1/2008	Bronx	Public School 37
5/2/2008	Manhattan	Public School 187
5/2/2008	Manhattan	Public School 87
5/2/2008	Manhattan	Manhattan Comprehensive
5/2/2008	Brooklyn	Green School Brooklyn Center
5/5/2008	Brooklyn	The Environmental Science Academy IS 220
5/8/2008	Manhattan	Water Conservation Art and Poetry Ceremony
5/12/2008	Queens	Middle School 74
5/13/2008	Brooklyn	Public School 10
5/13/2008	Brooklyn	Connelly Middle School
5/14/2008	Queens	Public School 124
5/14/2008	Bronx	Children's Aid Society
5/14/2008	Queens	Wendell Holmes Intermediate School
5/15/2008	Brooklyn	Public School 29
5/15/2008	Manhattan	Math and Science Exploratory School
5/15/2008	Manhattan	PS 163
5/15/2008	Queens	Hunter and Public School 78
5/16/2008	Manhattan	Neighborhood School
5/16/2008	Brooklyn	Brooklyn New School
5/17/2008	Manhattan	American Museum of Natural History
5/20/2008	Manhattan	Baruch College Campus High School
5/23/2008	Brooklyn	High School for Youth and Community Development
5/23/2008	Manhattan	High School for Law and Public Service
5/23/2008	Brooklyn	High School for Youth and Community Development
5/23/2008	Manhattan	High School for Law and Public Service
5/30/2008	Manhattan	St Clare's School
6/5/2008	Brooklyn	John Dewey High School
6/6/2008	Queens	Middle School 217
6/9/2008	Queens	Public School 116
6/12/2008	Bronx	Ethical Culture Fieldston School
6/17/2008	Manhattan	Columbia Secondary School for Math, Science and Engineering
7/1/2008	Manhattan	Humanities Preparatory Academy
7/3/2008	Manhattan	Alianza Dominicana
7/8/2008	Brooklyn	Groundswell
7/14/2008	Brooklyn	Groundswell
7/15/2008	Brooklyn	Touro College
7/24/2008	Brooklyn	Urban Scholars Program, City College
7/28/2008	Manhattan	CUNY School of Professional Studies
8/6/2008	Queens	Middle School 109
9/6/2008	Staten Island	CSI High School for International Studies
10/7/2008	Bronx	Middle School / High School 368
10/15/2008	Manhattan	Drop Summit Seminar
10/16/2008	Queens	Public School 78

Public Outreach - Education Report, 2008:
Events and Materials

Date	Borough	Organization
10/17/2008	Citywide	Green Horizons
10/21/2008	Queens	Green Connections
10/22/2008	Queens	LaGuardia Community College
10/29/2008	Brooklyn	Public School 9
10/29/2008	Bronx	The Exploration Academy High School
10/29/2008	Staten Island	St Clare's School
10/30/2008	Queens	Queens Museum Teacher Workshop
11/6/2008	Queens	Queens Museum
11/6/2008	Queens	Newtown High School
11/14/2008	Staten Island	Public School 57
11/15/2008	Queens	Public School 78
11/7/2008	Manhattan	Youth Noise
11/7/2008	Queens	Public School 148
11/10/2208	Manhattan	Nightingale School
11/10/2008	Manhattan	Manhattan East School
11/13/2008	Queens	Newtown High School
11/21/2008	Manhattan	Public School 33
111/25/2008	Manhattan	Baruch College Campus High School
11/25/2008	Manhattan	High School for Law and Public Service
21/1/2008	Manhattan	Public School 33
12/3/2008	Staten Island	Public School 57
12/3/2008	Manhattan	The Neighborhood School
12/4/2008	Queens	Public School 133
12/8/2008	Manhattan	The Neighborhood School
12/9/2008	Manhattan	Baruch College Campus High School
12/10/2008	Manhattan	Middle School 54 Booker T. Washington
12/11/2008	Manhattan	Allen Stevenson
12/16/2008	Queens	Public School 102
12.17/2998	Queens	Public School 33
12/19/2008	Manhattan	Public School 33
12/19/2008	Manhattan	High School for Law and Public Service

Additional Promotional Items, Literature, and Publications Were Sent to the Following Organizations	
Location	**Organization**
Bronx	Exploration Academy HS
Bronx	Middle School/High School 368
Bronx	Exploration Academy High School
Bronx	PS 90
Bronx	Community School 66
Bronx	PS 71
Bronx	Urban Assembly School for Wildlife
Bronx	PS 75
Bronx	New Explorers High School
Bronx	PS 754
Bronx	CS 66
Bronx	Ethical Culture Fieldston School

Additional Promotional Items, Literature, and Publications Were Sent to the Following Organizations	
Location	**Organization**
Bronx	PS 119
Brooklyn	Groundswell Mural Project
Brooklyn	IS 296
Brooklyn	Touro College
Brooklyn	Girl Scout of New York
Brooklyn	79 PCT Explorers
Brooklyn	Edward Murrow High School
Brooklyn	PS 31
Brooklyn	CUNY School of Professional Studies
Brooklyn	Staten Island Green Belt
Brooklyn	PS 58
Brooklyn	Girls Scout at St. Mark School
Brooklyn	PS 27
Brooklyn	PS 321
Manhattan	Hunter Elementary School
Manhattan	Baruch College Campus HS
Manhattan	Manhattan East Middle School
Manhattan	HS for Law & Public Service
Manhattan	Museum of the City of New York
Manhattan	Children for Children
Manhattan	Corlears School
Manhattan	Harvey Milk High School
Manhattan	NYC Dept of Health
Manhattan	PS 33
Manhattan	Museum of the City of New York
Manhattan	PS 166
Manhattan	IS 61
Manhattan	Metropolitan Montessori School
Manhattan	Nightingale Bamford School
Manhattan	HS for Environmental Studies
Manhattan	Delta Middle School
Manhattan	Patrick Henry Middle School
Manhattan	NYC Parks Department
Manhattan	City Parks Foundation
Manhattan	Health Venture Group
Manhattan	NYC Dept. of Education
Manhattan	New York City Soil & Water Conservation
Manhattan	Millennium HS
Manhattan	PS 124
Manhattan	MS 104
Manhattan	PS 116
Manhattan	Grace Church School
Manhattan	Horticultural Society
Manhattan	American Museum of Natural History
Manhattan	UNICEF
Manhattan	PS 116
Manhattan	Institute of Collaborator Education
Queens	MGI/Gear up @ Queens College
Queens	PS 33

Additional Promotional Items, Literature, and Publications Were Sent to the Following Organizations	
Location	**Organization**
Queens	PS 78
Queens	Theresa Paplin School
Queens	John Bowne High School
Queens	PS 213
Queens	Queens Museum of Art
Queens	PS 43
Queens	Lexington School for the Deaf
Queens	Boy Scouts of America
Queens	PS 133
Queens	Bell Academy (MS 294)
Queens	Bronx HS of Science
Queens	Hunter -Middle School
Queens	PS 212Q
Queens	PS 70
Queens	John Adams High School
Queens	Newtown High school
Queens	PS 139
Queens	PS 199
Queens	IS 109
Queens	Dept. of Design & Construction
Staten Island	PS 57
Staten Island	Staten Island Bluebelt

Number of Education Events
Per Borough, 2008

Location	Number of Events
Bronx	9
Brooklyn	29
City-wide	5
Manhattan	54
Queens	31
Staten Island	6
TOTAL	**134**
Average Events per Month	**17**

Public Event-Based Programs

In 2008, the DEP attended 229 public outreach events, averaging approximately 19 events per month. Events included table top displays and outreach at 6 fairs, festivals, and concerts, most of which were community based. Other events included displays and outreach at 24 Greenmarket events, 6 beach clean-up events, the International Hotel/Motel Restaurant trade Show, and National Night Out, with the remainder including a combination of community group outreach, such as materials, presentations and table top displays at expos, professional associations, as well as events conducted at City parks. The following table includes the schedule of public outreach events during 2008.

Schedule of DEP Public Outreach Events, 2008

Date	Borough	Event Description
1/2/2008	Bronx	Town Hall Meeting
1/2/2008	Queens	Town Hall Meeting
1/3/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
1/9/2008	Manhattan	Housing Preservation & Development (HPD) Water Conservation Class
1/12/2008	Queens	PIP Public Outreach
1/24/2008	Manhattan	HPD Water Conservation Class
1/26/2008	Staten Island	PIP Public Outreach
1/29/2008	Brooklyn	PIP Public Outreach
1/30/2008	Brooklyn	PIP Public Outreach
2/4/2008	Manhattan	New York Water Environment Association (NYWEA) Winter Meeting
2/4/2008	Brooklyn	HPD Water Conservation Class
2/5/2008	Manhattan	New York Water Environment Association (NYWEA)
2/6/2008	Bronx	Town Hall Meeting
2/7/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
2/7/2008	Queens	PIP Public Outreach
2/11/2008	Manhattan	PIP Public Outreach
2/13/2008	Brooklyn	PIP Public Outreach
2/17/2009	Bronx	HPD Water Conservation Class
2/19/2008	Queens	Queens Community Board #14 Community Outreach
2/19/2008	Brooklyn	PIP Public Outreach
2/21/2008	Brooklyn	PIP Public Outreach
2/26/2008	Queens	PIP Public Outreach
2/28/2009	Manhattan	HPD Water Conservation Class
3/3/2008	Brooklyn	HPD Water Conservation Class
3/4/2008	Manhattan	PIP Public Outreach
3/5/2008	Bronx	Town Hall Meeting
3/6/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
3/7/2008	Manhattan	PIP Public Outreach
3/10/2008	Manhattan	HPD Water Conservation Class
3/11/2008	Brooklyn	PIP Public Outreach
3/13/2008	Manhattan	Conservation Seminar – Housing Conservation Coordinators
3/18/2008	Queens	Town Hall Meeting
3/22/2008	Manhattan	Go Green East Harlem
3/24/2008	Manhattan	HPD Water Conservation Class
3/27/2008	Queens	PIP Public Outreach
4/2/2008	Bronx	Town Hall Meeting
4/2/2008	Bronx	PIP Public Outreach
4/3/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
4/7/2008	Brooklyn	HPD Water Conservation Class
4/9/2008	Manhattan	PIP Public Outreach
4/12/2008	Queens	Beach 30th Street Clean-up and Restoration Planting Day

Schedule of DEP Public Outreach Events, 2008

Date	Borough	Event Description
4/15/2008	Queens	Town Hall Meeting
4/16/2008	Staten Island	PIP Public Outreach
4/19/2008	Manhattan	Earth Day Harlem
4/23/2008	Brooklyn	PIP Public Outreach
4/25/2008	Brooklyn	Plum Beach Clean-up/Planting Project
4/26/2008	Brooklyn	Plum Beach Clean-up/Planting Project
4/29/2008	Manhattan	HPD Water Conservation Class
4/29/2008	Manhattan	21st Annual Co-op and Condo Expo
4/30/2008	Queens	PIP Public Outreach
5/1/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
5/3/2008	Queens	Beach 30th Street Rockaway Earth Day Environmental Art Unveiling
5/5/2008	Brooklyn	HPD Water Conservation Class
5/7/2008	Bronx	Bronx Community Board #12 Community Outreach
5/7/2008	Brooklyn	PIP Public Outreach
5/7/2008	Queens	Town Hall Meeting
5/10/2008	Queens	Twin Ponds Stream Clean-up Day
5/12/2008	Manhattan	HPD Water Conservation Class
5/20/2008	Queens	Town Hall Meeting
5/27/2008	Manhattan	HPD Water Conservation Class
6/3/2008	Manhattan	Morgan-Stanley Sustainability Exhibit
6/4/2008	Bronx	Bronx Community Board #12 Community Outreach
6/5/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
6/9/2008	Brooklyn	HPD Water Conservation Class
6/12/2008	Manhattan	HPD Water Conservation Class
6/13/2008	Citywide	MTA Conservation Workshop
6/16/2008	Manhattan	Buildings NY
6/17/2008	Manhattan	Buildings NY
6/17/2008	Queens	Town Hall Meeting
6/28/2008	Queens	Plover Awareness Day at Rockaway Beach 54th Street
7/2/2008	Bronx	Town Hall Meeting
7/3/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
7/15/2008	Bronx	Greenmarket: Boro Hall
7/15/2008	Queens	Queens Community Board #1 Community Outreach
7/15/2008	Brooklyn	Multi-Family Buildings Conference
7/17/2008	Brooklyn	Greenmarket: Boro Hall
7/17/2008	Queens	Open House at the Queens Museum
7/17/2008	Queens	Open House at the Queens Museum
7/18/2008	Manhattan	Greenmarket: Union Sq.
7/19/2008	Brooklyn	East New York Diagnostic & Treatment Center 18th Annual Health Fair
7/22/2008	Bronx	Greenmarket: Boro Hall
7/22/2008	Manhattan	Power Engineering Society
7/24/2008	Brooklyn	CUNY School of Professional Studies
7/24/2008	Brooklyn	Greenmarket: Boro Hall
7/26/2008	Manhattan	City of Water
7/29/2008	Bronx	Greenmarket: Boro Hall

Schedule of DEP Public Outreach Events, 2008

Date	Borough	Event Description
7/31/2008	Brooklyn	Greenmarket: Boro Hall
8/1/2008	Manhattan	Greenmarket: Union Sq.
8/5/2008	Bronx	Greenmarket: Boro Hall
8/5/2008	Bronx	National Night Out
8/5/2008	Brooklyn	National Night Out
8/5/2008	Manhattan	National Night Out
8/5/2008	Manhattan	National Night Out
8/5/2008	Manhattan	National Night Out
8/5/2008	Queens	National Night Out
8/5/2008	Queens	National Night Out
8/5/2008	Queens	National Night Out
8/6/2008	Bronx	Bronx Community Board #12 Community Outreach
8/6/2008	Manhattan	Concert
8/6/2008	Manhattan	Hunter College, CUNY
8/6/2008	Manhattan	Hunter College, CUNY
8/7/2008	Brooklyn	Concert
8/7/2008	Brooklyn	Greenmarket: Boro Hall
8/7/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
8/8/2008	Manhattan	Greenmarket: Union Sq.
8/9/2008	Manhattan	Summer Streets
8/11/2008	Brooklyn	Concert
8/12/2008	Bronx	Greenmarket: Boro Hall
8/14/2008	Brooklyn	Concert
8/14/2008	Brooklyn	Greenmarket: Boro Hall
8/15/2008	Manhattan	Greenmarket: Union Sq.
8/16/2008	Manhattan	CUNY Institute for Sustainable Cities
8/16/2008	Manhattan	Summer Streets
8/19/2008	Bronx	Greenmarket: Boro Hall
8/19/2008	Queens	Queens Community Board Community Outreach
8/21/2008	Brooklyn	Concert
8/21/2008	Brooklyn	Greenmarket: Boro Hall
8/22/2008	Brooklyn	Greenmarket: Boro Hall
8/22/2008	Queens	National Day Out
8/23/2008	Manhattan	Summer Streets
8/26/2008	Bronx	Greenmarket: Boro Hall
8/28/2008	Brooklyn	Concert
8/28/2008	Brooklyn	Greenmarket: Boro Hall
8/29/2008	Manhattan	Greenmarket: Union Sq.
9/2/2008	Bronx	Greenmarket: Boro Hall
9/3/2008	Bronx	Bronx Community Board Community Outreach
9/4/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
9/8/2008	Brooklyn	HPD Water Conservation Class
9/16/2008	Queens	Queens Community Board #14 Community Outreach
9/16/2008	Manhattan	HPD Water Conservation Class
9/20/2008	Brooklyn	International Beach Clean-up Day -
9/22/2008	Manhattan	Medellin, Colombia Visit to DEP
9/23/2008	Manhattan	NYC Soil and Water Conservation District(Conference)
9/23/2008	Manhattan	IEEE Power and Energy Society - Industry Application

Schedule of DEP Public Outreach Events, 2008

Date	Borough	Event Description
		Conference
9/24/2008	Queens	Business Resource Day
10/1/2008	Bronx	Town Hall Meeting
10/2/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
10/2/2008	Manhattan	Housing Conservation Coordinators Seminar
10/6/2008	Brooklyn	HPD Water Conservation Class
10/11/2008	Brooklyn	Bed-Stuy Alive 2008 Community Affair
10/14/2008	Manhattan	HPD Water Conservation Class
10/17/2008	Manhattan	Greenmarket: Union Sq.
10/19/2008	Manhattan	Mayor's CUP NYC Kayak Championship
10/21/2008	Queens	Queens Borough Cabinet Meeting
10/22/2008	Manhattan	NYC DEP
10/22/2008	Manhattan	NYC DEP
10/23/2008	Manhattan	The Stuyvesant Cove Park Association
10/24/2008	Manhattan	Con Ed's Advocacy Today Conference
10/24/2008	Manhattan	Greenmarket: Union Sq.
10/26/2008	Queens	Bayside Historical Society: Annual Fort Totten 5K Race
10/27/2008	Manhattan	BRAVO - Top Chef New York "Taste of the Five Boroughs" Grand Central Station
10/28/2008	Manhattan	Jamaica Bay Symposium
10/30/2008	Staten Island	Wagner College
10/31/2008	Manhattan	Barnard College
10/31/2008	Manhattan	Barnard College
10/31/2008	Queens	Queens Center Mall/Queens Economic Development Corp
11/5/2008	Bronx	Town Hall Meeting
11/5/2008	Queens	Town Hall Meeting
11/6/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
11/9/2008	Manhattan	Int'l Hotel/Motel & Restaurant Trade Show: Jacob Javits
11/10/2008	Manhattan	Int'l Hotel/Motel & Restaurant Trade Show: Jacob Javits
11/10/2008	Manhattan	Go Green To Save Green
11/11/2008	Manhattan	Int'l Hotel/Motel & Restaurant Trade Show: Jacob Javits
11/12/2008	Brooklyn	Senator Montgomery's Resource Expo
11/12/2008	Manhattan	Go Green To Save Green
11/14/2008	Manhattan	Greenmarket: Union Sq.
11/22/2008	Brooklyn	Brooklyn Children's Museum
12/3/2008	Bronx	Bronx Community Board Outreach
12/3/2008	Manhattan	The Neighborhood School (Trout in the Classroom)
12/3/2008	Manhattan	The Neighborhood School (Trout in the Classroom)
12/4/2008	Queens	Citizens Advisory Committee Meeting. Brooklyn-Queens Aquifer Feasibility Study
12/8/2008	Brooklyn	HPD Water Conservation Class
12/15/2008	Manhattan	"From Faucet to Flush" Exhibit
12/20/2008	Queens	105th Pct - Toys for Kids

Hydrant Education Action Teams ("HEAT")

DEP worked with six Hydrant Education Action Teams (HEAT) comprised of 75 high school and college students who canvassed neighborhoods in all five boroughs disseminating information about the effects of illegally-opened fire hydrants on water pressure in the City's distribution system. DEP and HEAT were present at several public events throughout the summer to raise awareness about two priority topics: water conservation and illegally-opened fire hydrants. DEP set up hydration stations, distributed reusable water bottles, and provided educational materials.

Hydrant Education Action Team Events

Date	Events Per Date	HEAT Organizations
7/1/2008	2	Ridgewood Southern Qns. Pk. Assoc.
7/2/2008	2	Ridgewood Southern Qns. Pk. Assoc.
7/3/2008	2	Ridgewood Southern Qns. Pk. Assoc.
7/7/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/8/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/9/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/10/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/11/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/12/2008	1	Ridgewood

Hydrant Education Action Team Events

Date	Events Per Date	HEAT Organizations
7/14/2008	1	Southern Qns. Pk. Assoc.
7/15/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/16/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/17/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/18/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/21/2008	4	Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Southern Qns. Pk. Assoc.
7/22/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/23/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/24/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/25/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2

Hydrant Education Action Team Events

Date	Events Per Date	HEAT Organizations
		Southern Qns. Pk. Assoc.
7/28/2008	4	Alianza CB 5 Alianza CB 4 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/29/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/30/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
7/31/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/1/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/2/2008	2	Ridgewood Alianza Manh. Team 2
8/4/2008	5	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Southern Qns. Pk. Assoc.
8/5/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/6/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/7/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1

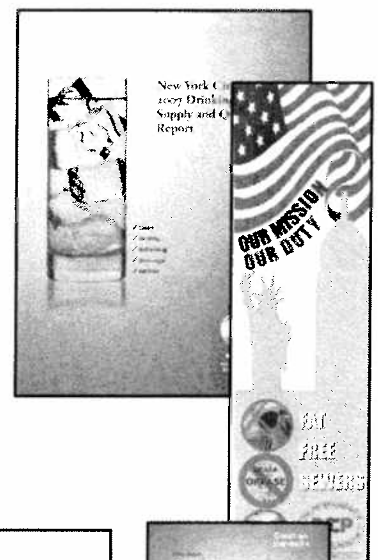
Hydrant Education Action Team Events

Date	Events Per Date	HEAT Organizations
		Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/8/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/9/2008	1	Alianza Manh. Team 2
8/10/2008	1	Ridgewood
8/11/2008	5	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Southern Qns. Pk. Assoc.
8/12/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/13/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/14/2008	6	Ridgewood Alianza CB 5 Alianza CB 4 Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.
8/15/2008	5	Ridgewood Alianza Alianza Manh. Team 1 Alianza Manh. Team 2 Southern Qns. Pk. Assoc.

Number of Public Outreach Events
Per Borough, 2008

Location	Number of Events
Bronx	23
Brooklyn	39
City-wide	1
Manhattan	65
Queens	43
Staten Island	3
Subtotal	**174**
HEAT Events	**179**
Average Events per Month	**29**
Total	**353**

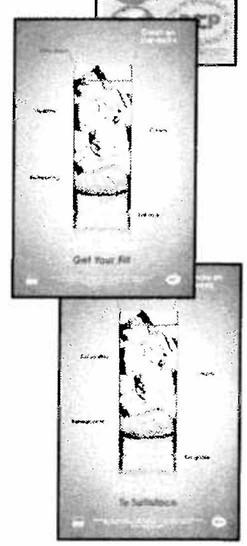
Publications



A list of flyers, brochures, posters, and publications is provided in Table 6-11. These items were displayed or distributed throughout the public education program, and most are readily available on the DEP website. Examples of the publications, including the floatables reduction and grease disposal tips flyers, and several versions of the "Clean Streets = Clean Beaches" posters, are shown along the right margin of the preceding and following pages.

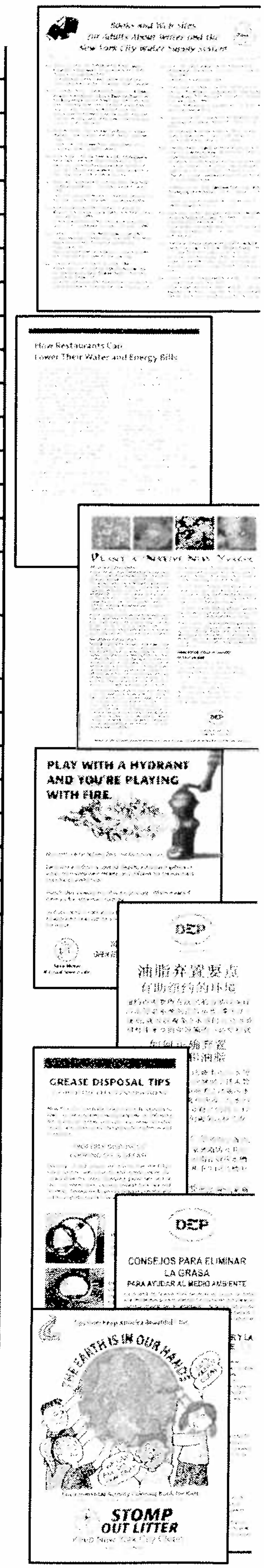
Literature / Publications 2008

2006 New York Harbor Water Quality Report (Report on CD)
Biosolids Beneficial Use Program (Leaflet)
BMPs for Non-Residential Direct and Indirect Dischargers of Grease to the Public Sewer System (Fact sheet)
Books and Websites for Adults about Water and the New York City Water Supply System (Brochure)
Bureau of Wastewater Treatment: Bureau Summary (Report)
Celebrating New York City's Clean Drinking Water (Fact sheet)
Celebrating New York City's Harbor Water Quality Programs (Fact sheet)
Central Park Reservoir Expedition Journal (Booklet)
City that Drinks the Mountain Sky (Leaflet)
Clean Streets = Clean Beaches (Litter Bag)



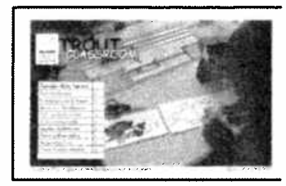
Literature / Publications 2008

Clean Streets = Clean Beaches (Poster/Leaflet)
Clean Streets = Clean Beaches When It Rains You Don't Go To the Beach, Your Litter Does (Leaflet)
Combined Sewer Overflow Stakeholder Meeting (Poster)
Comprehensive Water Reuse Program Applications and Instructions
Don't Let the Water Run (Journal)
Dos & Don'ts of Water Conservation (Leaflet) *English, Spanish, Chinese, Korean, Russian*
Earth Day (Banner)
Environmental Education Resources for Students and Teachers (Fact sheet)
Facts about the New York City Water Supply System (Fact sheet)
Fat Free Sewers – Our Mission Our Duty (Leaflet)
Floatables Reduction Program (Leaflet)
Glossary of Wastewater Treatment Terminology (Fact sheet)
Glossary of Water Terminology (Fact sheet)
Good Cleaning Practices – Food and Restaurant Industry (Leaflet)
Grease Disposal Tips to Help the City's Environment (Leaflet) *English, Spanish, Chinese, Korean*
Grease Down the Drain Think Again (Poster) *English, Spanish, Chinese, Russian, Greek, Hindi, Arabic, Yiddish*
Great Books and Websites for Children about Water and the New York City Water Supply System (Brochure)
High Efficiency Clothes Washers (Fact sheet)
How DEP Protects New York City's Beaches (Bill insert)
How Restaurants Can Lower Their Water and Energy Bills (Poster/Leaflet)
How Water and Sewer Fees Improve Your Water and Protect Your Environment (Fact sheet)
Jamaica Bay Watershed Protection Plan/Prioritized Strategies (Poster)
Jamaica Bay Watershed Protection Plan/Salt Marsh Islands (Poster)
New York City 2006 Drinking Water Supply and Quality Report (Report)
New York City Water Is… (Coloring book)
New York City Water Supply Activity, Create a Rainstorm (Educational Activity)
New York City Water Supply Activity, The Value of Water (Educational Activity)
New York City Water Supply Activity, What is a Watershed? (Educational Activity)
New York City Water Supply Monitoring, Testing and Treatment (Leaflet)
New York City's Wastewater Treatment System (Report)
New York Water Guide (Brochure)
Newtown Creek Nature Walk Scavenger Hunt (Booklet)
Newtown Creek Nature Walk (Leaflet)
No Grease, Hand Washing Only (Laminated Sign)
No Grease, Vegetable/Fruit Washing Only (Laminated Sign)
NY – NJ Harbor Estuary Pumpouts – Keep Our Waters Clean, User Pumpout Guide (Brochure)
NYC DEP Automatic Meter Reading - AMR (Bill Insert)
NYC Water Get Your Fill (Assortment of 5/Enlish, Spanish flyer)
NYCDEP Harbor Survey Program (Leaflet) *English, Spanish, Chinese*
NYCDEP Harbor Survey Program (Panel at the South Street Seaport Wet Lab)
Once-Through Water-Cooled Refrigeration, Ice-Making and Air Conditioning (Fact sheet)



Literature / Publications 2008

Plant a Native New Yorker (Leaflet)
Play With a Hydrant and You're Playing with Fire (Poster) *English, Spanish*
Preventing Grease Discharges into Sewers Guidelines for New York City Businesses (Brochure) *English, Spanish, Chinese, Korean, Russian*
Reading Your Water and Sewer Bill (Bill Insert)
Reduce Your Water and Sewer Bill (Fact Sheet)
Residential Water Use - Leaks and Their Cost (Fact sheet)
Residential Water Use (Fact sheet)
Save Water! (Jar Opener)
Smart Business, a Guide to DEP Environmental Regulations and Permitting Requirements for Businesses in New York City (Brochure)
Smart Printing, a Guide to Environmental Regulations and Permit Requirements for Printers (Booklet)
Staten Island Bluebelt (Brochure)
STOMP Out Litter - Keep New York City Clean (Coloring book)
The DEP in the News (Newsletter)
The Magic School Bus at the Waterworks, Special New York City Edition (Book)
The Magic School Bus at the Waterworks, Teacher's Guide (Booklet)
Top 10 Ways to STOMP OUT LITTER (Leaflet) *English, Spanish, Chinese, Korean, Yiddish, Russian*
Trout In The Classroom (Booklet)
Water Conservation Art and Poetry Certificates
Water Conservation Art and Poetry Invites
Water Conservation Art and Poetry Program Guidelines 2008 (flyer)
Water Conservation Series/Innovative Toilet & Urinal Technologies (Poster)
Water, water, everywhere! (Panel at the South Street Seaport Wet Lab)
Water? Just Ask. Don't Drip New York Dry (Restaurant Tent Card)



Long-Term Land Acquisition Plan

2012 to 2022

Prepared by
NYC DEP Bureau of Water Supply
Division of Watershed Lands & Community Planning
Land Acquisition Program

Submitted to NYS DOH, NYS DEC and US EPA
in accordance with the 2007 FAD

September 30, 2009

Long-Term Land Acquisition Plan 2012 to 2022

Table of Contents

Section **Page**

Executive Summary

Since 1997, the City has operated a Land Acquisition Program (LAP) in the Catskill-Delaware System which seeks to acquire land and conservation easements for watershed protection. LAP is a key component of the City's Watershed Protection Program, which seeks to increase watershed protection and avoid filtration of the world's largest surface water supply. This **Long-Term Land Acquisition Plan 2012 to 2022** is being submitted in accordance with the 2007 FAD to detail the City's proposed approach to land acquisition under the next Water Supply Permit.

Section III has a detailed evaluation of **LAP progress to date,** including the following highlights:

- Through LAP, the City has **protected over 96,000 acres of land** in the one million acre Catskill-Delaware System, increasing the percentage of protected lands from 24 percent to 34 percent of the basin land area. That percentage is over 40 percent using either of two alternative metrics which weight the level of protected lands by reservoir diversions or by basin contribution to supply;
- As of July 1, 2009, the City and WAC have **signed or closed 1,172 transactions**, resulting in the protection of over 61,000 acres in fee simple and 35,000 acres with conservation easements;
- So far, **LAP has acquired 17 percent of lands solicited**. The success rate is a more impressive 26 percent in Priority Areas 1 and 2, where solicitations started first; and
- In the critical **West Branch reservoir basin, LAP has acquired 8,300 acres,** raising the level of protected land from 15 percent to 47 percent.

Section V identifies the following **Goals** to guide our efforts from 2012 to 2022:

- **Continue the proven real estate methods** that have guided the program since 1997;
- **Increase the percentage of protected lands in the Cat-Del System** as a whole, with a particular emphasis on non-terminal reservoir basins with less than 30 percent protected lands, specific sub-basins with a low percentage of protected lands and reservoir basins that are expected to provide a large contribution to future water supply;
- Develop parcel selection procedures to **maximize the water quality benefit of acquisitions**;
- **Build on our existing programs to promote City lands as a working landscape** in partnership with local communities; and
- Develop strategies to **promote the wise use of acquisition resources** over the long-term.

To achieve these goals, we identify regional **Areas of Focus** based primarily on the current level of protection in a sub-basin or basin. This will allow LAP to focus its solicitation efforts and resources on acquisition in those areas where it can provide the most water quality benefit. Several methods and strategies will be employed to focus LAP solicitation and acquisition within these areas:

- Develop a **variable solicitation schedule** that will result in more frequent attempts to contact landowners in Areas of Focus;
- **Identify additional opportunities to solicit for fee simple acquisition** on properties adjacent to existing City lands and smaller vacant lots with stream buffers; and
- Incorporate the Areas of Focus and level of protection into our **conservation easement** standards to make the best use of this valuable but resource intensive land protection tool.

Section I – Introduction

The mission of the City's Land Acquisition Program (LAP) is to acquire fee simple and conservation easement interests to protect environmentally-sensitive land in the New York City watershed as a part of the City's overall Watershed Protection Program. LAP is a key component of the City's efforts to increase watershed protection and avoid filtration of the Catskill-Delaware (Cat-Del) System, which provides water to over 9 million residents of the City and nearby communities in New York State. Since its creation in the 1990s, LAP has protected, through acquisition, over 96,000 acres of land in the 1 million-acre Cat-Del System. Together with lands protected by the State and other entities, these acquisitions have raised the level of permanently protected land in the Cat-Del System from 24 percent in 1997 to 34 percent today.

Land acquisition is an anti-degradation strategy, which can reduce the threat of adverse water quality impacts associated with future development. As such, LAP complements a wide variety of successful remediation strategies employed by the City which have already improved water quality in the Cat-Del System. LAP has operated under an evolving set of strategies, policies and approaches since 1997; this Long-Term Plan addresses the methods and strategies which will guide the City in the continuation of this critical watershed protection program over the ten years from 2012 to 2022.

Section II of this Plan provides an overview of LAP, including its regulatory context, methods and guiding planning principles. Section III presents program-to-date status and a detailed analysis of the progress achieved over the program's first 12 ½ years. Section IV provides an analysis of land use trends in the watershed. Sections V, VI and VII present a new Long-Term Strategy, with a discussion focusing on Goals (Section V), Strategies to Achieve these Goals (Section VI), and Basin Plans (Section VII). Unless otherwise noted, all program summary data presented in this Plan are as of July 1, 2009.

Section II – LAP Overview

A. <u>Regulatory Context</u>

The Land Acquisition Program grew out of the City's response to the Federal Safe Drinking Water Act Amendments (1986) and Surface Water Treatment Rule (SWTR, 1989). As a result of an increased awareness of the threat posed by micro-organisms in unfiltered surface water systems, the SWTR required such public water supplies to either filter their supply or meet specific "filtration avoidance criteria." The City, through its Department of Environmental Protection, sought to meet those criteria and avoid filtration through the development of a comprehensive Watershed Protection Plan for the Cat-Del System.

Under the SWTR, an applicant for filtration avoidance needs to "demonstrate through ownership and/or written agreements with landowners within the watershed that it can control all human activities which may have an adverse impact on the microbiological quality of the source water." Ownership of watershed lands is a key component of the City's ability to meet this condition. Prior to 1997, the City owned approximately 35,500 acres of land in the Cat-Del System (excluding reservoirs), and the State of New York owned another 202,000 acres, for a total protected land base of approximately 24 percent of the watershed land area. Since the early 1990s, the City has sought to increase those percentages though a robust land acquisition program.

DEP initially sought to establish a land acquisition program in the Cat-Del System as a condition of the first Filtration Avoidance Determination (FAD), issued by the US Environmental Protection Agency (EPA) in 1993. In August 1993 the City applied for a Water Supply Permit (WSP) from the NYS Department of Environmental Conservation (DEC). That application, and the City's concurrent efforts to promulgate new Watershed Rules and Regulations with the NYS Department of Health (DOH), met strong resistance from municipalities in the watershed. Many residents in these upstate communities saw these efforts as a threat to local economic development.

Over the ensuing three and a half years, the City, Federal and State regulators, local governments and environmental organizations engaged in wide-ranging, intensive and ultimately successful negotiations to reach a comprehensive New York City Watershed Memorandum of Agreement (MOA) in January 1997. Under this landmark agreement, the City agreed to undertake a wide array of programs to protect water quality while also supporting local economic development. The MOA called on the City to dedicate up to $300 million for a land acquisition program in the Cat-Del System, and identified specific program parameters and acquisition procedures, as detailed below in Section II.B.

In January 1997, the City received a WSP issued by DEC, and the first closing under LAP occurred in October, 1997. The WSP was issued for a ten-year period (through January 2007), with a five-year renewal option (through January 2012). Since 1997, EPA has issued several FADs that have continued to place a strong emphasis on land acquisition. In 2007, EPA, in collaboration with DOH and DEC, issued a ten-year FAD that required the City to dedicate an additional $241 million for land acquisition in the Cat-Del System. The 2007 FAD also required the City to apply for a new WSP in January 2010. As a prelude to that permit application, the FAD called for a "long-term land acquisition strategy…for the period from 2012 to 2022" to be submitted by September 30, 2009. This Long-Term Plan has been developed to meet that deliverable, and to describe the City's proposed approach to land acquisition under the WSP that it will apply for in 2010.

B. <u>Real Estate Methods and Procedures</u>

LAP utilizes a number of methods and procedures that were devised early in the program's development and are largely memorialized in the MOA and WSP. These methods and procedures govern the way the City contacts landowners, how appraisals are conducted, the real property rights to be acquired, provisions for public recreational access, and how the City pays property taxes on lands acquired. The City has a strong record of compliance with its MOA, FAD and WSP obligations. The key components of such compliance are as follows:

1. Willing Buyer / Willing Seller (MOA Paragraph 60) – Landowners and the City must both enter into a proposed transaction on a strictly voluntary basis. Landowners are under no obligation to sell until and unless a contract of sale is executed.

2. Fair Market Value (MOA 61) – Land and easements are appraised at fair market value by independent, certified NY State Appraisers commissioned by the City. The City's offers are based strictly on the results of these appraisals; landowners have the right to present their own appraisals which must be considered by the City's appraiser. Only under very limited circumstances (mortgage or tax foreclosure, legal judgment) can the City acquire land at below fair market value.

3. Solicitation (MOA 60, 64, 65 and Attachment Z) – The City's obligation to diligently pursue acquisition is defined in Attachment Z of the MOA. Although the City retains the flexibility to decline to appraise a property upon inspection, the City is obligated (except in very limited circumstances and subject to regulator approval) to pursue acquisition once an appraisal is ordered. Since 1997 under the MOA (and since 2002 pursuant to the FAD), the City has been required to meet a series of annual targets for landowner solicitation. The term "solicitation" includes both "original solicitation" in which the City makes the initial outreach to pursue acquisition of a property, and "re-solicitation", in which the City makes subsequent attempts to contact a landowner, after being unable to make contact or reach agreement at the point of original solicitation.

4. Rights Acquired – Through LAP the City can acquire, or fund the acquisition of, three distinct types of property interests:

a. ***Fee Simple*** **–** The City acquires land outright. This is the City's preferred acquisition method. Fee simple acquisition results in the highest level of control, allows the City to consider recreational, natural resource management and other uses on the property acquired, and makes the most efficient use of City staff resources.
b. ***Watershed Conservation Easements*** **–** In cases where landowners want to retain ownership and exclusive use of their land, conservation easements ("CEs") allow the City to limit future development through the acquisition of perpetual deeded rights. Although initial acquisition costs are lower than for fee simple purchases, CEs involve significantly higher long-term costs for monitoring and potential enforcement of deed provisions. CE purchases are pursued on larger properties whose owners are not interested in selling a fee simple interest.
c. ***Watershed Agricultural Easements*** **-** The City also funds the acquisition of CEs on farms by the Watershed Agricultural Council (WAC). These CEs, which require the farmer to have a Whole Farm Plan that governs best management practices for agricultural uses, allow for a diversity of farm-related uses but preclude most other types of development.

5. Property Taxes (MOA 79 and 80) – The City pays property taxes on all land and CEs acquired under LAP, including any lands under watershed agricultural CEs that are not agriculturally-exempt.

C. <u>Planning Principles</u>

The Cat-Del watershed (see Figure 1, page 30) spans just over 1 million acres draining into nine reservoirs in eight upstate counties. The identification of the most important parcels for acquisition within this vast watershed is an ongoing process based on a number of geographic, topographic and real estate factors. LAP first prioritizes property for solicitation on the basis of its location within the water supply system, followed by site-specific characteristics. These principles are embodied in the Priority Area and Natural Features Criteria provisions of the MOA:

1. Priority Areas – The basins and sub-basins comprising the Cat-Del System were assigned to Priority Areas (as depicted in Figure 1) as follows:

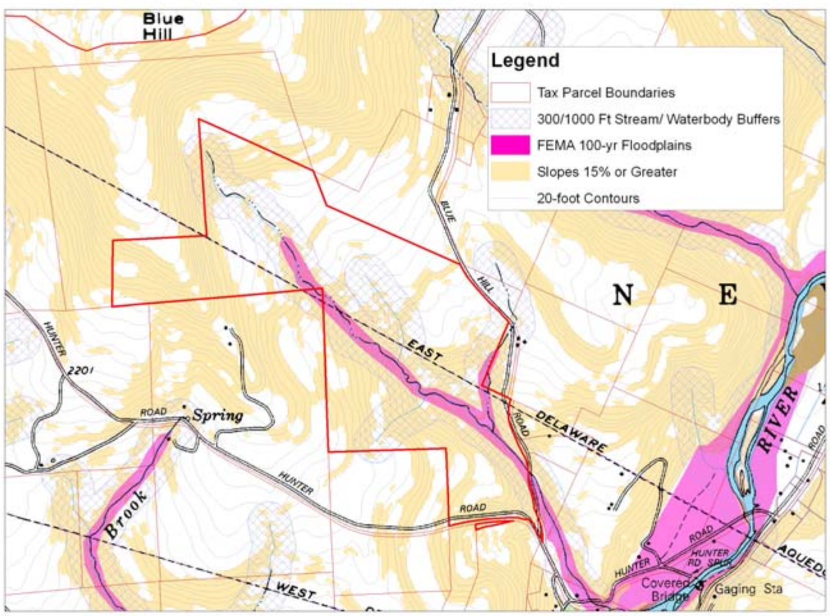
a. ***Priority 1A*** **–** Sub-basins within 60-day travel time to distribution located near reservoir intakes;
b. ***Priority 1B*** **–** All other sub-basins within 60-day travel time to distribution;
c. ***Priority 2*** **–** All remaining sub-basins in terminal reservoir basins;
d. ***Priority 3*** **–** Sub-basins in non-terminal reservoir basins with existing water quality problems; and
e. ***Priority 4*** **–** All other sub-basins in non-terminal reservoir basins.

The MOA required that the City solicit at least 355,050 acres in accordance with a schedule that reflected LAP's priorities both in timing (higher priority areas were solicited first) and in percentage of eligible lands solicited (ranging from 95 percent of eligible lands in Priority 1A and 1B to 50 percent of eligible lands in Priority 4).

Following the new funding commitments contained in the 2007 FAD, the City's 2008 to 2010 Solicitation Plan called for an additional 90,000 acres of new solicitation. These additional acres were solicited primarily in Priority Areas 3 and 4 (since Priority 1 and 2 had already been almost entirely solicited), effectively raising the level of solicitation in those Priority Areas above the levels specified in the MOA.

2. Natural Features Criteria – These criteria, as defined in MOA 63, establish a set of hydrologic and topographic features, one or more of which must be present on a property in order to qualify for acquisition in Priority Areas 2, 3 or 4. LAP uses the DEP Geographic Information System (GIS) to overlay these features onto digitized tax parcels as part of the parcel evaluation process, as shown in Figure 2:

Figure 2*:* **<u>Sample GIS Map showing Natural Features Criteria</u>**



3. Out-Basin Plan – In 2000 LAP issued its Out-Basin Plan, which detailed a strategy for solicitation in Priority Areas 3 and 4. This strategy included the following key components:

a. ***Parcel Ranking*** – LAP developed a GIS-based ranking system that utilized three equally-weighted components (property size, percent surface water features and slope characteristics) to rank each parcel for its solicitation potential. The equal weights mean that, for example, a 300-acre parcel with steep slopes and a small amount of stream buffer would be ranked about equal to a 60-acre parcel with moderate slopes, and several streams or wetlands. Both parcels would be ranked higher than a 60-acre parcel with steep slopes and no stream buffer.

b. ***Distance to Reservoir*** – The distance of a parcel to the reservoir is not a predominant factor in determining its desirability for solicitation. Rather, the distance from the stream network and slopes on the property (both incorporated into the parcel ranking system) are considered determinative factors. This approach is based on the fact that pollutants which enter the stream network during storm events (when most pollutant transport occurs) are likely to enter the reservoir rapidly regardless of the distance along the stream network to the reservoir.

These planning principles have guided LAP solicitation so as to maximize the water quality benefit of lands acquired. The discussion of program-to-date results and the level of protected lands in the Cat-Del System (Section III) emphasizes the importance of *where* those lands are located within the watershed. This Plan recommends a general continuation of the guidelines developed in 1997, although the Long-Term Strategy (see Sections V, VI and VII) will make specific modifications to reflect the results of LAP acquisitions to-date, land use trends and real estate market conditions.

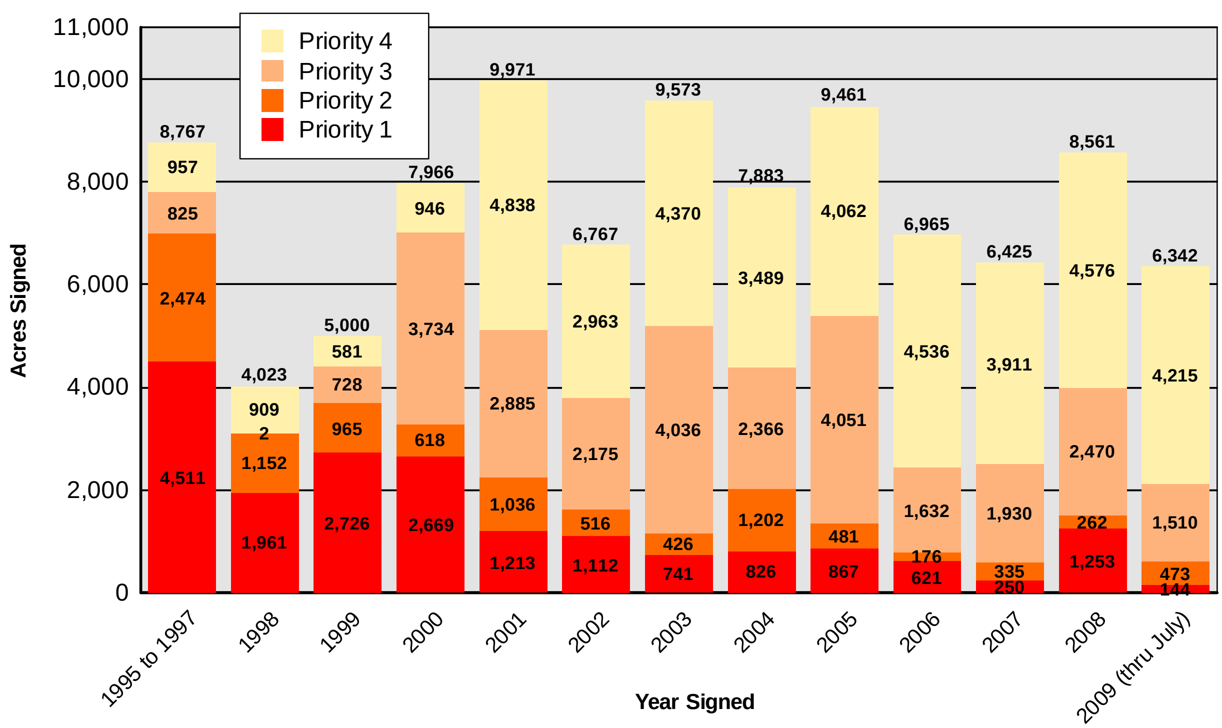
Section III - Program Status as of July 1, 2009

A. Program-to-Date Activity

As of July 1, 2009, LAP (including WAC) had acquired a total of 97,704 acres in the Cat-Del System.[1] Reaching this point has involved over 1,150 separate real estate transactions, an average of about two transactions per week and about 7,800 acres per year.

1. Trends over Time - Since 1997, LAP acquisitions have proceeded on a steady basis, influenced by the location of solicitations, real estate market trends and program development initiatives.

Figure 3: **Acres Acquired by Priority Area and Year**

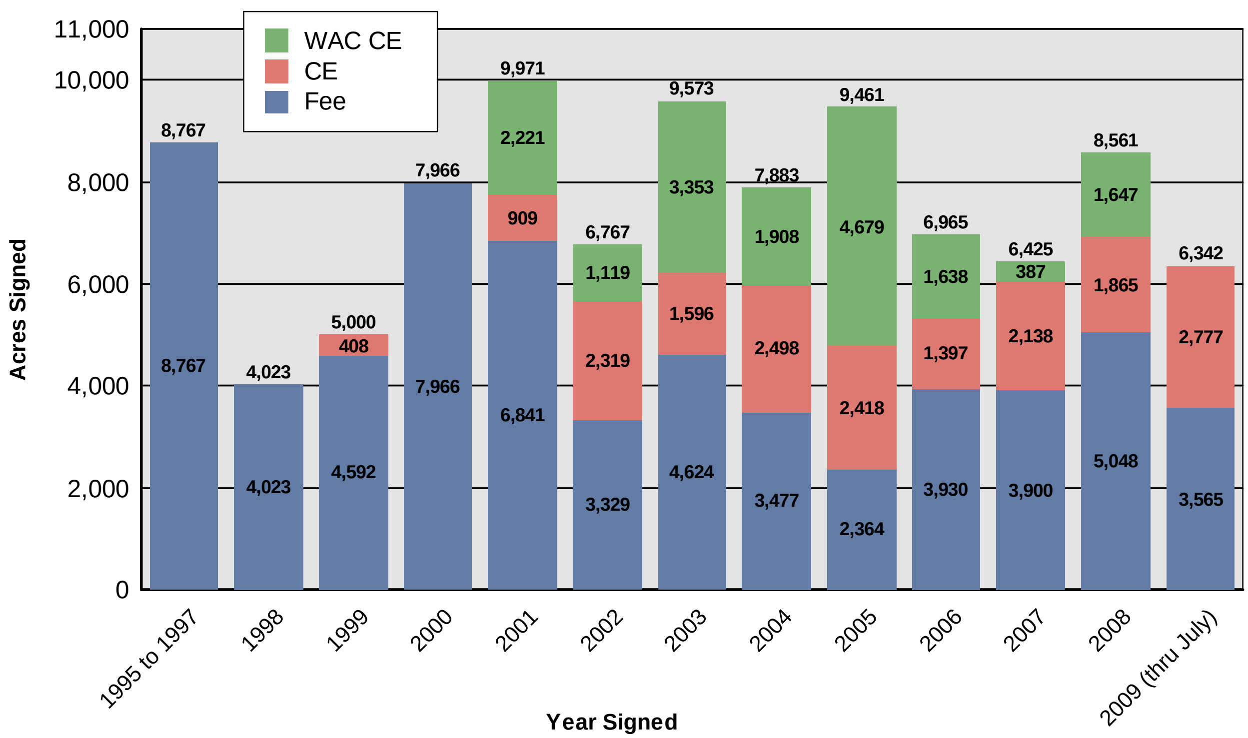


[1] This total, and the totals in Tables 1 and 3, include about 1,000 acres acquired outside the watershed boundary or in the Croton System as a part of Cat-Del acquisitions.

As shown in Figure 3, contracts signed from 1995 through 2000 were focused in Priority Areas 1 and 2 (predominately in Putnam and Ulster Counties). After 2000, the volume shifted to Priority Areas 3 and 4, where the majority of acquisitions continue to occur.

Examining yearly activity by real estate type (Figure 4) shows the impact of program development activities. Fee acquisitions dominated during the early years of LAP. The first two contracts to acquire CEs were signed in 1999, but that program component did not become fully established until 2001. Since 2001, LAP has signed between 900 and 2,700 acres in easements each year. Similarly, the WAC CE program did not sign its first contract until 2001 but has subsequently secured 90 CEs. Together, the DEP and WAC CE programs have contributed about 35 percent of the total acres protected under LAP (see Table 1, page 7).

Figure 4: **<u>Acres Acquired by Real Estate Type and Year</u>**



Figures 3 and 4 both show the general impact of the real estate market on LAP activity. Looking specifically at City signings of fee simple acquisitions (those most reflective of overall market conditions), LAP activity had an early peak in 2000 and 2001, reflecting a stable, slowly rising market at a time when LAP fee acquisition efforts were firmly established. Following September 11, 2001, the real estate market began a period of rapid growth from 2002 through 2007. LAP fee acquisitions moderated during this period (ranging between 2,300 and 4,600 acres per year), as sellers were able to consider competing (and often higher) purchase offers from private buyers. Since its peak in 2007-2008, the market has leveled or dropped, particularly with respect to the volume of private sales in the marketplace. In this weakened market environment, LAP purchase offers have received more favorable responses, and fee acquisitions have increased noticeably.

2. Acquisitions by Real Estate Type - As shown in Figure 4, fee simple acquisitions have comprised the majority of LAP acres protected, but CEs (both City and WAC) are an increasingly important component of overall program activity. Looking at program-to-date totals by real estate Type (see Table 1, below) reveals significant distinctions between fee and CE acquisitions. Fee simple acquisitions, comprising 82 percent of the 1,171 total projects, average 65 acres in size and have an average price per acre of $3,885. In contrast, City CEs (averaging 153 acres at a cost of $2,049/acre) and WAC CEs (averaging 188 acres at a cost of $1,258/acre) are significantly larger and less costly to acquire on a per acre basis.

Table 1: **Signed Contracts by R.E. Type**

R.E. Type	Number of Parcels	Acres	Average Size	Purchase Price	Average Price/Acre
Fee	963	62,426	65	$242,505,795	$3,885
CE	119	18,324	154	$37,546,641	$2,049
WAC CE	90	16,954	188	$21,330,278	$1,258
Program Totals	**1,172**	**97,704**	**83**	**$301,382,714**	**$3,085**

3. Acquisition Cost by Location - The cost of acquisition varies dramatically depending on the location of a property within the watershed. Since acquisition costs have also risen over time, and the level of LAP activity has varied over time and location (as shown in Figure 3), program-to-date average cost or geographic cost averages can be misleading. The best way to compare cost variation across the Cat-Del System is to look at similar properties (by size) during the same, limited timeframe. Table 2 depicts the value of fee simple appraisals between 10 and 50 acres from 2003 to the present:

Table 2: **Fee Simple Appraisals, 10 to 50 acres, between 2003 and 2009**

District	Market Area	Total Acres Appraised*	Total Value	Average Price per Acre
EOH	Kensico (Westchester)	62	$14,746,250	$237,002
	West Branch (Putnam)	891	$16,190,550	$18,178
WOH	Ashokan (Ulster)	2,317	$19,033,413	$8,214
	Schoharie (Greene/Schoharie)	3,146	$18,872,319	$5,998
	Rondout & Neversink (Ulster/Sullivan)	1,097	$5,273,167	$4,807
	Pepacton & Cannonsville (Delaware)	5,240	$19,341,038	$3,691

* Includes all fee appraisals ordered, whether offers were accepted or not

4. Success rates - As discussed in Section II.B.3 above, regulatory mandates for LAP have consisted of solicitation requirements, not acquisition targets. However the program's effectiveness can be measured by its success in converting solicitations into signed contracts. Success rates provide a useful metric to evaluate program effectiveness over time, by method of solicitation, property type and location.

Table 3: **Success Rates by Priority Area**

	Solicited	City Acres Acquired	City Success Rate	WAC Acres Acquired	Total Acres Acquired	Purchase Price	Average Price/ Acre
Priority 1A	14,407	4,933	34%	0	4,933	$33,594,647	$6,811
Priority 1B	52,359	13,006	25%	954	13,960	$101,026,696	$7,237
Priority 2	43,139	10,115	23%	0	10,115	$28,315,484	$2,799
Priority 3	121,855	21,065	17%	7,277	28,343	$50,673,638	$1,788
Priority 4	243,637	31,631	13%	8,723	40,354	$87,772,248	$2,175
Totals	**475,397**	**80,750**	**17%**	**16,954**	**97,704**	**$301,382,714**	**$3,085**

The higher success rates in Priority Areas 1A, 1B and 2 are the result of two factors: First, the City has been soliciting land in these higher Priority Areas far longer than in Priority Areas 3 and 4, and success rates climb over time as landowners that had previously been uninterested decide to sell. Second, market values in Priority Areas 1 and 2 are higher, and program experience has shown that higher appraised values result in higher acceptance rates.

B. Program Effectiveness - Level of Protection

Land acquisition is an anti-degradation tool that does not have any immediate impact on water quality. Further, it is impossible to predict with certainty whether or how a property protected by LAP might have been developed, and how such development would have impacted water quality. For these reasons, direct measures of the effectiveness of LAP in the context of watershed protection are not possible. However a careful analysis of the location and level of LAP-acquired and other protected lands in the context of the Cat-Del System provides a clear picture of the program's effectiveness and suggests future areas of emphasis.

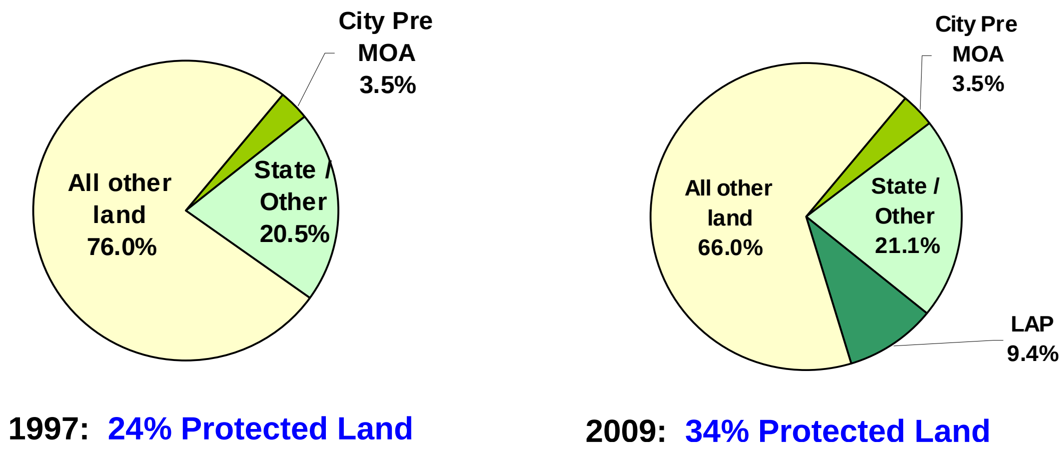
In order to fully evaluate the level of protected lands in the Cat-Del System, LAP has conducted extensive research to confirm ownership and the "protected" status of lands and CEs owned by the State, other governmental entities and land trusts.

1. Overall Level of Protection - Prior to the commencement of acquisitions under LAP, the City owned about 35,500 acres of buffer lands surrounding the nine reservoirs of the Cat-Del System. These lands (excluding the reservoirs) comprised about 3.5 percent of the system land area. The State of New York owned another 202,000 acres, mostly in the Catskill Forest Preserve. Together with about 8,000 acres protected by municipalities or private conservation groups, this protected land represented about 24 percent of the Cat-Del System.

As shown in Figure 1 (page 30), these protected lands were clustered in two distinct locations: 1) around the reservoirs, in buffer lands varying in width from a few hundred to a few thousand feet from the reservoir, and 2) in the Catskill Forest Preserve, the large State land holdings that comprise a significant proportion of the Rondout, Ashokan, Pepacton and Schoharie Basins.

Under LAP, the City has increased its ownership of protected lands from 35,500 (3.5 percent of the Cat-Del System) to 132,500 (13 percent). Together with State and Other Protected Lands, the Cat-Del System currently has 34 percent protected land, as shown below in Figure 5:

Figure 5: **Protected Land in the Cat-Del System, 1997 vs. 2009**



This figure illustrates a signal achievement of the Land Acquisition Program. Through a continuation of existing policies (with the modifications presented in this Plan) the percentage of protected lands is expected to grow substantially between now and 2022.

2. Protected Land by Reservoir Basin - The overall level of protected lands in the Cat-Del System is more impressive if viewed by reservoir basin. The vast size of the City's water supply, with multiple terminal[2] reservoirs in each of two complimentary systems (three if the Croton System is included) implies that the level of protection within the system should be judged partly by *where* the protected lands are located. A simple example helps to illustrate this point:

Consider a hypothetical 150,000 acre watershed with two reservoirs, "South" and "North." "South" is a terminal basin of 50,000 acres that is 20 percent protected (10,000 acres), while "North" is a larger, non-terminal basin that is 100,000 acres in size and 50 percent protected (50,000 acres). The overall level of protection is 40 percent, *but most of that protected land is located in the less critical, non-terminal reservoir*. If, on the other hand, that protected land was evenly divided, with 30,000 acres in each basin, the overall level of protection remains at 40 percent but the *effective level of protection* is higher, because a higher proportion of the terminal basin is protected:

Table 4: **Effective Level of Protection (example)**

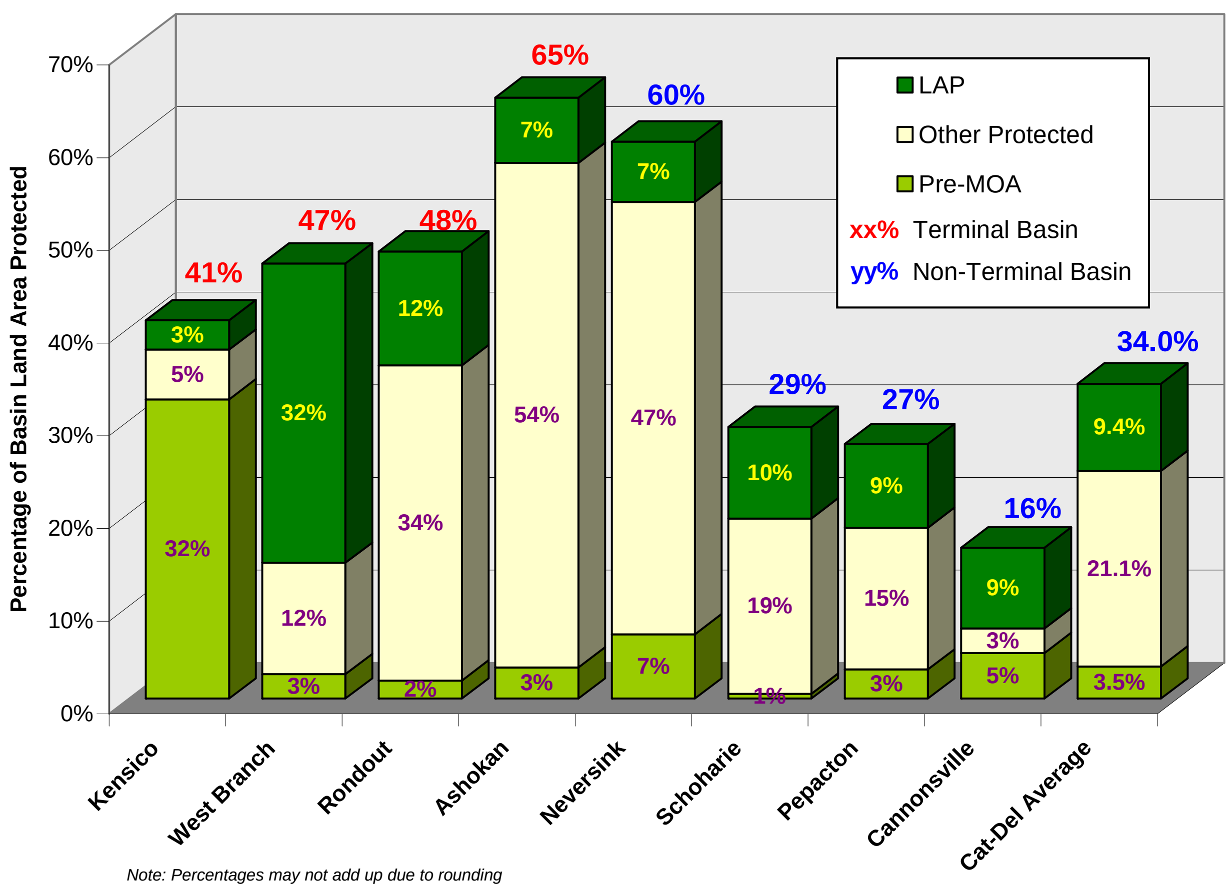
	Reservoir	Basin Land Area	Protected Land	Percent Protected
Scenario 1* *(Non-Terminal more protected)				
	"South" (Terminal)	50,000	10,000	20%
	"North" (Non-Terminal)	100,000	**50,000**	**50%**
	Total	**150,000**	**60,000**	**40%**
Scenario 2* *(Terminal more protected)				
	"South" (Terminal)	50,000	**30,000**	**60%**
	"North" (Non-Terminal)	100,000	30,000	30%
	Total	**150,000**	**60,000**	**40%**

[2] A terminal reservoir is a reservoir which, under certain operating conditions, is the last reservoir prior to distribution. In the Cat-Del System there are four terminal reservoirs: Kensico, West Branch, Ashokan and Rondout. Terminal basins are of greater concern for protection because they are the final "stop" before water is delivered to the consumer.

The same acreage of protected lands (60,000) affords a higher degree of watershed protection in Scenario 2 because all of the water from the North basin flows into the South Basin; with an under-protected terminal basin, clean water yielded from the non-terminal basin can be degraded upon entering the terminal reservoir.

In practice, the Cat-Del System, and its distribution of protected lands, more closely resembles Scenario 2, in which the terminal reservoir basins have a higher percentage of protected lands than the non-terminal basins:

Figure 6: **Protected Land as a Percentage of Basin Land Area**



In order to reflect the importance of terminal reservoir basins in the evaluation of protected lands, LAP has developed an alternative metric which directly incorporates the total volume of water diverted[3] from each reservoir to develop a "Diversion-Weighted Level of Protected Land." Using this metric, acres in terminal reservoirs receive a higher weighting because those acres afford protection not just for the volume of water contributed by overland flow within its own basin, but also for water from upstream reservoirs:

[3] "Diverted" water refers to water which exits the reservoir via an aqueduct to be delivered to the next reservoir or to the distribution system.

Table 5: **Diversion-Weighted Level of Protected Land**

System	Reservoir	Percent Protected Land	Average Annual Diversions 1992 to 2008 (mg)	Percentage of Total Diversions	Cumulative Diversion-Weighted Average
Delaware	Cannonsville	**16.3%**	52,629	3.7%	**0.6%**
	Pepacton	**27.5%**	116,631	8.1%	**2.2%**
	Neversink	**60.1%**	44,447	3.1%	**1.9%**
	Rondout	**48.2%**	261,629	18.2%	**8.8%**
`	West Branch	**46.9%**	281,744	19.6%	**9.2%**
Catskill	Schoharie	**29.3%**	67,734	4.7%	**1.4%**
	Ashokan	**64.8%**	174,758	12.1%	**7.9%**
	Kensico	**40.8%**	439,029	30.5%	**12.5%**
Cat-Del Totals		**34.0%**	**1,438,602**	**100.0%**	**44.3%**

Another useful metric to characterize the level of protection in the Cat-Del System incorporates weighting based on the contribution of each reservoir basin to overall supply. Historical supply data from 1992 to 2007 show that 47.1 percent of total supply comes from the Pepacton and Ashokan Basins:

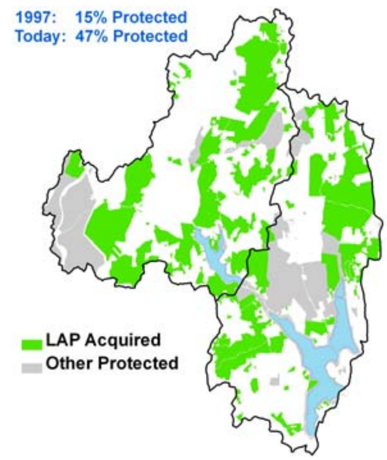
Table 6: **Supply-Weighted Level of Protected Land**

System	Reservoir	Percent Protected Land	Average Annual Contribution to Supply 1992 to 2007 (mg)	Percentage of Total Supply	Cumulative Supply-Weighted Average
Delaware	Cannonsville	**16.3%**	52,629	11.9%	**1.9%**
	Pepacton	**27.5%**	116,631	26.3%	**7.2%**
	Neversink	**60.1%**	44,447	10.0%	**6.0%**
	Rondout	**48.2%**	43,480	9.8%	**4.7%**
`	West Branch	**46.9%**	19,770	4.5%	**2.1%**
Catskill	Schoharie	**29.3%**	67,734	15.3%	**4.5%**
	Ashokan	**64.8%**	92,298	20.8%	**13.5%**
	Kensico	**40.8%**	6,876	1.5%	**0.6%**
Cat-Del Totals		**34.0%**	**443,866**	**100.0%**	**40.6%**

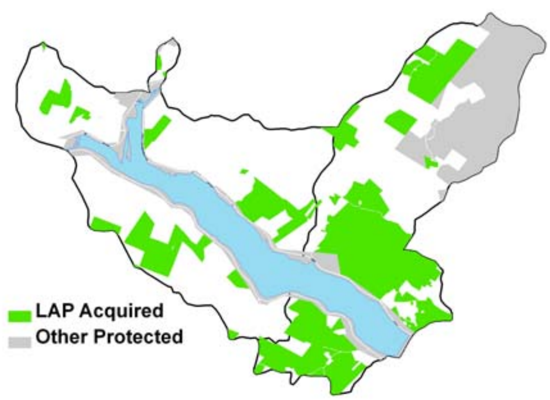
The distribution of protected lands in the Cat-Del System is a driving force in the development of this Long-Term Plan. The three measures of the level of protection in the Cat-Del System presented above show that the distribution of protected lands supports the City's overall protection goals. Looking forward, LAP can augment the high current level of protection in terminal basins, and in basins with a high contribution to supply, through an increased focus on basins and sub-basins with lower levels of protection. While solicitation will continue throughout the watershed, including in highly-protected Priority Areas 1A, 1B and 2, LAP will fine-tune its solicitation schedules and project design policies to emphasize acquisitions in the less-protected parts of the watershed.

3. Success Stories - As described above, LAP has protected approximately 9.4 percent of the Cat-Del System, raising the overall level of protection to 34 percent. Within that system-wide result lie specific areas where LAP has had an even more dramatic impact. Areas of concentrated success can be attributed to a variety of factors, including the duration of solicitations, market conditions, property configurations and socioeconomic factors.

West Branch/Boyd's Corner: These two connected reservoir basins are located East-of-Hudson, but serve as a terminal reservoir basin for the Delaware System. They are located in Putnam County, which was the second fastest growing county in NY State between 1990 and 2000. The rapid suburbanization of these two critical basins was a serious concern in the mid-1990s. The City's Pre-MOA buffer around the reservoirs is very narrow (totaling 683 acres) and the combined total of City, municipally- and State-protected lands was only 15% of the total basin land area in 1997.

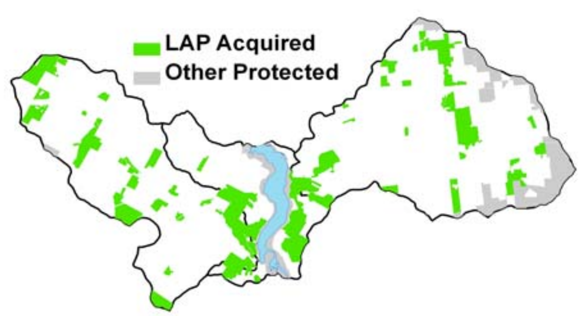


Due to fortuitous timing and a ready supply of large properties with willing sellers, LAP has now acquired over 8,300 acres of land, raising the level of protection by the City and others from 15 percent to 47 percent. These purchases, most of which were completed before 2001 at a cost of about $78 million total, probably represent LAP's most important regional achievement.



Rondout Direct Tributaries: Like West Branch, Rondout is a terminal basin in the Delaware System, and it too has very narrow buffer lands (totaling 1,222 acres) around the reservoir. Unlike West Branch, the Rondout Basin is characterized by rural (rather than suburban) and forested land uses. The northern portions of the basin are largely State-owned land, but the sub-basins containing the direct tributaries to the reservoir (excluding Chestnut Creek and Rondout Creek) were much less protected as of 1997, with a total of 19 percent protected land. LAP has acquired over 6,700 acres in these sub-basins, raising the level of protection to 45 percent.

Schoharie Direct Tributaries: The Schoharie Reservoir also has a very narrow strip of Pre-MOA buffer lands totaling 1,038 acres. LAP acquisitions adjoining that buffer, as well as in the Bear Kill and Manor Kill sub-basins, have increased the level of protection from 7 percent in 1997 to 21 percent today.



Other notable areas of success include the following:

Sub-Basin(s)	1997 Protected Acres (%)	2009 Protected Acres (%)
Beaver Kill / Little Beaver Kill sub-basins (Woodstock)	7,521 **(28%)**	12,842 **(48%)**
Batavia Kill Main Stem and tributaries (Greene Co.)	3,352 **(9%)**	8,247 **(22%)**
East Branch Delaware River Headwaters (Roxbury)	813 **(3%)**	6,175 **(19%)**

Section IV – Land Use Trends in the Cat-Del System

Land use patterns in the Cat-Del System vary widely according to location, but the period since 1997 has been generally characterized by stability. The biggest change in land use since 1998 is the increase in protected lands from 24 percent to 34 percent of the basin land area.

A. East-of-Hudson

Land use in the Kensico and West Branch/Boyd's Corner reservoir basins consists primarily of medium-density residential uses.

The Kensico basin has the highest residential density in the Cat-Del System, averaging about 50 residential units per 100 acres of basin land area. Most of this development occurred prior to 1990. With very little available vacant land remaining for development, Kensico has seen little new development in the past 12 years, although in some cases owners have replaced smaller residences with new larger "McMansions."

In contrast to Kensico, the West Branch and Boyd's Corner basins in Putnam County have experienced rapid residential development and population growth in recent years. Between 1990 and 2000 Putnam County was the second fastest growing county in New York State, increasing in population from 83,941 to 95,745, or 14.1 percent [4]. In keeping with this pace of development, the period since the inception of LAP saw an increase of approximately 300 residential units in these basins, and demand for housing remains strong. This growing population has created a strong demand for additional commercial development, but most of the commercially-zoned areas serving the population in these basins are located outside the Cat-Del System.

B. West-of-Hudson

1. Population - In contrast to the fast growth in Putnam County, population growth West-of-Hudson (WOH) was generally low, except for Sullivan County:

Table 7: **Population within NYC Watershed by County 1990 to 2008, West-of-Hudson** [4]

County	1990 Population	2000 Population	Percent Change 1990 to 2000	2008 Population	Percent Change 2000 to 2008
Delaware	25,137	25,679	2%	24,998	-3%
Greene	9,024	9,407	4%	9,764	4%
Schoharie	1,083	1,134	5%	1,110	-2%
Sullivan	2,287	2,735	20%	3,002	10%
Ulster	9,356	9,872	6%	10,260	4%
Totals	**46,887**	**48,827**	**4%**	**49,134**	**1%**

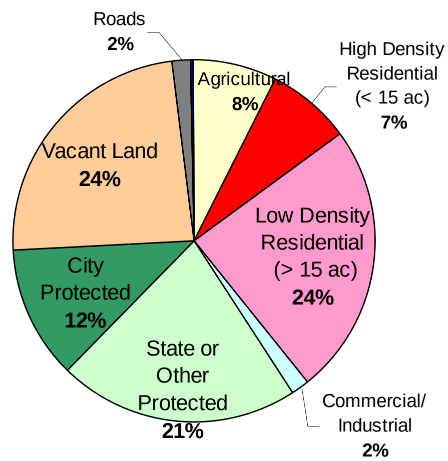
[4] US Census (1990, 2000; Demographics Now, 2008), adjusted by DEP; County populations within the watershed were estimated using town population, pro-rated using the proportion of the town's residences within the watershed.

Population growth in Delaware County, which contains about half of the WOH population, was essentially flat during the period from 1990 to 2008, while Greene, Sullivan and Ulster Counties experienced somewhat higher population growth. These census counts understate the actual pace of residential growth in the watershed, since population counts exclude seasonal or second-home residents. The 2000 Census of Housing shows that the percentage of total housing units used for "seasonal, recreational or occasional use" averages about 20 to 25 percent in the WOH District.

2. Land Use - An examination of land use across the WOH shows the rural character of the region. "Urban" uses, including residential lots under 15 acres, and commercial /industrial parcels comprised less than 10 percent of the total. In contrast, about 48 percent of the land consists of privately-owned vacant land and residential parcels over 15 acres.

Table 8: **West-of-Hudson Land Use Based on 2008 Town Assessment Data**

Land Use Category	Parcels	Acres
Agriculture	865	74,812
High Density Residential (< 15 ac.)	29,085	72,739
Low Density Residential (> 15 ac.)	4,438	241,546
Commercial / Industrial	3,377	16,236
State or Other Protected	1,664	212,094
City Protected *	2,561	116,459
Vacant Land	17,298	237,019
Roads [+]	n.a.	16,814
No Data	690	3,542
Total	**59,978**	**991,261**



* *Includes Pre-MOA (excluding reservoirs) and Closed Fee , Closed CE and Closed WAC CE*
[+] *Road rights-of-way, determined by subtracting the sum of the parcel data from total basin land area*

3. Agriculture - Agricultural land WOH is focused almost exclusively in the Cannonsville, Pepacton and Schoharie Basins, particularly in the Cannonsville basin in the towns of Hamden, Delhi, Kortright, Stamford, Bovina and Harpersfield. In these towns, dairy farming has traditionally been a dominant feature of the local landscape. From the standpoint of watershed protection, farms are critical in that they are typically comprised of relatively large contiguous holdings of land with moderate slopes, extensive road frontage and significant surface water features. DEP's Watershed Protection Program has recognized the critical importance of these working landscapes, and the City has devoted significant resources to the Whole Farm Program and the WAC CE Program.

While this prominent role of agriculture in the local economy continues, agriculture, and dairy farming in particular, has been in decline in recent years. An examination of data from the USDA's Census of Agriculture, conducted every five years on a county-wide level, portrays a consistent downward trend in agriculture for counties in the watershed as well as other nearby counties:

Table 9: **Agricultural Data by County, 1997, 2002 and 2007** [5]

	------- Number of Farms -------			--- Average Farm Size (acres) ---		
County	**1997**	**2002**	**2007**	**1997**	**2002**	**2007**
Delaware	848	788	747	231	243	222
Greene	292	342	286	176	169	155
Schoharie	600	579	525	194	195	182
Sullivan	383	381	323	159	167	156
Ulster	500	532	501	149	157	150
Counties outside the watershed						
County	**1997**	**2002**	**2007**	**1997**	**2002**	**2007**
Broome	627	588	580	150	167	149
Chenango	977	960	908	202	198	195
Columbia	545	498	554	219	240	192
Otsego	1,023	1,028	980	214	201	180

Looking exclusively within the watershed, land coded agricultural[6] using the town assessment data for the WOH has declined from 123,000 acres in 1998 to approximately 88,000 acres today[7].

4. Residential Development Trends - As shown in Table 8, residential development comprises over 314,000 acres in the WOH District, making it the most common private land use on an acreage basis. Given national and regional socioeconomic and land use trends, residential development is currently the primary land use to which vacant lands in the watershed are converted. LAP fair market value appraisals confirm this, in that residential use is consistently listed as the "highest and best use" for almost all watershed land. For these reasons, an understanding of the patterns of residential development in the watershed is important for acquisition planning.

Some town assessment rolls contain the "year built" for each residential lot. This data can be used to evaluate the pace and characteristics of residential development over time. The 2008 town assessment data, as provided to the NYS Office of Real Property Services, shows 15 WOH towns with year-built data for 85 percent or more of the residential parcels.[8]

Table 10: **Median Parcel Size over Time for Residential Lots by County, Sample Towns**

County	**Year Built**	**Number of Residences Built**	**Median Size (acres)**
Delaware (4 Towns)	Before 1960	2,647	0.5
	1960 to 1969	473	1.8
	1970 to 1979	790	3.7
	1980 to 1989	1,225	5.6
	1990 to 1999	442	5.9
	2000 or later	370	7.2

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[5] US Dept of Agriculture, 2002 and 2007; data is for entire county, including portions outside the NYC Watershed.
[6] Property Use Codes 100 through 189, NYS Office of Real Property Services.
[7] Agricultural land in 2008 includes 74,812 acres per assessor's code (see Table 8) plus most, but not all of the land currently in WAC CE's. Approximately 80 percent or 13,200 acres of the WAC CE lands are coded agricultural.
[8] The 15 towns are as follows: Andes, Kortright, Middletown and Walton (Delaware County); Ashland, Hunter, Jewett, Lexington, Prattsville and Jewett (Greene County); Neversink (Sullivan County) and Hurley, Olive, Wawarsing and Woodstock (Ulster County). In the remaining WOH towns, year built data is completely missing or available for less than 85 percent of the residential parcels.

Table 10: **(continued)**

County	**Year Built**	**Number of Residences Built**	**Median Size (acres)**
Greene (6 Towns)	Before 1960	2,238	1.0
	1960 to 1969	498	1.1
	1970 to 1979	1,012	1.1
	1980 to 1989	1,575	1.3
	1990 to 1999	564	3.2
	2000 or later	791	2.6
Sullivan (Town of Neversink)	Before 1960	314	2.6
	1960 to 1969	188	2.0
	1970 to 1979	213	2.1
	1980 to 1989	218	2.2
	1990 to 1999	127	3.3
	2000 or later	87	4.1
Ulster (4 Towns)	Before 1960	1,219	1.7
	1960 to 1969	309	1.3
	1970 to 1979	415	2.0
	1980 to 1989	391	3.1
	1990 to 1999	169	3.9
	2000 or later	154	4.3

The data from these 15 towns provides a representative sample to evaluate both the timing and size of land parcels devoted to residential use. Two trends are clear:

- The median size of residential lots has increased over time, particularly since 1990. This trend reflects the increased proportion of residential construction for second homeowners, and development activity skewed away from traditionally denser hamlet areas; and
- The volume of residential development since 1990 has moderated from the levels seen in the 1960's, 70's and 80's.

Both of these trends support the observation that the strong real estate market in recent years has not resulted in large-scale subdivision activity as was often the case in previous decades.

Section V – Long-Term Plan Goals

This Long-Term Plan covers the ten-year period from 2012 to 2022. As discussed in Section III, LAP acquisitions since 1997 have increased protected lands in the Cat-Del System from 24 percent to 34 percent of the system land area. More importantly, the spatial distribution of those protected lands, which are disproportionally found in the terminal reservoir basins of the Cat-Del System, provide a firm foundation for LAP's efforts over this coming ten-year period.

This Plan was developed through a careful evaluation of program activity, regional land use and economic trends, as presented above, with input from other stakeholders, including the City's regulators, local elected officials in the watershed and the environmental community. As a result of these evaluations and input, five specific goals have been identified:

1) Continue LAP's proven real estate methods that have resulted in the acquisition of over 96,000 acres in the Cat-Del System since 1997.

Since 1997, LAP and WAC have acquired over 1,150 parcels using the real estate and planning methods described in Section II. These methods, continued through 2022, can be expected to yield additional acreage of protected lands, with a continuing emphasis on preserving lands with a high water quality protection value.

2) Increase the percentage of protected lands in the Cat-Del System as a whole, with a particular emphasis on:

- **Non-terminal reservoir basins with less than 30 percent protected lands;**
- **Specific sub-basins with a relatively low percentage of protected lands; and**
- **Reservoir basins that are expected to provide larger contributions to future water supply.**

While widespread solicitation over the period from 2012 to 2022 is sure to increase the percentage of protected lands system-wide, specific basins and sub-basins merit focused solicitation efforts based on some combination of their location within the system as a whole, the basin or sub-basin's level of protection, and a basin's anticipated contribution to future water supply. These "Areas of Focus" are identified in Section VI, along with specific strategies that will concentrate LAP and WAC acquisition efforts on these areas.

3) Develop parcel selection procedures to maximize the water quality benefit of acquisitions.

LAP is committed to soliciting parcels whose acquisition provides the maximum possible water quality benefit relative to other parcels. This can be accomplished through a combination of regional strategies, such as focusing on under-protected basins and sub-basins, as well as parcel-specific considerations.

The parcel ranking system that has served as a general guide to parcel selection in the non-terminal basins (see Section II.C.3, page 4) will be augmented by incorporating a new GIS stream network, expected to be completed in 2011. This new layer, to be developed using a high resolution LiDAR-generated[9] topographic model, should provide a more accurate and complete stream network for input into the ranking process. Development potential will also be more fully incorporated into the ranking system through the addition of a new road frontage factor.

Parcel selection under this Plan will primarily consist of iteratively evaluating the 375,000 acres already solicited but not yet acquired, since few of the remaining unsolicited acres merit pursuit. The ranking system will be used in conjunction with the regional Areas of Focus to prioritize LAP efforts to acquire a significant portion of these remaining solicited acres.

[9] LiDAR, or Light Detection and Ranging, is a laser-based remote sensing technology that can be used to develop high resolution terrain models.

4) Build on our existing programs to promote City Lands as a working landscape in partnership with local communities.

Many local communities have consistently expressed how important recreational access, forestry and agriculture are to their local economy, which has historically been focused on these land-dependent activities. Under the MOA, the City committed to consider recreational access for lands acquired in fee simple. Since 1997, DEP has expanded the use of City fee lands that support local economic vitality while maintaining its obligation to protect water quality. Increased recreational access, in partnership with DEC, has been at the forefront of these changes.

These efforts have gained a measure of acceptance, even among traditionally skeptical communities in the West-of-Hudson watershed. The City's continued commitment to expand the use of City lands holds the potential to further improve community support for land acquisition, which can bolster the City's acquisition efforts through 2022.

5) Develop strategies to promote the wise use of acquisition funds over the long-term.

As shown in Table 2 (page 7), acquisition costs vary tremendously within the Cat-Del system. Further, the high cost areas (Kensico, West Branch and Ashokan, in descending order) correspond in large part to the basins that now have the highest percentage of protected lands. Therefore the incremental protection value of acres acquired in the less-protected basins WOH is higher than the value of acquiring acreage in more expensive, highly protected basins. For these reasons, LAP's parcel selection strategy will more directly consider cost and levels of protection.

LAP is still committed to pursuing the acquisition of compelling parcels – those with significant development potential in close proximity to surface water features – wherever they are found. However LAP does not intend to focus on acquisition of properties in higher-valued basins if those properties have limited development potential and/or are in less sensitive locations with respect to water quality.

Section VI – Strategies to Achieve these Goals

The five goals outlined above will be implemented using solicitation and project design strategies that will vary by region and property type. Those strategies are outlined below. Section VII provides basin-specific plans for the application of these strategies.

A. <u>Areas of Focus</u>

Areas of Focus have been developed to identify basins and sub-basins which warrant additional attention for solicitation based on current levels of protection, success rates, contribution to water supply and other factors.

1. **Less-Protected Reservoir Basins -** The Schoharie, Pepacton and Cannonsville basins are the largest basins in the Cat-Del System, together comprising some 720,000 acres or over 70 percent of the system land area. They contain about 75 percent of the remaining solicited land. For this reason, any acquisition strategy from 2012 to 2022 will necessarily be focused on these three basins. The fact that these three non-terminal basins also contain the lowest percentage of protected lands (as shown in Figure 6 and Tables 5 and 6) provides further justification for this focus.

2. Critical Sub-Basins - Each reservoir basin is comprised of discrete sub-basins whose location, topography and land use patterns vary in ways that greatly influence the water quality leaving each reservoir. LAP has identified several categories of sub-basins whose characteristics merit heightened focus:

a. ***Sub-Basins Near Intake -*** Sub-basins which drain directly into a reservoir near intakes[10] are particularly sensitive because an inflow of pollutants from even a small sub-basin at these locations can have a large impact on the overall quality of water leaving the reservoir. This factor, identified by the City through study of the Malcolm Brook sub-basin at the Kensico intake, was reflected in the Priority Area 1A designations for basins within 60-day travel time. LAP plans to extend this concept to specific sub-basins in Priority Areas 3 and 4.

As shown in Section III.B.3, LAP has had particular success in raising the level of protection in several of these areas, including Rondout 1A and the sub-basins near Schoharie Reservoir. In other basins, such as Pepacton and Cannonsville, sub-basins near intake have had low success rates. The latter sub-basins merit careful attention, and LAP will develop specific strategies, as further discussed in Section VII, to improve our success rates in these areas.

b. ***Less-Protected Sub-Basins –*** While basin-wide protection levels provide a useful tool to evaluate system-wide progress, the distribution of protected lands on a sub-basin level reveals patterns masked at the basin level. As shown in Figure 7 (page 31), sub-basins with less than 20 percent protected lands are primarily located in the Pepacton and Cannonsville Basins. In cases where these sub-basins are also located near intakes (such as the Tremper Kill, Bryden Hill and Bryden Lake sub-basins north of the Pepacton Reservoir), protection efforts are particularly critical.

3. Contribution to Future Supply - The LAP Priority Areas emphasize travel time to distribution as a primary concern for water quality protection. The success of LAP to date in increasing protected lands in Priority Areas 1 and 2 allows us to add additional factors going forward to prioritize future acquisitions to build on this success. One such factor is the proportion of source water originating from each reservoir basin.

Basin size, meteorological factors and topography combine to endow each basin with a base annual flow, but the vast size and configuration of the Cat-Del System provide DEP with flexibility in determining the day-to-day mix of basin sources to meet daily supply needs. Bureau of Water Supply (BWS) Operations staff take advantage of this flexibility to meet multiple objectives including water quality, reserved storage for drought protection and mandated downstream releases. Historical contributions to supply in the Cat-Del System are presented in Table 11.

Long-term planning by BWS has identified several trends which will influence future supply rates. These trends, including turbidity control measures for the Catskill System, improved water quality

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[10] *Intakes* are the point where water leaves the reservoir and enters an aqueduct for transport towards distribution.

in the Cannonsville Basin and the pending completion of the Croton Filtration Plant will result in supply shifts that should be taken into consideration in planning LAP's solicitation strategy. As shown in Table 11, the Ashokan and Pepacton basins will continue to provide the most supply, with increased projected for Rondout, Cannonsville and especially the Ashokan basin (highlighted in **blue**).

Table 11: **Historical and Projected Future Contributions to Overall Supply**

System	Reservoir	Historical Average Contribution 1992 to 2008 (mgd)		Projected Future Contribution under Modified Reservoir Operations[11]	
Delaware	Cannonsville	52,629	**(11.9%)**	48,655	**(12.4%)**
	Pepacton	116,631	**(26.3%)**	88,685	**(22.7%)**
	Neversink	44,447	**(10.0%)**	31,795	**(8.1%)**
	Rondout	43,480	**(9.8%)**	48,366	**(12.4%)**
	West Branch	19,770	**(4.5%)**	10,534	**(2.7%)**
Catskill	Schoharie	67,734	**(15.3%)**	54,183	**(13.9%)**
	Ashokan	92,298	**(20.8%)**	102,047	**(26.1%)**
	Kensico	6,876	**(1.5%)**	6,589	**(1.7%)**

In practice, these three Areas of Focus (Less-Protected Basins, Critical Sub-Basins and Contribution to Future Supply) overlap to some degree. For example, the sub-basins north of Pepacton Reservoir qualify in all three categories and therefore will be Areas of "High" Focus, while certain sub-basins in Schoharie Basin that already have a high percentage of protected land only qualify on the basis of one factor (Less-Protected Basins) and will receive less focus.

B. Property-Type Strategies

As discussed above, LAP expects to continue to re-solicit most of the 375,000 acres of solicited land not yet acquired. The vast majority of these solicited parcels are comprised of vacant land over 20 acres in size or residential parcels over 30 acres with slope or surface water features that merit protection for water quality protection. However some marginal parcels previously solicited will not be actively pursued, and some new lands will be solicited, according to the criteria detailed below:

1. Parcels Adjoining Previously-acquired Land – Parcels adjoining lands acquired in fee simple should continue to be identified and solicited to support multiple program objectives, including management efficiency, increased utility for working landscape partnerships and recreational opportunities. The importance of these program objectives will result in the solicitation of some connecting parcels that would not otherwise merit consideration based solely on water quality criteria. The identification of these parcels will be continually updated as new acquisitions occur.

2. Smaller Vacant Parcels in Proximity to Surface Water Features – The Cat-Del System includes over 1,000 vacant parcels of between 10 and 20 acres, taken alone or in small assemblages. On one hand, many of these lots lack the steep slopes or proximity to streams associated with significant water quality impacts. However other small lots, especially those in

[11] *Projected Future Contribution* evaluated using the BWS OASIS model and is subject to change. Total Cat-Del diversions in these projections are lower than in the 1992 to 2008 data due to a projected increase in the use of Croton System supply upon completion of the Croton Filtration Plant.

proximity to streams, merit protection. Program experience since 1997 has also shown that the management burden of smaller fee lots is relatively minimal, particularly compared with CEs. For these reasons, LAP will identify more small lots near water for solicitation, particularly in Areas of Focus. This strategy will enable LAP to maximize the water quality impact of its acquisitions.

3. **Conservation Easements** – In contrast to fee simple acquisitions, CEs require a significant ongoing dedication of resources for annual monitoring and occasional enforcement. Despite these long-term costs, CEs provide a unique tool to protect lands (particularly those with residences) whose owners are not interested in selling their land outright. Under the Long-Term Plan, CE guidelines will include an assessment of the natural features criteria, development potential and location of the proposed CE in the context of the regional protection goals discussed above:

a. ***Properties in well-protected Basins and Sub-Basins*** – In locations where protected lands already comprise a high percentage of the basin and/or sub-basin area, potential CE's between 75 and 100 acres will be evaluated to ensure that their development potential and proximity to surface water features merit proceeding with the acquisition;

b. ***Properties in Areas of Focus*** **–** LAP will develop guidelines to acquire smaller CEs (under 75 acres) in less-protected basins and sub-basins, particularly where land use patterns result in a higher degree of landowner interest in CEs in comparison to fee simple acquisition. In **Areas of High Focus**, such as the sub-basins north of the Pepacton Reservoir in Andes and Colchester, smaller parcels will be more likely to be pursued than in other areas; and

c. ***Compelling Properties*** **–** LAP will continue to pursue CEs on properties over 100 acres with significant development potential and proximity to surface water throughout the watershed.

Size, natural features, development potential and location will be the primary programmatic criteria used to make decisions to pursue a particular CE, but other factors will continue to be considered although in ways that may vary from past practice depending on the level of protection in a given area. These factors include the size and configuration of tax parcels comprising the CE, the presence or absence of other CE's on adjoining or nearby lands, and an analysis of the landowner's stated plans for future use of the property.

C. <u>Solicitation Procedures</u>

Under the Long-Term Plan, LAP will modify certain solicitation procedures at the margins to achieve the goals identified above, particularly regarding acquisitions in Areas of Focus and cost-benefit analysis. Under these new procedures, some parcels previously solicited may no longer be pursued, and in other cases new properties will be identified for solicitation:

1. Continue to Solicit Significant Parcels Throughout the Cat-Del System – The revised parcel ranking system and qualitative review will be used to clearly identify properties throughout the Cat-Del System that have a combination of significant development potential and a water quality sensitive location. As discussed below, these properties will be solicited on a regular basis.

2. Develop Variable Solicitation Schedules – LAP will fine-tune its overall solicitation schedule to support the priorities identified in this Plan. Since the start of formal re-solicitation in 2005, efforts to re-contact landowners have varied based primarily on the result of the most recent solicitation. Thus LAP has reviewed previous "Offer Refused" properties annually, re-contacted "Non-Responders" every two years and re-contacted "Owner Not Interested" parcels every five years. Under the Long-Term Plan, these procedures will be replaced with solicitation schedules that reflect the Plan's new priorities:

a. ***Re-Solicit every one to two years***
   i. Parcels in Areas of High Focus
   ii. Significant Parcels
b. ***Re-Solicit every two to three years***
   i. Other parcels in Areas of Focus
c. ***Re-Solicit every four years***
   i. All other parcels

3. Owner Initiated Contacts – Historically, about 30 percent of land is solicited as a result of owner-initiated contacts. These "call-ins", which can occur on previously-solicited lands or "new" lands, have a high success rate due to owner motivation. LAP will seek to develop policies to encourage landowner-initiated contacts and will evaluate these properties in accordance with the strategies discussed above. Owner contacts on land not previously solicited will continue to be evaluated on a case-by-case basis, and are expected to result in a significant number of acquisitions.

D. <u>Other Program Components and Improvements</u>

The discussion above has primarily focused on solicitation and project design strategies that will govern LAP over the period covered by this Plan. A number of additional program features will impact how the Long Term goals identified in Section V are achieved:

1. Ongoing Discussions to Expand Designated Areas – The Coalition of Watershed Towns (CWT) challenged the increase in LAP funding under the 2007 FAD, substantially beyond the $300 million level agreed to by the parties to the MOA, through litigation, among other contexts. In an effort to resolve the CWT's objections, and to seek input from interested parties as anticipated by the FAD prior to its application for a new WSP in 2010, the City has engaged in ongoing negotiations with the CWT, Delaware County and other stakeholders. The primary emphasis of these negotiations to date has been to expand the geographic extent and rules governing "Designated Areas" as defined in MOA Paragraph 68. Under the MOA, West of Hudson towns were given the opportunity to identify these Designated Areas, including villages, hamlets, village extension areas and industrial/commercial areas, and to determine, by resolution, whether to exclude the City's acquisition of property in fee simple in these areas. The intent of the Designated Areas was to "…provide reasonable opportunities for growth in and around existing population centers."

In the current negotiations, the CWT requested and the City has tentatively agreed that each WOH town could identify additional "Expansion Areas" for future growth. The parties have agreed that such expansion areas are appropriate given the relatively small size of the MOA Designated Areas (which are already largely developed) and the increased scope of LAP. In addition, the City and the CWT have tentatively agreed, subject to acceptance by the regulatory agencies, that these Expansion Areas would be off-limits to all LAP acquisitions (including City and WAC CEs), not just to fee simple purchases as was previously the case.

As of this writing, 17 watershed towns have proposed Expansion Areas totaling about 39,000 acres. The City, together with the State, EPA, and several environmental groups have worked diligently with CWT, the watershed counties, and individual towns to balance community concerns with water quality protection needs in determining the appropriate scope of each town's proposal. Currently the parties have agreed on the location of Expansion Areas in nine towns which have proposed 8,000 acres, while discussion is continuing on another eight towns whose current proposals total about 31,000 acres.

While a number of issues besides the specific Expansion Area proposals remain to be agreed on, the parties are optimistic that an agreement can be reached. The City is confident, based on the outline of this tentative agreement, that LAP can meet its regulatory commitments amid a renewed spirit of cooperation and partnership with local communities.

2. WAC Conservation Easement Program – The discussions in Sections II through IV have clearly highlighted the importance of agriculture to the landscape and economy of significant portions of the WOH District. The WAC CE Program provides critical support to farming in the watershed while protecting these sensitive lands from the potential impact of non-farm development. The EPA and DOH have recognized the importance of the WAC CE Program by requiring a series of increases in funding by the City, from the initial commitment of $20 million in the MOA to $70 million today. This level of funding is expected to ensure that the program can continue its current success and have adequate resources to meet the expected level of demand for CEs in the future.

As a part of this Plan, the City and WAC have identified several areas where the Program can be enhanced:

a. ***WAC Governance Procedures*** – In accord with comments from the City and local stakeholders, WAC has initiated a comprehensive review of its internal governance procedures in areas including board composition, voting procedures, transparency and dispute resolution. This review is expected to be completed soon, and promises to streamline WAC operations and strengthen local partnerships.

b. ***Database and GIS Upgrades*** – WAC has hired an outside consultant to develop an integrated database and GIS system which promises to improve planning, communications and record-keeping within WAC and with its partners, including local Soil and Water Districts and the City.

c. ***Coordinated Solicitation Planning*** **–** The City and WAC are committed to developing an improved solicitation framework that will allow WAC solicitations to directly complement the City's solicitation plan and to support the goals in this Plan.

d. ***Small Farms*** – LAP and WAC have had ongoing discussions aimed at closing a program gap focused on small-scale farm operations. In recent years a number of small specialty farms have been established in the watershed. In some cases the size and nature of the small farms do not fit well into current program parameters for either WAC or City CEs. WAC and the City will pursue modifications to fill this gap.

3. Land Trust Initiative - The 2007 FAD requires the City to "substantially increase the use of land trusts and other non-government organizations to identify and help the City acquire eligible lands", and to prepare a strategy that outlines the City's plans to do so. Accordingly, DEP issued its Land Trust Strategy in November 2007, as well as a 2008 annual summary of efforts taken in accordance with the Strategy. Of the program areas described in those documents or subsequently pursued, those that are the most promising for long-term implementation at this time appear to be:

a. ***Solicitations of landowners by land trusts*** - One land trust has been engaged to solicit 30 non-responsive landowners in the West Branch basin, and a second has stated an interest in doing so in the Ashokan basin. The goal is to convert non-responding landowners into sellers.

b. ***Acquisitions by land trusts of properties to be conveyed to DEP*** - A number of "pass-through" transactions have been successfully completed and/or signed to date, and this process is expected to continue to generate roughly one or two successful projects per year.

c. ***Acquisition of conservation easements by land trusts*** - Some landowners may be willing to encumber their land with CEs if a land trust, rather than the City, is the "grantee" (owner and long-term monitor and enforcer of the CE). The City is aware of two such instances, and is working with a land trust to develop a process through which City funds could be used by the land trust to acquire CEs for long-term ownership and stewardship – pursuant to the City's MOA and FAD obligations.

d. ***Strengthening of land trust capacity*** **-** The City has developed a process to offer financial support for events and forums that are hosted by land trusts in the watershed. These events are designed to increase landowner interest in selling real property interests. The City is also seeking other such ways to strengthen land trust capacities to work in the watershed. The City will continue to pursue development of this area, with the long-term goal of increasing landowner awareness of and interest in land protection options.

e. ***Support of watershed, aquifer, and well-head protection plans by local municipalities*** **-** The City continues to explore opportunities to fund technical assistance and land acquisitions by local governments. The result would be land that is protected using City funds, but owned and managed by local municipalities.

All of these pending program areas appear likely to result in permanent protection of lands that would otherwise not be protected, which is the over-arching goal for developing partnerships with land trusts. Given this prospect of success, DEP will continue to work on developing and strengthening such relationships and programs with land trust partners.

4. Conservation Easement Language - The language that comprises the deed of conservation easement is critical to landowner acceptance of the City's CE program. To date more than 100 landowners have sold over 16,000 acres of easements to the City, with many more being actively negotiated. This success can be attributed in part to the City's efforts to revise language over time in order to find a balance between landowner acceptance and defensible protection and enforcement provisions. Since 1999 (when the first model easement document was finalized), certain language improvements have been made; the following are just a few examples among many:

a. Language pertaining to activities within building envelopes (which contain residential uses) was highly restrictive in the first model easement, and has been relaxed to include only minimal restrictions.

b. In situations where a property is both under a DEP easement and enrolled in any NYS DEC-managed forestry program, language has been revised to reduce potential conflicts, thereby allowing landowners to avoid penalties that DEC might otherwise be required to issue for non-compliance with harvest or management plans.

c. Agricultural use was prohibited in early versions of the City's CE, but after recognizing that many landowners wished to engage in small-scale gardening or to maintain a few domesticated animals, the model CE was revised to allow certain farming uses "as-of-right on" areas smaller than ten acres. This revision was made in consultation with WAC in order to ensure that both CE programs remained coordinated.

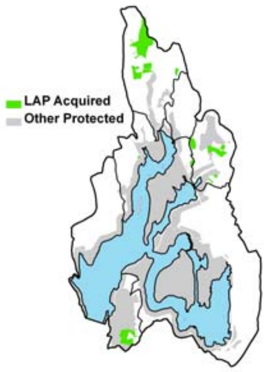
Thus, success of the City's CE program – like other such CE programs – has depended in large part on careful balancing of the needs of both the City and the landowner. Further refinements of terms are being considered as of the writing of this Plan, and such evolution of language can be expected to continue during the period covered by this Plan.

5. Landowner Outreach and Public Relations – As a transaction-driven program, the success of LAP depends in large part on landowner perceptions and the information they receive regarding LAP and the NYC watershed. Efforts to improve LAP's communications strategy can result in a greater volume of landowner-initiated solicitations, which historically have a much higher success rate than City-initiated contacts. Another goal of our communications strategy is to provide a counter-balance to enhance local press coverage. The following components of a success outreach strategy will be pursued:

a. Improved web-based outreach and information sources;
b. Utilization of land trusts in Education and Outreach;
c. Regularly-scheduled local meetings to present LAP to landowners; and
d. Greater use of print and broadcast media to reach watershed audiences.

Section VII – Basin Plans

A. Kensico Basin



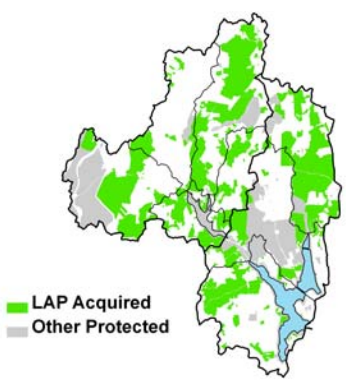
Overview:

Land Area:	6,406 acres
Acres Solicited:	1,072 acres
Acres Acquired:	207 acres
LAP Costs to Date:	$34,083,000
Success Rate:	19 %
Protected Land (City, State, Other)	41 %
Comparative Costs:	Very High
Predominant Land Uses:	Suburban Residential Office / Institutional

Kensico, the terminal basin of the Catskill System, is located in a densely populated suburban area of Westchester County barely 15 miles north of New York City. Very little undeveloped land remains available for acquisition. While acquisition of certain parcels with significant development potential is warranted, the City can best manage future water quality in this critical basin through targeted remediation programs such as non-point source programs, septic repair and waterfowl management. Specific acquisition strategies will include:

- *Pursue significant parcels near streams;*
- *Pursue partnerships with other private and governmental bodies to offset high acquisition costs; and*
- *Cease solicitation of small, isolated parcels and parcels distant from streams.*

B. West Branch / Boyd's Corner Basins



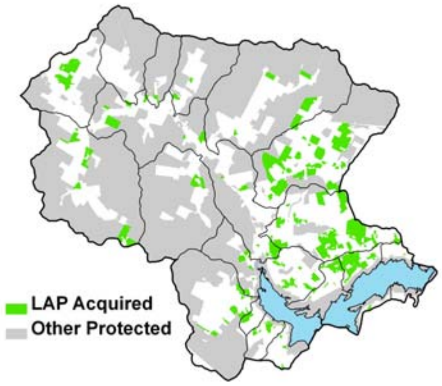
Overview:

Land Area:	25,830 acres
Acres Solicited:	14,834 acres
Acres Acquired in Basin:	8,338 acres
LAP Costs to Date:	$78,660,000
Success Rate:	56 %
Protected Land (City, State, Other)	47 %
Comparative Costs:	High
Predominant Land Uses:	Suburban Residential

West Branch Reservoir is the terminal basin of the Delaware System, and 50 percent of average daily supply flows through its intake. The basin is characterized by medium and low density suburban development and high acquisition costs. Since 1997 LAP has acquired over 32 percent of the basin land area. The remaining solicited lands include several significant properties and a number of smaller vacant or low-density residential lots. Specific strategies:

- *Continue pursuit of significant parcels; and*
- *Evaluate smaller parcels for adjacency, development potential and proximity to streams.*

C. **Ashokan Basin**



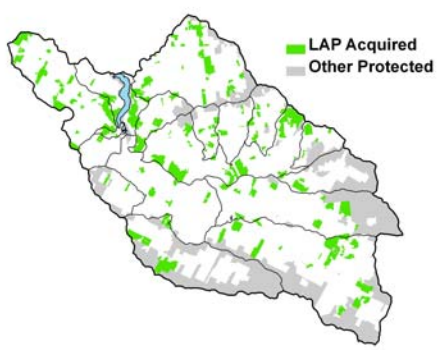
Overview:

Land Area:	155,299 acres
Acres Solicited:	46,716 acres
Acres Acquired:	10,952 acres
LAP Costs to Date:	$34,366,000
Success Rate:	23 %
Protected Land (City, State, Other)	65 %
Comparative Costs:	Moderately High
Predominant Land Uses:	Forested Rural
	Low-Density Residential
	Forest Preserve

Over 82,000 acres of state-owned Forest Preserve land give Ashokan the highest percentage of protected land of all basins in the Cat-Del System. The southeastern portion of the basin, in the towns of Woodstock, Olive and Hurley, comprise a strong market for low- and medium-density residential development. Ashokan provides over 20 percent of daily supply and has been the focus of significant study with regard to turbidity associated with native soils and storm events. Specific strategies:

- *Areas of Focus: Entire Basin (large contribution to future supply);*
- *Continue regular solicitation of most lands previously solicited; and*
- *Selectively reduce solicitation of dry, steep and isolated building lots.*

D. **Schoharie Basin**



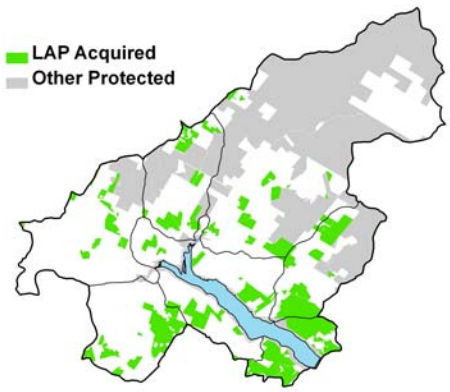
Overview:

Land Area:	200,895 acres
Acres Solicited (City):	95,777 acres
Acres Acquired (City):	19,001 acres
Success Rate (City):	20 %
WAC Acres Acquired:	843 acres
LAP Costs to Date:	$57,385,000
Protected Land (City, State, Other)	29 %
Comparative Costs:	Moderately High
Predominant Land Uses:	Forested Rural
	Ski-oriented Residential
	Forest Preserve

The eastern portion of Schoharie has experienced higher levels of development than found in most other parts of the West-of-Hudson due to proximity to the Thruway and several large ski areas. This growth has resulted in higher land values and an increasingly high LAP success rate. The southern portion of the basin includes a high percentage of State Land. Specific strategies:

- *Continue regular solicitation of most lands previously solicited;*
- *Areas of Focus: Entire Basin (less-protected);*
- *Areas of High Focus: Johnson Hollow Brook and Schoharie Creek sub-basins (less-protected sub-basins); and*
- *Tailor CE solicitation based on the level of protection in a given sub-basin.*

E. **Rondout Basin**



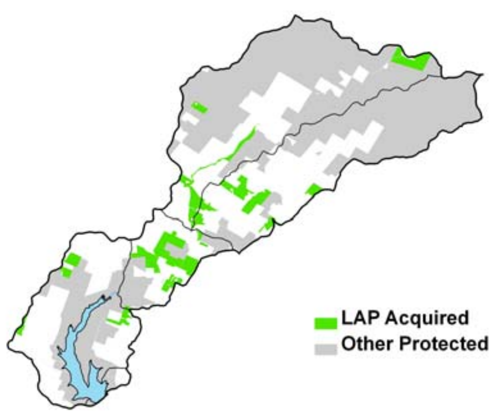
Overview:

Land Area:	59,003 acres
Acres Solicited (City):	30,379 acres
Acres Acquired (City):	6,290 acres
Success Rate (City):	21%
WAC Acres Acquired:	954 acres
LAP Costs to Date:	$14,373,000
Protected Land (City, State, Other)	48 %
Comparative Costs:	Moderate
Predominant Land Uses:	Forested Rural
	Low & Medium Density Residential
	Forest Preserve

Rondout is characterized by State Forest Preserve lands to the north, very low-density residential uses to the southeast and hamlet development in the Town of Neversink to the southwest. LAP has experienced a low success rate in the Town of Neversink, possibly due to expectations of new casino-oriented development opportunities in Sullivan County. Specific strategies:

- *Continue regular solicitation of most lands previously solicited;*
- *Areas of Focus: Chestnut Creek and Red Brook sub-basins (less-protected); and*
- *Implement higher thresholds for CE acquisition (size, development potential) in sub-basins to the north.*

F. **Neversink Basin**



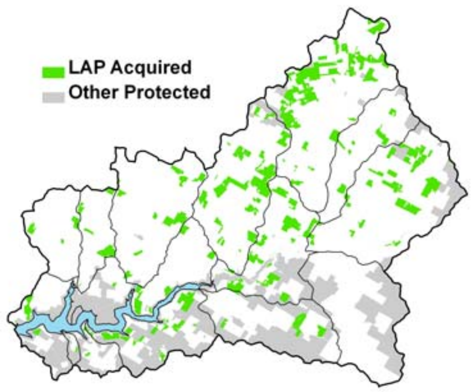
Overview:

Land Area:	57,410 acres
Acres Solicited (City):	22,147 acres
Acres Acquired (City):	3,229 acres
Success Rate (City):	15 %
WAC Acres Acquired:	508 acres
LAP Costs to Date:	$4,482,000
Protected Land (City, State, Other)	60 %
Comparative Costs:	Moderate
Predominant Land Uses:	Forest Preserve
	Institutional Open Space
	Low Density Residential

After Ashokan, Neversink boasts the highest percentage of protected land in the Cat-Del System, The headwaters of the East and West Branches of the Neversink River are largely comprised of forest preserve and large private forested lands, and the absence of any significant population centers results in superior water quality. Specific strategies:

- *Continue solicitation of most lands previously solicited; and*
- *Implement higher thresholds for CE acquisition (size, development potential).*

G. **Pepacton Basin**



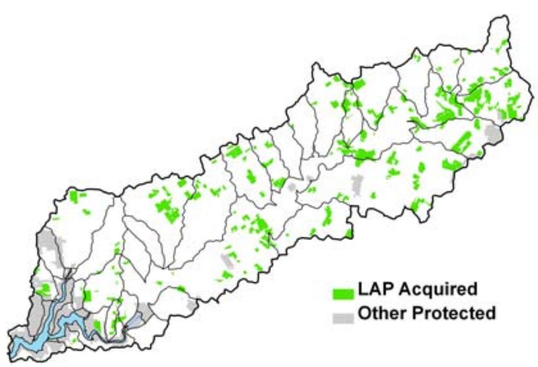
Overview:

Land Area:	232,276 acres
Acres Solicited (City):	121,590 acres
Acres Acquired (City):	18,531 acres
Success Rate (City):	15 %
WAC Acres Acquired:	2,481 acres
LAP Costs to Date:	$40,602,000
Protected Land (City, State, Other)	27 %
Comparative Costs:	Low
Predominant Land Uses:	Low Density Residential Agricultural Forest Preserve

The sub-basins south of the reservoir contain extensive state land holdings. To the east, medium and low density residential land predominates in Middletown. The sub-basins north of the reservoir in Andes, Colchester and Hamden are characterized by a high proportion of low density residential land. Specific strategies:

- *Areas of Focus: Entire Basin (less-protected, high contribution to future supply);*
- *Areas of High Focus: Sub-basins north of reservoir (near intake and low percentage of protected land);*
- *Continue solicitation of most lands previously solicited; and*
- *Implement higher thresholds for CE acquisition (size, development potential) in sub-basins south of the reservoir.*

H. **Cannonsville Basin**



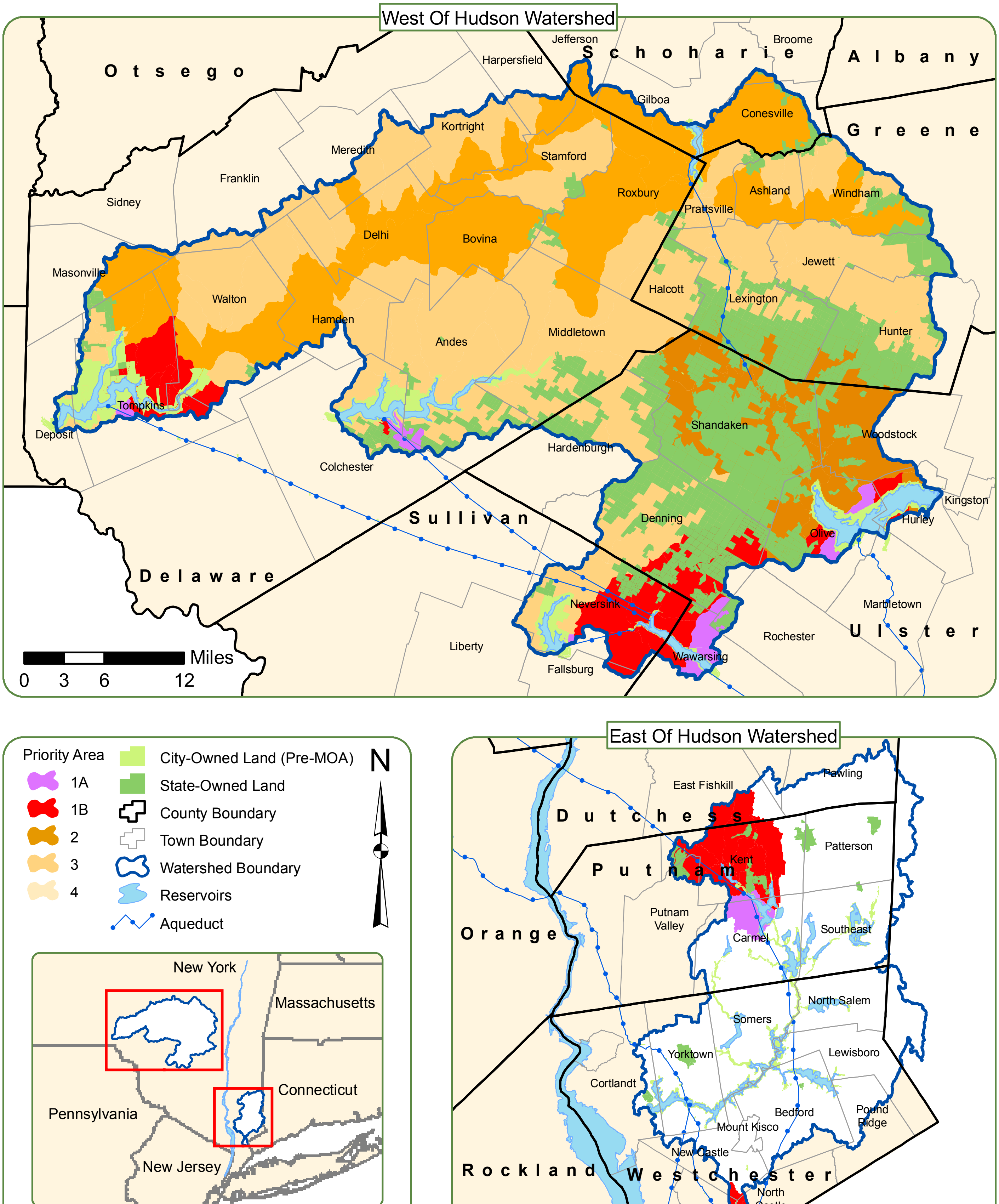
Overview:

Land Area:	286,377 acres
Acres Solicited (City):	142,624 acres
Acres Acquired (City):	12,791 acres
Success Rate (City):	9 %
WAC Acres Acquired:	12,168 acres
LAP Costs to Date:	$37,465,000
Protected Land (City, State, Other)	16 %
Comparative Costs:	Low
Predominant Land Uses:	Agricultural Low /Medium Density Residential

The Cannonsville basin contains the majority of agricultural lands in the Cat-Del System, as well as a number of larger villages and hamlets. In addition, State land comprises only 2 percent of the land, much less than other WOH basins. The LAP success rate (10 percent) is low, due to the more recent onset of LAP solicitation activity (compared to other basins) and low values. Cannonsville has been the focus of a number of successful water quality remediation programs, and as a result the use of its source water for future supply is projected to rise. Specific strategies:

- *Continue regular solicitation of most lands previously solicited;*
- *Areas of Focus: Entire Basin (less-protected, contribution to future supply); and*
- *WAC CEs will continue to play a critical role in land protection.*

Figure 1: Cat-Del System Priority Areas



Data Sources:
Mapped Features: NYC DEP GIS, 1999-2009
Produced by DLP, 9/1/09

Figure 7
Percent Protected Lands by Sub-Basin
West-of-Hudson District